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SUSTAINABLE AVIATION

The future is green



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Mobilising ambition: key to a sustainable future for aviation

Rannia Leontaridi

*Director General for Civil Aviation, Department for Transport,
United Kingdom, and ECAC Focal Point for Environmental matters*



While the aviation sector continues to suffer from the pandemic, climate change has not been put on hold. Vaccinations now provide us with hope of beating the pandemic, and it is our duty to look forward and focus on the next priority for aviation: to seize the initiative and steer the sector towards decarbonisation.

This 72nd edition of *ECAC News* provides a welcome overview of the already significant mobilisation of industry, States, and the scientific community towards a more sustainable future for international aviation. This provides evidence that the sector is more conscious than ever of the high expectations placed on it, including by customers and wider society. But we now need to move up a gear, in order to reach a historic commitment at the next ICAO Assembly, demonstrating that international aviation is and will remain both a pioneer and a responsible sector. This will be critical for future generations to continue to enjoy the many economic and social benefits of aviation.

You will read in this edition how States, regions, and the industry are increasingly committing to net-zero carbon emissions, including the welcome political determination of key ECAC partner States and regions. This is certainly cause for optimism, but it is unlikely alone to be enough. We need to fully understand and address the many remaining challenges, and seize further opportunities that lie on the way. I hope the articles here on hydrogen in aviation, e-fuels, and sustainable aviation fuels, as well as the scientific article on non-CO₂ impacts, will help each of us better identify the specific contributions we can make. These will have to take different forms. They will include policy measures to foster innovative technologies and exploit new sources of renewable energy. As well as pursuing industrial research and development, we

should continue to support scientific research – most notably on non-CO₂ impacts, given the possibility of new ‘win-win’ options which could bring welcome improvement to local air quality as well as reducing CO₂ and non-CO₂ impacts. You will also read about ECAC’s own work on environmental capacity building, helping Member States to better understand the challenges and take action accordingly.

Achieving global decarbonisation of aviation will require the mobilisation of all our efforts around the world towards a common goal, driving progress and innovation in one direction. To avoid the risks of fragmented or inconsistent policy measures, and to allow for large scale deployment of green sources of energy, international commitment is vital. Painsstaking work in ICAO towards a long-term aspirational goal for international aviation emissions, drawing on the best expertise worldwide, is to be commended. I also welcome efforts by ICAO and others to ensure we take an inclusive approach, including for example through the Global Aviation Dialogues (GLADs) this May. This process should allow for consolidation and sharing of best practices, help foster innovation, and give necessary visibility to the public. Just as importantly, it will enable us to more clearly identify and understand the priorities of partners in all regions of the world, in an endeavour to reach a strong agreement through constructive dialogue.

I would like to thank all the contributors to this edition of *ECAC News* and hope you find it an inspiring read!



A long-term goal for international aviation

Michael Lunter

Senior Policy Advisor, Ministry of Infrastructure and Water Management, the Netherlands, Chair of ECAC Environmental Forum and Co-chair of the European Aviation and Environment Working Group

► Background and objective

Following the global framework set out by the Paris Agreement of 2015 to avoid dangerous climate change by keeping global warming to well below 2°C and aiming to limit it to 1.5°C, countries and industrial sectors, including the international maritime and aviation sectors, continue to consider how they can contribute to the challenge of meeting these climate goals.

In 2019, in its Resolution A40-18, the ICAO Assembly repeated its recognition of the Paris Agreement and repeated the international aviation sector's global aspirational goals of improving fuel efficiency by 2 per cent per annum and of keeping the net carbon emissions from 2020 at the same level, by compensating and reducing all emissions beyond a set baseline. Resolution A40-18 also reaffirmed the important role of the industry and noted the industry's collective commitment to their long-term goal to reduce carbon emissions by 50 per cent by 2050 compared to 2005 levels, as agreed by the Air Transport Action Group (ATAG)⁽¹⁾ in 2009.

This time, however, and after intense and long deliberations, a paragraph was included in the resolution with the following text:

"Requests the Council to continue to explore the feasibility of a long-term global aspirational goal for international aviation, through conducting detailed studies assessing the attainability and impacts of any goals proposed, including the impact on growth as well as costs in all countries, especially developing countries, for the progress of the work to be presented to the 41st Session of the ICAO Assembly. Assessment of long-term goals should include information from Member States on their experiences working towards the medium-term goal;" (A40-18, par. 9).

During its 219th Session in March 2020, the ICAO Council took the decision to task the Committee on Aviation Environmental Protection (CAEP) with working on this feasibility by developing options (scenarios) for further consideration by the ICAO Council and to be brought to the 41st ICAO Assembly.

It is important to note that the text of the resolution is complemented with the Assembly report, and that specifically the Secretary General's closing remarks highlight developing options and an implementation roadmap as part of the feasibility.

The decision taken at the 40th ICAO Assembly has resulted in a list of various work items currently being addressed by the ICAO Secretariat, the Council and its sub-committees, such as CAEP, to:

- Facilitate the involvement of relevant stakeholders outside the aviation sector to collect all information needed to support the exploration of the feasibility of an LTAG.
- Ensure that the best expertise is available for the assessment of the data, for the development of scenarios and for the assessment of the cost and benefits of scenarios.
- Keep ICAO governing bodies informed and consulted during the process.
- Ensure a transparent and inclusive process when consulting with States.
- Provide a forum for the agreement of the possible options prior to the next ICAO Assembly.

(1) ATAG Air Transport Action Group: a not-for-profit association that represents all sectors of the air transport industry working together on long-term sustainability issues.

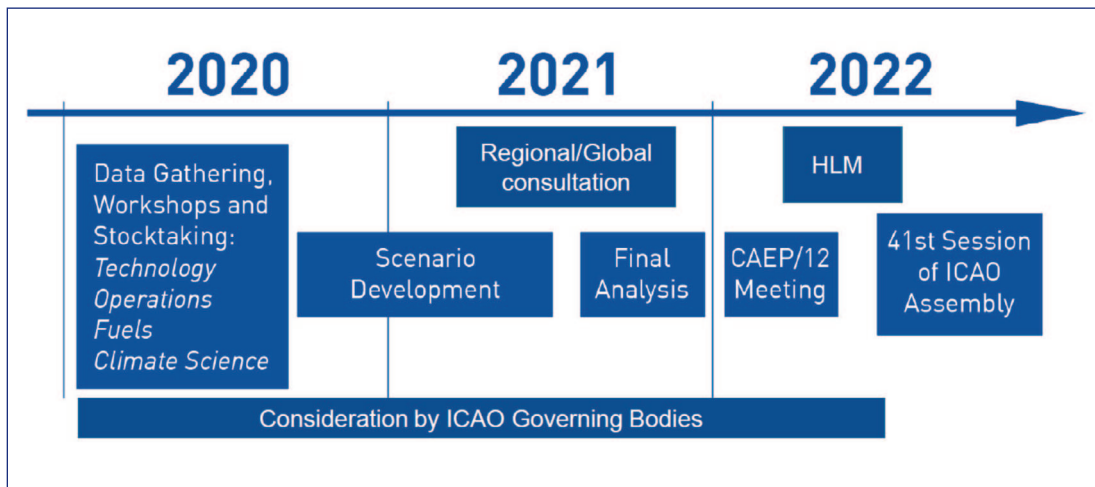


Figure 1: LTAG general work timeline (source: ICAO)

► The LTAG process and the importance of information exchange

With the clear target of delivering to the 41st ICAO Assembly, the work has to be conducted sticking closely to the general timeline presented in Figure 1 and which clearly illustrates the considerable pressure to deliver the results on time.

The results not only need to be ready for assessment by CAEP, but also need to be prepared for consideration by the 225th ICAO Council Session in February/March 2022. After this Council session, a High-Level Meeting (HLM) is foreseen in spring 2022 to discuss proposals and identify a direction that could form the basis for a resolution text which the Assembly could potentially reach an agreement on. In light of this, the 226th Council Session in June 2022 can be considered as a crucial session. Previous Assembly years, however, show that it is not uncommon to have additional Council sessions in the last weeks before the start of this triennial event.

Another element in the timeline is the data collection period. Where data are crucial, and despite the tight timeline, the data collection period was extended and became way longer than initially considered necessary. Continuing well into 2021, data are still coming in and in particular on innovative technologies and concepts; some of these are still in the very early stages of development. A key element was the challenge to engage with, and collect data from, stakeholders, who so far had not necessarily been part of the traditional industrial aviation partners ICAO has been working with over the past decades in setting standards.

In that sense, the LTAG process has already shown to have valuable trade-offs in terms of linking with a wide group of stakeholders in all areas, ranging from environmental science institutes to a variety of innovative industries. A stocktaking seminar on aviation in-sector CO₂ emissions reductions organised by

ICAO in September 2020 turned out to be an important source of information for the LTAG process, bringing together nearly 100 stakeholders and offering a wealth of information to be further considered in the LTAG process. In September 2021, a next stocktaking event is being planned and it could be very helpful in further shaping the narratives to accompany the options to be presented to the ICAO Council, the High-Level Meeting and finally the 41st ICAO Assembly.

At this point in time, with only a year and a half to go until the 41st ICAO Assembly, it is of utmost importance to keep all ICAO Contracting States informed about the progress and the discussions on potential scenarios arising from the data being analysed. To that end, ICAO will organise a series of global dialogues (GLADs) in May 2021 to provide an opportunity for all ICAO Contracting States to become familiar with the process and the intermediate results. An even more important element of these GLADs - and one that is very often a bit hidden - will be the chance for States to share their views and concerns about an LTAG.

A long-term goal for international aviation

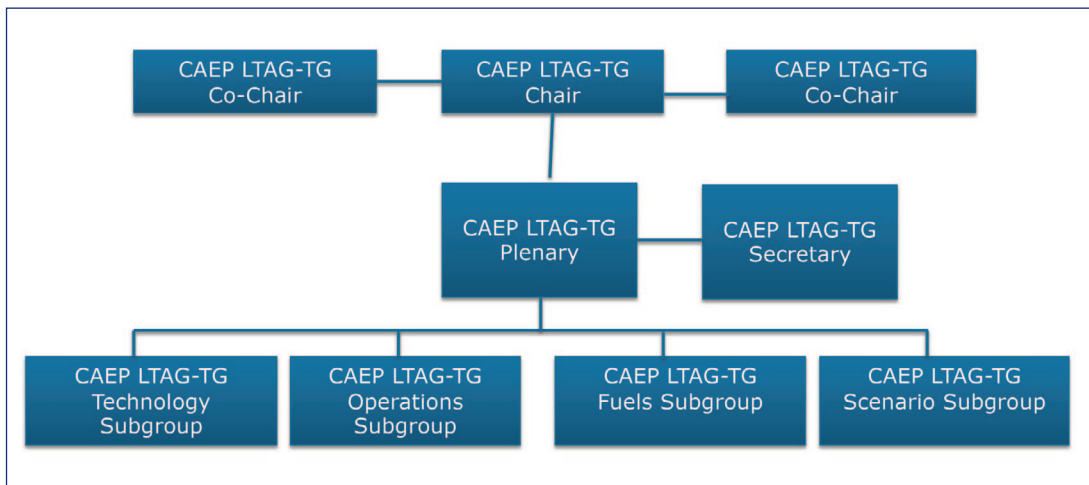


Figure 2: LTAG organisation (source: ICAO)

▶ LTAG process in CAEP

Most if not all of the technical work on the LTAG is conducted by CAEP. After being tasked by the Council to work on a long-term aspirational goal, CAEP immediately established the LTAG Task Group (LTAG-TG) and three subgroups. These subgroups look at the potential for CO₂ emissions reduction from developments in technology, in fuels and in operations. In mid-October 2020, a fourth subgroup was established to develop scenarios based on integrating the results of the other three groups. The organisational chart is represented in Figure 2. The way the governance has been established reflects clearly the wide global engagement in this process that ICAO is aiming for. The current leadership of the LTAG-TG and its four subgroups originates from nine different States.

Experts representing a wide variety of States, industry and civil society from around the world participate in the four subgroups, making up a total of close to two hundred experts. These experts were nominated by their respective CAEP member but, as in the process of developing CORSIA, experts who are not directly affiliated

with one of the CAEP members or observers also participate and contribute largely to the process.

The LTAG work started just after the COVID pandemic had found its way to nearly every corner of the world, affecting the aviation sector at all levels. Given that the task in itself is complex enough, this situation further increased the challenges to the global cooperation of the experts. To a varying extent, the problems encountered are the potentially limited availability of industry representatives, their limited access to (confidential) information because of having to work from home, the long virtual meetings sometimes very early in the morning or late at night because of time differences, and the total lack of in-person working sessions that have always been fundamental to the work of CAEP, enhancing the efficiency and the quality of the work. While the idea of compromising on the quality of the work is virtually non-existent, an impressive schedule of weekly and fortnightly sessions with the various task groups has been taking place, complemented by regular coordination meetings with the co-leads and online plenary sessions with all

involved experts. Now, at the end of March 2021, the work is at an important junction in the process.

Based on nearly a year of collecting information and data on technologies and measures at a varying level of disaggregation (engine, aircraft, airports, biomass for fuels, etc.), three integrated technology scenarios have been identified. A reference scenario can be described as the so-called “frozen technology” consisting of the currently used certified aircraft using conventional jet A-1 fuel, where infrastructural changes are just to accommodate the growth of current technology. To describe improvements to this system, three integrated technology scenarios are considered: advanced conventional technology, revolutionary technology and transformational technology. The latter referring to substantial changes including energy transition and related concepts. For each of the integrated scenarios, their development paths, costs and (most important) CO₂ reduction potential will now be further analysed and elaborated into scenarios. These scenarios will finally form the basis for options for a long-term aspirational goal for CO₂ emissions from international aviation.

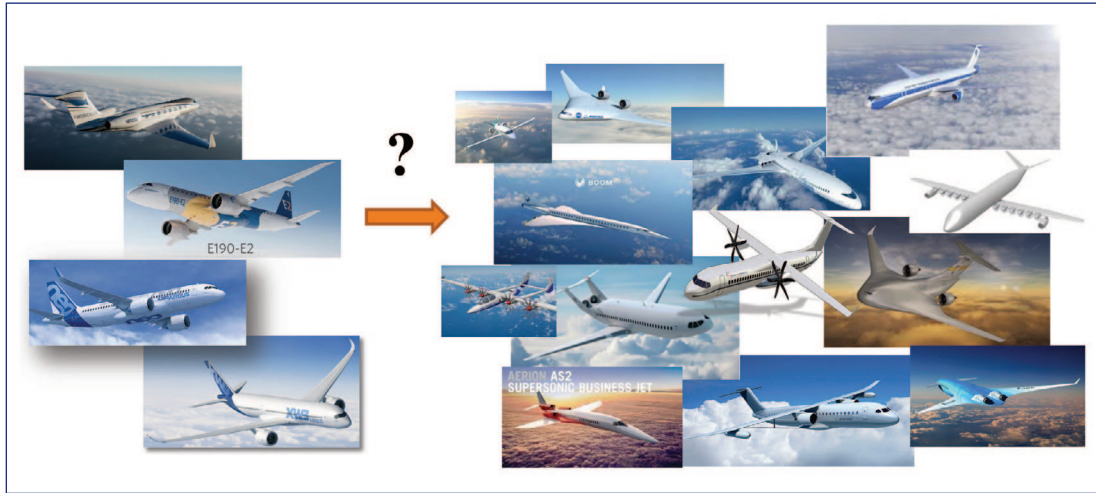


Figure 3: Aircraft under consideration (source: ICAO)

▶ ECAC involvement and perspective towards 2022

The participation of experts from around the world is crucial for a successful outcome of this process. Also, in previous processes, early engagement in the technical work in CAEP has proven to be extremely valuable ensuring that all relevant information remains available throughout the process. Similarly, based on the experiences in recent years with the development of certification standards and CORSIA, ECAC has proven to play a key role in mobilising expertise and providing a platform for States and stakeholders (industry and NGOs) to exchange information and discuss and prepare for the global debate.

A good example is the ECAC Environmental Forum, which was held in January 2021 and presented

a wealth of information on climate science, sustainable fuels and many other topics on sustainable aviation with relevance to the LTAG process. It brought together not only experts from the ECAC community, but also a number of representatives from Africa, Asia, the Middle East, North and South America.

Under the flag of the European Aviation Environment Group (EAEG), the European experts engaged in the LTAG-TG work regularly exchange views on how best to assist the LTAG work with data input and methodological proposals to contribute more actively. Currently, the EAEG involves all ECAC Member States in the discussion in the LTAG scenario development group on

defining scenarios and to prepare for the debates that will continue to take place at all levels throughout 2021 and beyond.

It goes without saying that 2022 will be a very important year for international aviation and for ICAO. Not only will there be an anticipated recovery of the sector from the effects of the measures taken because of the COVID pandemic, but it will also be a year in which the LTAG, the first periodic review of CORSIA, and States' action plans will need an integrated approach prior to the 41st ICAO Assembly. At the end of this year, the UNFCCC COP26 could play a key role by increasing awareness of the importance of carbon neutrality, and even more importantly establishing the commitment to a decision on a long-term aspirational goal for CO₂ emissions from international aviation. ■

Since 2007, **Michael Lunter** has been working in the field of sustainable aviation in what is currently called the Ministry of Infrastructure and Water Management in the Netherlands. Before entering the aviation world, he worked on a number of environmental topics in the field of legislation, inspection, consultancy and in various private companies and governmental organisations, including the European Commission. In 2012, he took over as member for the Netherlands of the ICAO Committee on Aviation Environmental Protection (CAEP), and since 2013 he has played a role as (co-) chair of the ECAC Environmental Forum and the ECAC European Aviation Environment Group (EAEG) and their preceding groups. In CAEP he participates in WG3 (Emissions), that developed the aeroplane CO₂ standard and recently the nVPM standard for engines, and in WG4 (CORSIA). Since February 2020, he has been co-chair of the CAEP task group that is working on options for a long-term aspirational goal (LTAG) for CO₂ emissions reduction for international aviation.



Waypoint 2050

Michael Gill

Executive Director of the Air Transport Action Group (ATAG)

In his article “Pursuing a green recovery for air transport” published in edition #71 of *ECAC News* in December 2020, Michael Gill, Executive Director of the Air Transport Action Group, presented the *Waypoint 2050* report, which sets out the different options available to our sector to help drive our thinking and make some strategic choices in order to meet the climate goal of cutting CO₂ emissions in half by 2050, compared with 2005.

The full Waypoint report can be downloaded [here](#).

“Pursuing a green recovery for air transport” can be downloaded [here](#).



Michael Gill is Executive Director of the Air Transport Action Group (ATAG), the only global association that represents all sectors of the air transport industry. Its mission is to promote aviation’s sustainable growth for the benefit of global society. Prior to ATAG, he spent six years as senior legal counsel in IATA, supporting IATA’s external affairs portfolio. In that role, he led IATA’s delegation to three ICAO diplomatic conferences on airline regulatory and security issues. Before joining IATA in May 2007, Michael was an aviation lawyer in private practice at the Paris Bar, acting for airlines and their insurers.



Flying sustainably in the EU

Filip Cornelis

Director for Aviation, DG MOVE, European Commission

When COVID-19 hit our continent, air traffic almost came to a halt. The sight of parked planes was particularly troubling for those with jobs dependent on air traffic or logistics. While there is hope of recovery on the horizon, the situation is now so serious that Europe's longer-term connectivity is beyond eroded. For every supply chain maintained intact by our transport system, hundreds of thousands of European jobs are saved.

So we need our transport to get back to doing what it does, but to do it better – this is what the EU's recently presented Sustainable and Smart Mobility Strategy is about. A pragmatic approach for the sector to grow, while being cleaner, smarter, future-proof, resilient; in short, to “build back better”. Greening mobility must be the new licence for the transport sector to grow.

► There is no time to lose

Each transport mode has a vital role to play in our transport system, in connecting our cities, towns, villages and islands. Each is here to stay. But each also has a responsibility to adapt, embrace innovation, smart technologies and digitalisation to make our transport system fit for a better future.

When faced with the current crisis, unprecedented cooperation is indeed needed – cooperation among the EU institutions, among Member States, ministries and agencies and especially among stakeholders.

The fact that the whole aviation sector, in each and every part, came together with a broad and joint vision of what is needed for recovery resulted in the *European Aviation Round Table Report* of last November.



That report was innovative – not just in how it was prepared but also in terms of its content. It was not just about “more of the same”, or getting back to pre-crisis ways and means. Rather, it offered a vision of a sector that is stronger, more sustainable and more forward-looking than before.

Especially in the area of environmental sustainability, the *Aviation Round Table Report* testified to a clear industry commitment which was inspired by the European Green Deal and goes further than what is currently possible in other parts of the world. This industry commitment was further developed through the *Destination 2050* decarbonisation roadmap.

It is really important not least because it underpins the European Commission's and the EU's actions to promote sustainable aviation, both within the EU and globally in the International Civil Aviation Organization.

In the aviation sector, decisions taken today – or indeed not taken – will largely influence the situation 20 years from now. The fact that changes take a long time to materialise can be frustrating but also tells us that there is no time to lose.

► The first climate-neutral continent by 2050

Currently, the European Commission is preparing an economy-wide “Fit for 55” package that is scheduled to be launched this summer in order to support the achievement of reducing the total EU greenhouse gas emissions by at least 55% by 2030 compared to their levels in 1990. This is a milestone target towards the overall goal of the European Green Deal: for the EU to become the first climate-neutral continent by 2050.

Aviation is unfortunately a sector that is hard to decarbonise and therefore ICAO's basket of measures needs to be pursued, also at the EU level. This means that we

Flying sustainably in the EU

need to take action in each of these four areas:

- aircraft and engine technology;
- air traffic management and operations;
- sustainable aviation fuels; and
- economic/market-based measures.

► The EU Sustainable and Smart Mobility Strategy

The EU Sustainable and Smart Mobility Strategy sets out a large number of measures to promote sustainable aviation in all the four areas mentioned.

Overall, we must shift the existing paradigm of incremental change to fundamental transformation. By 2035, “zero-emission” large aircraft should become ready for market. The EU should create the enabling environment to achieve this, including through research and innovation in particular through the partnerships that could be put in place under the Horizon Europe programme, such as “Clean Aviation” and “Clean Hydrogen”. The proposed set-up of a Clean Aviation partnership with the aviation industry should follow in the footsteps of the Clean Sky Joint Undertaking, and should have a participation of EUR 1.7 billion from the EU budget. The priority focus should be on the development of technologies that can generate the largest impact on overall aviation emissions, notably hybrid and full electric propulsion, ultra-efficient aircraft configurations, and the development of sustainable alternatives such as the emerging potential of hydrogen-powered aircraft. Accompanying measures will be necessary to develop infrastructure and production capacity for green hydrogen.

In addition, more efficient air navigation can bring about substantial environmental gains. It has been estimated that this can reduce up to 10% of air transport CO₂ emissions and also help to address the non-CO₂ climate impacts of aviation. This requires action both from airlines to systematically favour the most economical



Frans Timmermans, Executive Vice-President for the European Green Deal, and Commissioner for Transport Adina Vălean

flight path, and from air navigation service providers to make this possible. When it comes to air navigation, some would like to just carry on as before, and hope that problems will go away by themselves. This will not be sustainable. We must all together take our responsibility to embrace the future and implement solutions that address both congestion (that will surely come back!) and environmental performance. The aim of the Commission’s proposal for a SES2+ legal framework is precisely to create the incentives and mechanisms to make this happen. The technological pillar, the SESAR project, aims to establish the “digital European sky” that will allow the optimal use of the European airspace through innovative technological and operational solutions based on a high degree of digitalisation and automation. It addresses both air and ground operations that will allow modern aircraft to fully exploit their greener and quieter technologies.

► Time for ReFuelEU Aviation!

As a concrete deliverable of the European Green Deal, the European Commission is preparing the “ReFuelEU Aviation” initiative, with the aim of delivering a legislative proposal that maintains a competitive level playing field on the EU aviation internal market while increasing the uptake of sustainable aviation fuels (SAF) by aircraft

operators, and the distribution of SAF at airports located in the EU.

Sustainable advanced biofuels are currently not produced at scale, and most biofuel consumption happens at a low percentage blending with conventional fuels. Power-to-liquid fuels from renewable sources are available only at demonstration scale. While there could be sufficient demand for all types of sustainable transport fuels, there is still a lack of investments in production capacity. Volumes are limited and the resulting product price is not competitive with the fossil-based fuels, even when factoring in the carbon price (airlines can deduct SAF use from the emission allowances to be purchased under the ETS) and other existing incentives. In a vicious circle, the resulting lack of demand at such prices does not trigger the necessary investments in feedstock and renewable electricity production and refining capacity that could bring about the required economies of scale.

Therefore, a long-term policy framework with strong incentives and closer industrial cooperation appear necessary to break this circle and boost confidence for major investments, particularly for transport modes such as aviation that have no other technologically viable and proportionate short-term decarbonisation alternative.

The European Commission is now looking at the best way to design a SAF blending mandate, which would allow to break the

“chicken or egg” spiral that has hampered the SAF market so far.

This will need to be accompanied by the right amount of financing, to accelerate the research, develop the production capacity and accompany the market in bridging the price gap with conventional fossil kerosene.

Furthermore, the Commission is considering establishing a Renewable and Low-Carbon Fuels Value Chain Alliance, within which public authorities, industry and civil society would cooperate to boost the supply and deployment of the most promising fuels, complementing action under the European Clean Hydrogen Alliance and building on the success of the European Battery Alliance.

▶ Leave nobody behind

The fourth category of measures falls in the category of economic/market-based measures. Carbon emissions from aviation have been included in the EU emissions trading system (EU ETS) since 2012. Under the EU ETS, all airlines operating in Europe, European and non-European alike, are required to monitor, report and verify their emissions, and to surrender allowances against those emissions.

They have been receiving tradeable allowances covering a certain level of emissions from their flights per year. The system has so far contributed to reducing the carbon footprint of the aviation sector by more than 17 million tonnes per year. It is envisaged to phase out the free allowances airlines have been able to claim so far.

Given the international nature of the dominant part of aviation's carbon emissions, a level playing field internationally is indispensable for the aviation sector to decarbonise and remain competitive. So while the EU has the ambition to be leading, it is essential that other major players also take steps towards making international aviation sustainable, to avoid traffic and carbon emissions moving to other hubs outside the EU.

In 2016, the EU played a leading role in the adoption by the International Civil Aviation Organization (ICAO) of the first-ever sectoral scheme regulating CO₂, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). All EU Member States are participating in the pilot phase of the scheme, which started at the beginning of 2021, with the aim of offsetting any growth in emissions beyond 2020 levels, without preju-

dice to the upcoming revision of the EU ETS Directive as regards aviation. Depending on participation and quality of offsets used, at global level the CORSIA scheme could mitigate up to 2.5 billion tonnes of CO₂ and generate up to approximately USD 40 billion of climate financing by 2035. The European Commission is currently assessing different policy options for a legislative proposal to implement further aspects of CORSIA in the EU.

This evolution should leave nobody behind: it is crucial that mobility remains available and affordable for all, that rural and remote regions are better connected, and that the sector offers good social conditions and provides attractive jobs across the EU.

All in all, the recovery from the crisis caused by the COVID-19 pandemic should be used to accelerate the green modernisation of the entire transport and mobility system, limiting its impact on the environment and improving the safety and health of our citizens. The twin green and digital transitions should reshape the sector, restore connectivity and re-energise the economy. The European Commission acknowledges that this transformation – which needs to be socially fair and just – will not come easily, and will require the full dedication and support from all transport actors, as well as a substantial increase of growth-generating investment from both public and private sectors, e.g. in the production of sustainable aviation fuels.

Sustainable flying will secure aviation's future. It is not a dream; with our joint commitment, it will become reality! ■



Filip Cornelis has been Director for Aviation in the European Commission (DG MOVE), in charge of aviation, since October 2017. He joined the European Commission in 1994. After a posting abroad, he worked in the Task Force for Accession Negotiations. He then led the Commission team drafting the Treaties of Accession for the 12 new EU Member States. In January 2006, Filip moved on to transport policy by joining the office of the Director-General for Energy and Transport, Matthias Ruete. He was the leading member of the office from 2008. He was then appointed head of unit for Aviation Security in the European Commission in September 2010. He moved on to become head of unit for Aviation Safety from December 2012 until October 2016. He subsequently became head of unit for Aviation Policy until his appointment as director for aviation.



Destination 2050: The aviation sector's response to the European Green Deal

Thomas Reynaert
Managing Director, Airlines for Europe (A4E)

Europe's aviation sector just unveiled its flagship sustainability initiative, *Destination 2050 – A Route to Net Zero European Aviation*. Driven by the independent work of the research consortium Royal Netherlands Aerospace Centre and SEO Amsterdam Economics, *Destination 2050's* roadmap shows a decarbonisation pathway that combines new technologies, improved operations, sustainable aviation fuels and smart economic measures in achieving net-zero CO₂ emissions from all flights within and departing from the EU by 2050.

The modelling of *Destination 2050* envisages a reduction of 293 Mt CO₂ (metric tons of carbon dioxide equivalent) in 2050, compared with a hypothetical reference scenario where no sustainability measures are implemented.

Improvements in aircraft and engine technologies (-37%)

- 30% improvement in fuel efficiency for the largest single- and twin-aisle aircraft
- 50% improvement for regional aircraft based on hybrid-electric propulsion
- Regional hydrogen-powered aircraft (by 2035)

Sustainable aviation fuels (-34%)

- Exponential scale-up of SAFs from 2030, including blending to 100%
- 83% of total fuel consumption by 2050

Economic measures (-8%)

- Emissions trading – i.e. the EU Emissions Trading System (EU ETS)

- Offsetting schemes – Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

Improvements in ATM and aircraft operations (-6%)

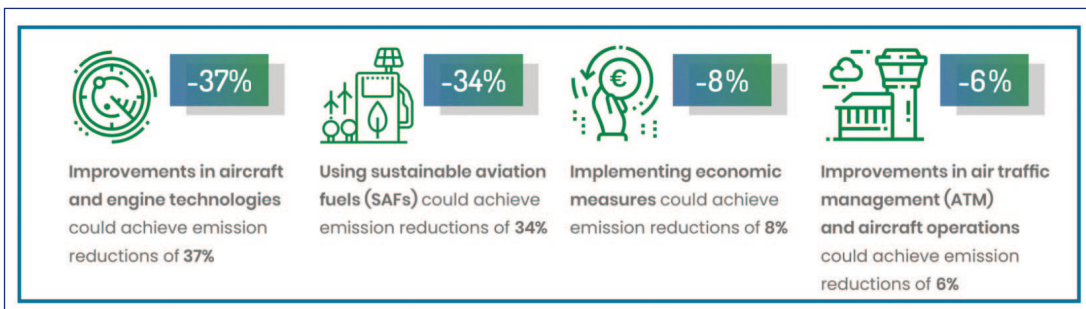
In addition, the model foresees a reduction in demand due to the increased cost of these technologies, whilst maintaining a compound average annual growth rate in passenger numbers of 1.4% (-15%).

The report clearly demonstrates how many different technologies are needed to chip away at emissions and across all aspects of aviation operations. There is no panacea for reducing greenhouse gas emissions; the solutions will vary with geography, economics and demand.

A comprehensive analysis of SAF, for example, shows that even the cheapest fuel will still be four to five times more expensive than ex-

isting jet fuel. The economics will only work with associated efficiency improvements, electrification where possible and supporting economic measures. Supplying enough SAF to meet the 2050 target from within the EU will be challenging. Europe has a limited capacity for sustainable biomass, requiring reliance on a wide range of feedstock sources.

Because of the specificities of the aviation sector, its global nature, existing decarbonisation technologies available and the challenges linked to their adoption – there can be no similar approach from other sectors. The route to net-zero aviation will need a dedicated policy mix and the collaborative contribution of all actors of the aviation ecosystem: airlines, airports, aerospace manufacturers, air traffic controllers, passengers and governments.



European aviation is able to be more ambitious for a number of reasons. This includes our slower projected traffic growth rates, given its higher level of maturity as a market; a greater level of advancement of the complex regulatory environment enabling such commitments; and crucially, greater political will.

The *Destination 2050* initiative indeed maps out a possible pathway to net-zero emissions. It demonstrates that the target is achievable - but it is not a guarantee of success. It is closely dependent on the capacity of European national policymakers, the EU and ICAO to back the aviation sector's decarbonisation plans with regulatory, investment and fiscal incentives, whilst ensuring that this radical transformation does not reduce connectivity or make air travel less affordable.

The aviation industry is experiencing its worst crisis in modern history due to the COVID-19 pandemic. Yet, as led by the EU, efforts to make Europe the world's first CO₂-neutral continent by 2050 are only accelerating. This includes the decarbonisation of European aviation. *Destination 2050* signals European aviation's unprecedented ambition and also its determination to lead aviation globally in cutting carbon emissions. But we cannot do this alone; success will require joint action.

Among the key commitments put forward by Europe's aviation sector as part of *Destination 2050*:

1) In line with the *Aviation Round Table Report on the Recovery of European Aviation* ⁽¹⁾ and on the basis of the *Destination 2050* roadmap ⁽²⁾, A4E, ACI EUROPE, ASD, CANSO and ERA have committed to work together



with all stakeholders and policymakers to achieve the following climate objectives:

- Reaching net-zero CO₂ emissions by 2050 from all flights within and departing from the EU ⁽³⁾. This means that by 2050, emissions from these flights will be reduced as much as possible, with any residual emissions being removed from the atmosphere through negative emissions, achieved through natural carbon sinks (e.g. forests) or dedicated technologies (carbon capture and storage). For intra-EU flights, net zero in 2050 might be achieved with close to no market-based measures.
 - Reducing net CO₂ emissions from all flights within and departing from the EU by 45% by 2030 compared to the baseline ⁽⁴⁾. In 2030, net CO₂ emissions from intra-EU flights would be reduced by 55% compared to 1990 levels.
 - Assessing the feasibility of making 2019 the peak year for absolute CO₂ emissions from flights within and departing from the EU.
- 2) With the *Destination 2050* roadmap and through these commitments, the European

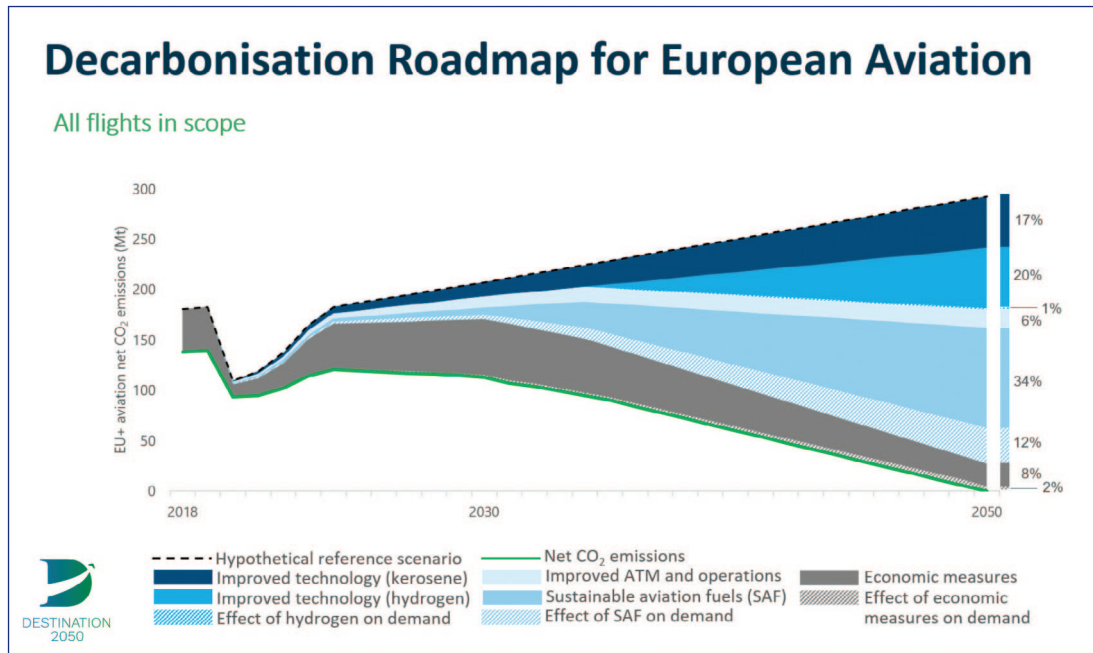
“The *Destination 2050* initiative indeed maps out a possible pathway to net-zero emissions. It demonstrates that the target is achievable - but it is not a guarantee of success. It is closely dependent on the capacity of European national policymakers, the EU and ICAO to back the aviation sector's decarbonisation plans with regulatory, investment and fiscal incentives, whilst ensuring that this radical transformation does not reduce connectivity or make air travel less affordable.”

(1) *Aviation Round Table Report on the Recovery of European Aviation*, November 2020.

(2) *Destination2050_ExecutiveSummary.pdf*

(3) *Destination 2050* encompasses all flights within and departing from the EU+, i.e. the European Economic Area, Switzerland + the United Kingdom. For the sake of simplicity, “EU” is used to address this region throughout the document.

(4) The baseline is a hypothetical “no-action” scenario whereby CO₂ emissions are estimated based on the assumption that aircraft deployed until 2050 have the same fuel efficiency as in 2018. Such a scenario is purely hypothetical, because even without additional sustainability measures, fuel efficiency is likely to improve due to already implemented climate policies and industry action.



aviation sector contributes to the Paris Agreement, recognising the urgency of pursuing the goal of limiting global warming to 1.5°C. By doing so, the aviation sector is also effectively contributing to the European Green Deal and EU's climate neutrality objective.

- 3) Putting into action our determination to build back better from COVID-19, we invite European and national policymakers to be strong partners in this endeavour, strengthening the pillars described in the *Destination 2050* roadmap and taking into account the Air Transport Action Group's (ATAG) *Waypoint 2050* report, presenting decarbonisation pathways for the global aviation sector. Indeed, the above-mentioned commitments are subject to securing the required supporting policy and financing framework at EU and national level.
- 4) We therefore urge national governments and the EU to establish a policy framework that effectively enables industry to decarbonise and provides the necessary clarity and stability. The European Green Deal offers a great opportunity for this. All actors of our sector should be able to recover the costs of decarbonisation through access to private capital and relevant public funding. As such, it is critical that decarbonisation initiatives of all stakeholders in the air transport ecosystem are included in the EU taxonomy for sustainable investments as well as the European Investment Bank lending policies.
- 5) Working towards these objectives will also require joint efforts from all actors in the European air transport ecosystem - including airlines, airports, air navigation service providers (ANSPs), manufacturers, ground handlers and fuel producers, together with all policymakers. Taking this leadership position, Europe's aviation sector is also sending a strong message to the rest of the industry globally and will use its influence to encourage wider adoption of its objectives and related actions, including the long-term global aspirational goal for international aviation (LTAG) to be agreed at ICAO in 2022.
- 6) Policies must be designed in a way which avoids distortion of competition between European and non-European aviation stakeholders and within the single aviation market. In a similar vein, we call on jurisdictions outside the EU to further support and accelerate aviation's decarbonisation, in particular by working under the mantle of ICAO. A level playing field is indispensable to enable aviation to decarbonise without compromising its ability to continue delivering social and economic benefits globally.
- 7) Industry action and policies are required across four main pillars:
 - Aircraft and engine technology
 - Air traffic management (ATM) and aircraft operations
 - Sustainable aviation fuels
 - Smart economic measures
- 8) These measures directly address reductions in net emissions. Based on the *Destination 2050* roadmap, the additional costs of these efforts may have an effect on demand. As a result, affordable air connectivity could potentially be impacted along with other sectors that rely on it.
- 9) Air transport growth and the revenues it generates will enable the aviation ecosystem to invest into its successful green transformation. Based on the *Destination 2050* roadmap, European air passenger numbers

are still projected to grow by an average of approximately 1.4% per year until 2050, without compromising the sector's ability to reach net-zero CO₂ emissions in 2050. *Destination 2050* thus shows that European air transport can grow in a sustainable manner.

- 10) The modelling in *Destination 2050* identified a range of emissions reductions stemming from the above-mentioned four pillars (point 7), which taken together can deliver net-zero CO₂ emissions for flights within and departing from the EU by 2050.

To fulfil the CO₂ reduction potential of the four pillars analysed in the roadmap, **industry will:**

- continue to substantially invest in decarbonisation;
- develop more energy-efficient aircraft and bring these into operation through continued fleet renewal;
- develop hydrogen-powered and (hybrid-)electric aircraft and supporting (airport and heliport) infrastructure and bring it to the market;
- scale up drop-in SAF production and uptake;
- implement the latest innovations in ATM and flight planning;
- compensate remaining CO₂ emissions by removing CO₂ from the atmosphere.

Governments should:

- support and strengthen global carbon markets and policy to achieve cost-effective carbon pricing at ICAO;
- support industry investments through incentives or by reducing risk through a consistent and stable policy framework;
- stimulate further development



DESTINATION 2050

and deployment of innovations by funding research programmes and promoting carbon removal technologies (Clean Aviation, SESAR partnerships, etc.);

- work with the energy sector to ensure sufficient availability of renewable energy at affordable cost;
- support the development of the SAF industry;
- contribute to optimising ATM, in particular by fully implementing the Single European Sky.

- 11) Through these commitments, the European aviation sector is also making a significant contribution to its proposed EU Pact for Sustainable Aviation, set forth in the *Round Table Report on the Recovery of European Aviation*. This Pact would allow to formalise and enact the required partnership between industry and European and national policymakers, ensuring agreement on joint sustainability targets and alignment between the related industry contribution and roadmap on the one hand, and the enabling regulatory and financial framework on the other.

“Aviation is an international activity, therefore a global policy framework is preferred. Whilst the scope of CORSIA should extend over time, and further work to improve the scheme's robustness will be welcomed, CORSIA is an unprecedented effort whose success should not be endangered by unilateral moves.”

ICAO will play a crucial role in setting long-term global targets for the decarbonisation of aviation. Aviation is an international activity, therefore a global policy framework is preferred. Whilst the scope of CORSIA should extend over time, and further work to improve the scheme's robustness will be welcomed, CORSIA is an unprecedented effort whose success should not be endangered by unilateral moves.

We are counting on the European States to actively embrace and drive this proposed EU Pact forward. ■

Thomas Reynaert has been Managing Director of Airlines for Europe (A4E), Europe's largest EU airline association, since March 2016. Prior to joining A4E, Thomas was president of United Technologies (UTC) International Operations (Europe), where he led their European government relations activities between 2008–2015. During this time, he provided counsel to the corporation and its business units on EU rulemaking and policy and served as a corporate liaison for key decision makers in the EU institutions and national governments. Prior to joining UTC, Thomas led the government relations and regulatory affairs team for Nortel Networks in EMEA, in 2000. Previously, he was director of EU public affairs for Lucent Technologies (today: 'Alcatel-Lucent'). Thomas was a member of the Supervisory Board of the UTC Company OTIS Management GmbH (Germany) from 2008-2014. From 2011-2015 he was chair of AmCham EU's Security and Defense Committee, and in 2015 was appointed a member of the Executive Committee of the European Centre for Public Affairs (ECPA).



Making “build back better” more than just a slogan

Andrew Murphy

Director, Aviation, Transport & Environment

2020 was an appalling year for the world – for individuals and for the aviation industry in particular. But somewhat buried behind this bad news was a surprising level of good news on climate action. Europe remained committed to its target of a net-zero economy by 2050, and was joined by other major emitters and large companies (including in the aviation sector) in setting such a goal. Joe Biden was elected on an ambitious programme of climate action, which is already being turned into law. The electrification of our road transport sector has accelerated, with electric vehicle sales surpassing a 10% share in Europe in 2020.

Perhaps this shouldn't have been a surprise. After all, there is strong evidence that the COVID-19 pandemic was caused, or at least worsened, by our damaging relationship with the natural world. It would therefore be odd to use the crisis as an excuse to make our planet even dirtier.

With some exceptions, the airline industry understands this. Since the crisis began, they have put out a number of position papers which show that they want a green recovery for the sector. Many actors have committed to a net-zero target. “Build back better” now rolls off the tongues of most industry executives and spokespersons. This is good and welcome.

However, let's be clear: even the best position papers and slogans won't be enough to reduce aviation emissions. If they were, then the aviation sector would be in a much better position climate-wise than it is at present. If papers and slogans won't be enough to help us, what will?

To answer that question, we need to remind ourselves that for all the challenges we face, the problem itself is quite simple: the aviation industry needs to stop burning fossil-based kerosene, and replace it with alternatives which eliminate both the CO₂ and the

non-CO₂ effects of flying. That is perhaps a simplification, and certainly no easy feat, but allows us to focus our thinking and efforts on what is needed.

What we need is a combination of zero-emission aircraft and zero-emission fuels, and we need to deploy them in a timescale consistent with the emission reduction pathways that our atmosphere demands. ATAG's *Waypoint 2050* is very helpful in this regard – it shows that there are a range of tech options available, and highlights e-kerosene as having the potential to scale up to meet aviation's total fuel demands.

So how do we get these planes and fuels into the sky as soon as possible? Here, we need to draw a clear line between what works and what doesn't work, because with the climate clock ticking, we don't have time to waste on measures that will not deliver the goods.

A single global measure will not deliver clean aircraft and clean fuels. Global aspirational goals will not drive the tens of billions, potentially hundreds of billions, of euro investment required, and will not force airlines and manufacturers to change their current, fossil-heavy, trajectory. A global offsetting scheme will not drive this uptake either, and investment will not be derisked by assembly resolutions.

This should be a surprise to no one. When the COVID-19 crisis first hit the sector, airlines did not turn to ICAO for a single global solution to rescue their industry. Everyone knew that ICAO was too slow and cumbersome to provide the support needed. Instead, the aviation industry turned to national governments, because that is where the real money and regulatory power lies.

What is true for COVID-19 is true for climate. The money and regulatory power needed to drive an uptake of fuels and aircraft lies at national and EU-level. All we ask is for some consistency between how we save airlines and how we save the climate. Our efforts therefore need to focus on which nations and European measures can deliver this outcome.

Here, we have ample experience to draw on from other sectors. Take for example the road transport sector, where we are finally seeing an acceleration in the deployment of electric vehicles, whose climate impact is always far, far lower than the internal combustion engine they replace. That success story is a combination of industry innovation, supported with public money, and binding CO₂ targets (here and elsewhere, such as in the US) to ensure this innovation makes it onto the road.

We should also look at the deployment of renewable energy across the bloc, where governments entered into contracts with suppliers where the State provided funding in return for a guaranteed supply of low-carbon energy. That has caused the share of renewable energy in Europe to jump.

The lesson here is simple: you can't simply provide cash to promising technologies and hope that industry goodwill or consumer interest will do the rest. Fossil energy is deeply entrenched in the aviation sector, and substantial effort is needed to dislodge it and replace it with zero-emission alternatives.

So how do we get rid of fossil energy, and how do we do so fast enough to meet our Paris goals (and the demands of ever more climate conscious investors and consumers)? First off, we need to support Europe's ReFuelEU initiative of a slowly increasing uptake of truly sustainable fuels such as e-kerosene. The EU should work with its neighbours, especially Norway, Switzerland and the United Kingdom, to ensure that such a measure is adopted across the bloc. There are promising signs from each of these countries that they will pursue such an approach.

The cost of these fuels will never meet the cost of untaxed fossil kerosene, at least not anytime over the coming decade. We should, however, aim to minimise the price gap through taxing kerosene and funding industrial support to bring down the cost of these alternative fuels.

We should be optimistic about what this means for Europe: producing zero-emission e-kerosene means funding an enormous in-

crease in renewable energy in Europe, and developing new technology such as capturing CO₂ and refining these fuels. Aviation is a crucial sector for Europe, and this offers us a chance to ensure it is powered by fuels made here. This would boost our economy and our security.

For aircraft, the story is more challenging, and we should be honest about that. E-kerosene can easily replace fossil kerosene through mandates, or if/when the price equalises. The same is not true for zero-emission aircraft, which will require an enormous change to airports and operations.

We don't doubt the ability of manufacturers to develop these aircraft, at least on paper and in test flights. We do doubt whether there are airline and airport CEOs willing to bet their future on a move to a whole new aircraft type. It won't be enough for the cost of these new aircraft to equal the cost of current jet aircraft, given the huge uncoded risks in making such a switch.

So what will work? In reality, the only approach which will work is a ban on certain aircraft types over certain routes, to provide a market for this new, alternative technology. We can start relatively small, requiring the use of zero-emissions aircraft for all general aviation on short routes within Europe, by 2030. We should then

expand to short-haul commercial aviation by 2035, when the EU's Smart and Sustainable Mobility Strategy tells us these aircraft will be available.

This is ambitious, but if we can't get these aircraft into service in the 2030s, then frankly it is too late for them to help us with the goals of the Paris Agreement. Industry must accept these targets before they are given public money, with the targets legislated for immediately. If industry tells us these targets are too ambitious, then that's a good sign that we should move public money elsewhere. Better to find out in 2021 that this can't be done, than in 2031 when we have lost a decade and countless billions of euro.

Aviation is an international sector, so what is our international approach to reducing emissions? Let's start off by recognising that there are many different types of international action. Leaving Montreal behind does not mean quitting the world. On aviation's non-CO₂ climate impact, we should seek to build immediate cooperation with our colleagues in North America, particularly in light of the change of administration in the United States. We can inspire the public by deploying the most recent understanding of these effects in order to reduce the climate impact of transatlantic flights.



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Making “build back better” more than just a slogan

Other parts of the world are following Europe in adopting zero-emission targets. We should continue to lead by confirming that all aviation emissions are included in our target, and push other countries to follow suit. Major emitters adopting zero-emission targets, which include aviation, will provide the greatest market for zero-emission fuels and aircraft.

All the above is quite ambitious, and if we pull it off, will put aviation on a trajectory to zero emissions by 2050, covering also the non-CO₂ effects. The problem is that even with the greatest will, many of these technologies will not be deployed at scale until the 2030s onwards. There is an inevitable time lag, which is true for all sectors. Developments in the road transport and energy sectors are due to decisions taken ten+ years ago, for example investments made in the US to drive down the cost of batteries.

So what do we do in the 2020s to ensure aviation contributes? Let's start by not pursuing false solutions. A dash for crop-based biofuels, or scouring the globe for offsets, will not deliver credible reductions. We should be wary of dressing up existing fuel feedstocks as “advanced” just to meet arbitrary targets set by regulators.

But there is still lots we can do. We need to ensure we are maximising efficiencies, especially by keeping older aircraft grounded where they belong. We should be comfortable with some demand not coming back post-COVID. Zooms and Teams worked fine for many meetings, and that should continue. Face to face is important, but not always essential.

Governments certainly shouldn't try to reflate demand using tax breaks and subsidies. The bill to decarbonise aviation is large enough as is, without adding more strain to the taxpayer.

This decade will be challenging for the sector. Not only must it recover from the effects of COVID-19, but it must also finally start on the path to deep decarbonisation. That is not something it can achieve alone, and it won't be achieved through a top-down global approach. Instead, a close partnership with governments, of the type that is seeing it through this crisis, is needed.

The partnership should be ambitious, and rooted in what is possible in the timeframe needed for Paris. We have no more time to waste to build back better. ■



Andrew Murphy joined Transport & Environment in 2014 having previously worked for the Green European Foundation and at the European Commission's Transport Directorate. He leads T&E's work on sustainable aviation, which includes pricing mechanisms, new fuels and finally addressing aviation's substantial non-CO₂ climate effects. Andrew is Irish, with a Bachelor of Arts in Political Science and Law and a Bachelor of Law from the National University of Ireland, Galway. Since 2021, he is a member of Ireland's Climate Change Advisory Council.

Supporting airports on the challenging path of decarbonisation amidst the worst industry crisis

Marina Bylinsky

Head of Sustainability, ACI EUROPE (Airports Council International)



336 airports worldwide, welcoming 46% of global air passenger traffic across 74 different countries, are currently part of Airport Carbon Accreditation. Depending on their level of accreditation, they are measuring their CO₂ emissions, establishing and implementing action plans to reduce them and engaging their stakeholders to do the same.

Every year since the launch of Airport Carbon Accreditation back in 2009, the overall programme results point to decreasing CO₂ emissions under the control of the certified airport operators, with a close to 5% reduction in total CO₂ emissions in 2018-2019⁽¹⁾.

When launching *Airport Carbon Accreditation* over a decade ago, with 17 European participants, we could not have foreseen the tremendous success of the programme – nor the unprecedented challenges the airport industry would face just roughly ten years on. It is encouraging and inspiring that in spite of the worst crisis in its history, the airport industry continues to be committed to ambitious climate action – and *Airport Carbon Accreditation* reaches new milestones.

Since COVID-19 was declared a pandemic a year ago, 36 airports globally have joined *Airport Carbon Accreditation*, while 32 have upgraded their levels of certification⁽²⁾. At the ACI EUROPE Annual Congress and General Assembly on 17 November 2020, *Airport Carbon Accreditation* introduced the first major, structural change to the pro-



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gramme since its inception: two new accreditation levels – Level 4 Transformation and Level 4+ Transition – were launched. Three airports have already reached accreditation at one of these levels: Christchurch International Airport in New Zealand at Level 4, and Dallas Fort Worth International Airport in the United States and Delhi Indira Gandhi International Airport in India at Level 4+.

With the introduction of these new levels, *Airport Carbon Accreditation* made a step-change in sev-

eral regards. First of all, it represents a shift in the ambition of the programme. Emissions savings and continuous improvement have been at the core of *Airport Carbon Accreditation* since its very beginning, but levels 1 to 3+ do allow for flexibility in the magnitude of reductions to be achieved. By contrast, levels 4 and 4+ require airports to align their carbon management strategies and plans with the ambition of the Paris Agreement, according to which global warming should be limited to below 2°C and ideally 1.5°C. These objectives have been translated into several emissions reduction scenarios by the Intergovernmental Panel on Climate Change (IPCC). Airports have to define their reduction targets and associated emis-

(1) This result relates to the reporting year May 2018-May 2019. More recent carbon performance data is not available yet due to the COVID-19 crisis.

(2) For more information on airport climate action during the COVID-19 pandemic, please refer to the *Airport Carbon Accreditation Interim Report 2019-2020*: <https://www.airportcarbonaccredited.org/component/attachments/?task=download&id=168>

Supporting airports on the challenging path of decarbonisation amidst the worst industry crisis



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sions pathways in alignment with these scenarios. Furthermore, airports have the possibility to include into their reduction target emissions sources which are not directly controlled by the airport operator (i.e. Scope 3 emissions as per Greenhouse Gas Protocol), provided they can demonstrate that they have significant influence over the sources concerned. This approach assists airports in identifying and pursuing the most effective emissions reduction opportunities, recognising that they might be outside the airport's operational control. The emissions that airports have to disclose in their carbon footprints are also broadened, so as to encompass all the significant operational sources on- and off-site. And finally, the requirements relating to stakeholder engagement are tightened, with effective partnerships, oriented towards delivering emissions reductions, coming to the fore. Levels 4 and 4+ thus bring *Airport Carbon Accreditation* in line with the latest scientific and policy developments of the last years. They also reflect enhanced public expectations, according to which the airport operator has to show that it does not only address its own emissions, but uses its influence to drive emissions reductions from third parties operating on its site.

The adaptability of the programme to accommodate such developments does, however, not entail a complete overhaul of *Airport Carbon Accreditation*. The ini-



tial levels 1 to 3+ remain in place as is, offering stability to participating airports, and confirming that the key principles and design elements of the programme are still relevant and future-proof.

The introduction of levels 4 and 4+ also marks another major milestone for *Airport Carbon Accreditation*, and in my view, it is maybe even the most significant one: with the new levels, the programme has finally become truly global. Of course, airports outside Europe started becoming certified back in 2011, when *Airport Carbon Accreditation* was extended to ACI Asia-Pacific, followed by ACI Africa, ACI North America and ACI Latin America and the Caribbean. As of end 2014, there have been accredited airports in all world regions. But these airports were joining a programme that had been built by European airports. The levels 4 and 4+, however, have been defined by a task force of airports from various regions. They are the result of hours and hours of meetings, informal

discussions and sometimes heated conversations that were taking place for over two years. Finding a compromise between the views and needs of all these airports, operating with different business models, in different climates and policy contexts, was challenging – but in the end, successful.

For European airports, levels 4 and 4+ provide guidance to help define pathways to meet their commitments to net-zero CO₂ emissions, made through ACI EUROPE in June 2019, in line with the objectives of the European Green Deal⁽³⁾. They confirm the credibility and robustness of these pledges, and recognise airports for their progress towards the ultimate goal.

The continuity of airports' leadership in climate action is, however, facing a major risk right now. With the COVID-19 crisis, airports have suffered significant financial losses for more than over a year now, and the air traffic trends continue to follow worst-case scenarios. Europe's airports have been burning over €350 million every week – resulting in most airports having a negative cash flow and financing daily operations through debt over a sustained period of time. These increased debt levels and related funding requirements combined with a weaker revenue outlook in the coming years will put airports under significant financial stress. This means that for the next five to

(3) For more information, please see <https://www.aci-europe.org/netzero>

Supporting airports on the challenging path of decarbonisation amidst the worst industry crisis

ten years, airports will be facing an investment crunch – and their financial ability to invest in sustainability and decarbonisation will be significantly hampered. As such, funding support from the EU and national governments in Europe will be absolutely key to enable the continuity of airport climate action, helping the industry regain its own investment capability.

Failing to do so would not only put the decarbonisation of airports, but also of the whole aviation sector, at risk. In fact, European aviation has just recently committed to reach net-zero CO₂ emissions for all flights within and departing from the EU/UK/EFTA through the landmark initiative *Destination 2050*⁽⁴⁾. Airport climate action complements and facilitates the achievement of this goal by supporting more efficient ground operations and optimised air traffic management, but also the provision of infrastructure and associated services for the use of sustainable aviation fuels (SAF) – and in the longer run, hydrogen-fueled and electrified aircraft operations. The “deeper” we get into the decarbonisation of air transport, the more important the role of airports will



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be as nodes of climate action, accelerating and removing roadblocks for new technologies and operations in cooperation with industry partners. This role is now at stake.

In any case, *Airport Carbon Accreditation* will continue to encourage and recognise airports' decarbonisation efforts. Through the strengthened focus on third-party emissions within the new levels 4 and 4+, *Airport Carbon Accreditation* is actually becoming an ever more important supporting tool to

address airport emissions within the broader context of aviation's climate impact. More broadly, the programme has also taken exceptional measures to help participants maintain their accreditations in spite of the crisis, for instance by merging two reporting years into one and thus allowing airports to renew their accreditation only once, instead of twice, in that period.

In closing, I would like to wholeheartedly thank all those who made levels 4 and 4+ a reality: the members of the *Airport Carbon Accreditation* Task Force, under the leadership of Emanuel Fleuti from Zurich Airport, whose exceptional expertise and professionalism were critical to navigate the difficult waters towards the launch of the new levels; the programme administrator WSP; all ACI regional offices and ACI World; and the *Airport Carbon Accreditation* Advisory Board. *Airport Carbon Accreditation* – as airport climate action in general – has been, is and will always be the result of relentless teamwork. ■



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(4) For more information, please see www.destination2050.eu

For more information:
www.airportCO2.org
www.airportcarbonaccreditation.org

Marina Bylinsky joined ACI EUROPE in September 2015 and is responsible for the coordination of all aspects of the association's sustainability strategy. In this regard, she represents ACI EUROPE in various high-level EU, ECAC and EUROCONTROL fora. She also monitors the administration and ongoing evolution of the global carbon standard, *Airport Carbon Accreditation*, which belongs to ACI EUROPE, and led the development of ACI EUROPE's Sustainability Strategy for Airports. Marina is a graduate of the Institute of Political Sciences in Paris. Prior to joining ACI EUROPE, she worked as a senior consultant at BearingPoint in France and in Belgium.



Aviation's non-CO₂ climate impacts – current understanding and uncertainties

David S. Lee

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For several decades, it has been known that aviation has impacts on climate that go beyond its CO₂ emissions (important as these are, at around 1000 million tonnes per year, prior to the COVID-19 pandemic).

These non-CO₂ impacts on “effective radiative forcing”⁽¹⁾ (ERF) include increases in high-level cloudiness from contrail cirrus in high-humidity regions, effects on atmospheric chemistry from emissions of nitrogen oxides (NO_x), aerosol-radiation interactions from soot and sulphur emissions, water vapour emissions, and aerosol-cloud interactions. These effects have recently been quantified in terms of their ERF values by Lee *et al.* (2021) and are shown below in Figure 1. In terms of the ERF metric,

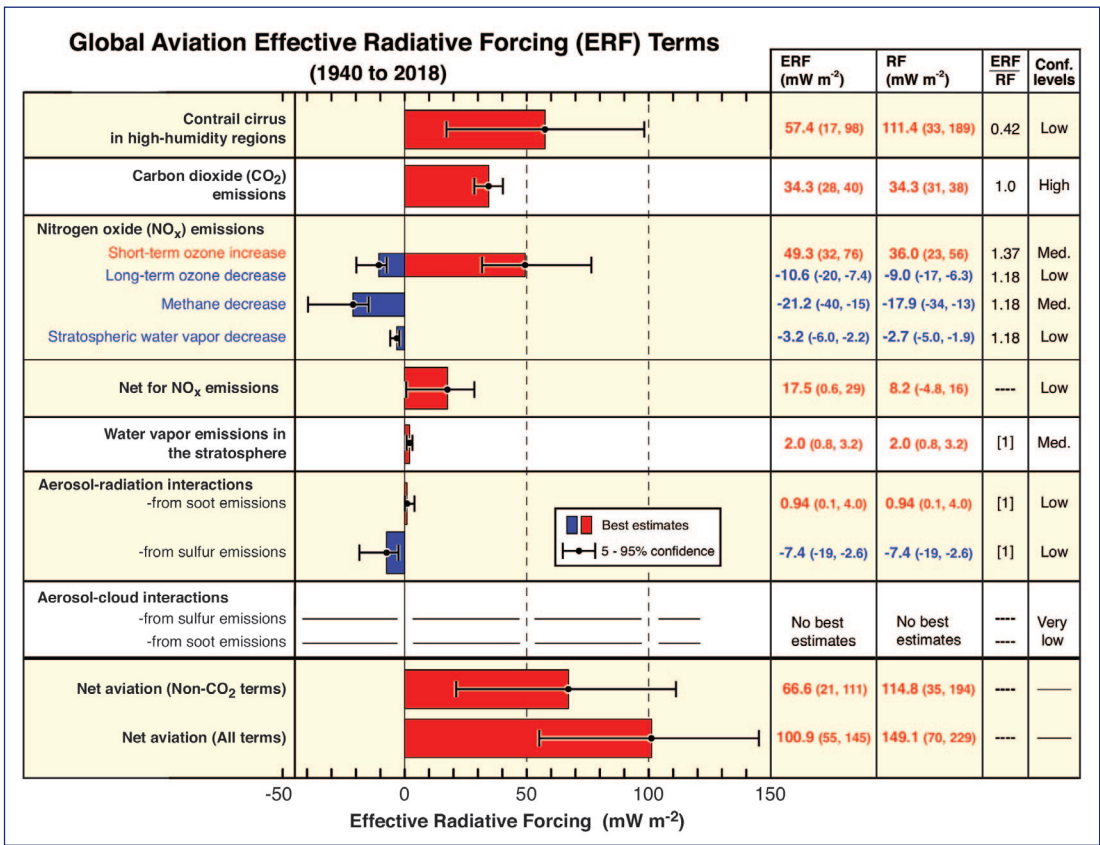


Figure 1: Best estimates for climate forcing terms from global aviation from 1940 to 2018. The bars and whiskers show ERF best estimates and the 5–95% confidence intervals, respectively. Red bars indicate warming terms and blue bars indicate cooling terms. Numerical ERF and radiative forcing (RF) values are given in the columns with 5–95% confidence intervals along with ERF/RF ratios and confidence levels. ERF/RF values designated as [1] indicate that no estimate is available yet (from Lee *et al.*, 2021).

(1) Effective radiative forcing (ERF) is the measure of climate forcing of a greenhouse gas or other effect quantified in watts per square metre (W m⁻²). ERF is the change in the Earth-atmosphere energy budget for a forcing since pre-industrialisation and is approximately linearly proportional (i.e. multiplied by a constant) to the equilibrium temperature response. The ERF metric is useful as it allows different forcings to be compared on the same scale, including, for example, changes in concentrations of greenhouse gases, aerosol concentration or cloud cover, and changes in the albedo of the Earth's surface from land use change or snow and ice cover.

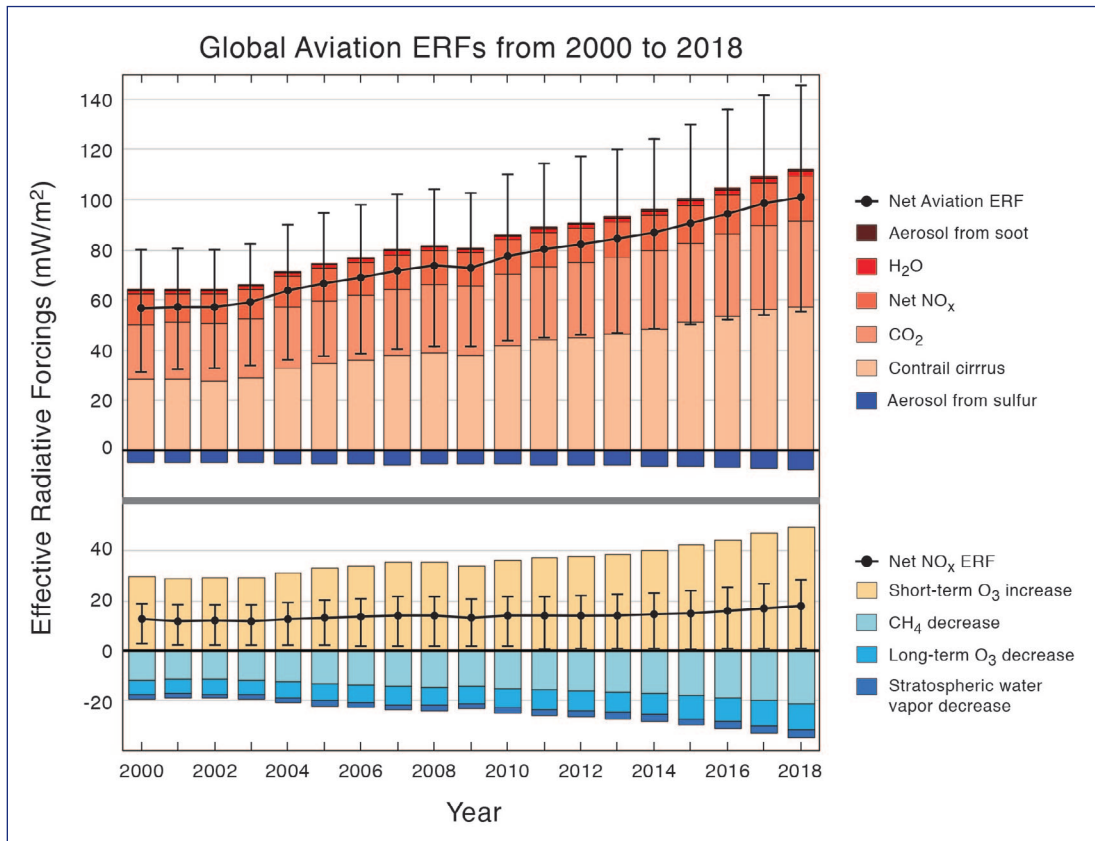


Figure 2: Timeseries of calculated ERF values and confidence intervals for annual aviation forcing terms from 2000 to 2018. The top panel shows all ERF terms, and the bottom panel shows only the NO_x terms and net NO_x ERF. The net values are not arithmetic sums of the annual values because the net ERF requires a Monte Carlo analysis that properly includes uncertainty distributions and correlations (from Lee *et al.*, 2021).

aviation's non-CO₂ forcings are approximately two thirds of the total forcing from aviation in 2018.

These non-CO₂ effects are complex and have been described in much greater detail elsewhere (e.g. IPCC, 1999; Lee *et al.*, 2010; 2021). The magnitude of these effects has grown over time, along with increases in global aviation activity, fuel usage and CO₂ emissions, although not always in a linear manner. The calculated increases in aviation's non-CO₂ forcings are shown in Figure 2.

Many of the non-CO₂ forcings are still associated with large scientific uncertainties and a range of confidence levels ranging from "medium" to "very low", assessed in a manner consistent with a methodology prescribed by the Intergovernmental Panel on Climate Change (IPCC) (Mastrandrea *et al.*, 2011). The uncertainty distributions (5%, 95%) illustrated in Figure 3 (next page) show that non-CO₂ forcing terms contribute about eight times more than CO₂ to the

uncertainty in the aviation net ERF in 2018. Also, it should be noted that the aerosol-cloud interactions, which have estimated forcings that range from the relatively large through to negligible, cannot, at present, be given best estimates. Indeed, even the sign (warming/cooling) of those from aerosol-cloud interactions from emissions of soot from aircraft has some uncertainty.

Given that the non-CO₂ contributions to aviation's net ERF are such a large fraction, there is great interest in the scope for mitigating these climate impacts (e.g. Arrow-smith *et al.*, 2020). However, the uncertainties make this far from straightforward. Also, it is not simply the inherent uncertainties of the ERF quantification of these non-CO₂ components that are involved, but also "trade-off" issues with CO₂ emissions and also other uncertainties associated with climate or meteorology that make mitigation uncertain.

The two largest (quantified) aviation non-CO₂ forcings are those

from contrail cirrus and "net-NO_x". If the background atmosphere is cold enough and super-saturated with respect to ice, then persistent contrails may form from water condensing on exhaust soot particles. Under favourable meteorological conditions, the ice crystals remain and grow in the atmosphere (from the background water vapour) forming persistent contrails that spread to form extensive contrail cirrus cloud coverage causing (overall) a climate warming (Kärcher, 2018). The areas of the atmosphere that form contrail cirrus tend to be quite heterogeneous, and 10s to 100s of km wide but ~ 1 km, or less, deep (Schumann and Heymsfield, 2017). While the occurrence of contrails can be predicted quite well through thermodynamics, the *persistence* of contrails and their spreading is much harder to predict reliably.

It has been suggested that navigational avoidance of contrail cirrus may be a feasible near-term mitigation measure with minimal

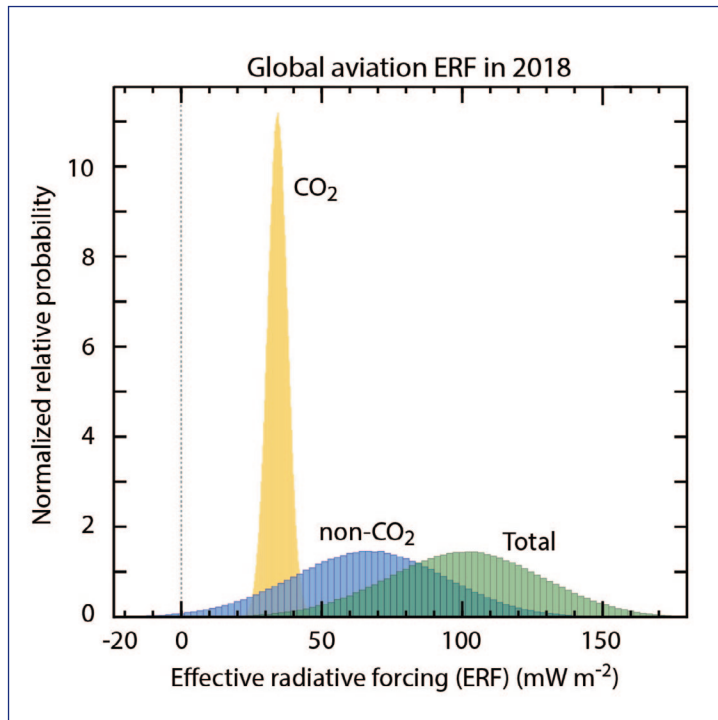


Figure 3: Probability distribution functions (PDFs) for aviation ERFs in 2018 based on the results in Figure 1. PDFs are shown separately for CO₂, the sum of non-CO₂ terms, and the net aviation ERF. Since the area of each distribution is normalised to the same value, relative probabilities can be intercompared. Uncertainties are expressed by a distribution about the best-estimate value that is normal for CO₂ and contrail cirrus, and lognormal for all other components. A one-million-point Monte Carlo simulation run was used to calculate all PDFs (from Lee *et al.*, 2021).

extra fuel usage, and therefore minimal additional CO₂ forcing (e.g. Teoh *et al.*, 2020). However, Gierens *et al.* (2020) show that contrail persistence can only be predicted with low reliability with sufficient accuracy in space and time for the purposes of navigational avoidance with the current generation of meteorological models. If these inaccuracies remain, and such avoidance is implemented, there is a large risk that inaccurate predictions could *increase* net climate forcing. For avoidance measures to be valuable, any extra fuel usage and associated CO₂ emissions would need to be “traded off” against achieved reductions in contrail cirrus forcing. Trade-off calculations are not straightforward, since CO₂-emission equivalence metrics for present-day contrail forcing, depending on the metric and time horizon chosen, can vary over a large range (1.5 to 39) (Lee *et al.*, 2021). Different emissions-equivalent metrics quantify different things, and the associated time horizon chosen is a subjective “user” choice.

There is clearly much more work to be done before such an avoidance mitigation measure by navigational means for contrail cirrus can be considered for operational use. Moreover, there may be other ways to mitigate contrail cirrus that are more “climate effective”. For example, the use of alternative fuels is proposed as a means of reducing total CO₂ emissions from global aviation. Alternative low life-cycle C fuels, although not yet widely available and used from bio or e-fuel sources, would greatly reduce the aromatic content of aviation fuel. It is well-established that it is the aromatic content of fuel that is primarily responsible for the soot emissions, and that reductions in aromatic content reduce the soot number concentration (Moore *et al.*, 2017). Initial climate model simulations of contrail cirrus show that reduced soot emissions result in substantially reduced contrail cirrus formation and associated climate forcing (Bier *et al.*, 2017; Bier and Burkhardt, 2019). Such an approach would not invoke any trade-off issues, since it is a “win win” sce-

nario, and the risks of unintended consequences are much lower than with navigational avoidance.

The “net NO_x” effect is the second largest aviation non-CO₂ forcing. This complex and non-linear effect of aircraft NO_x emissions on atmospheric chemistry increases (a warming effect) short-term concentrations of ozone (O₃), a greenhouse gas, while reducing (a cooling effect) background concentrations of ambient methane (CH₄), another greenhouse gas. In addition, there are smaller secondary effects from reductions in stratospheric water vapour and background long-term O₃, both of which are cooling effects. The net effect from aircraft NO_x is warming, at present. The calculated net NO_x forcing has increased very little over the last years, despite significant increases in NO_x emissions from increased air traffic (Lee *et al.*, 2021). This offsetting occurs because the reduction in CH₄ (the main associated cooling effect) grows more rapidly than the warming effect from short-term O₃ (Skowron *et al.*, 2021).

In terms of NO_x mitigation, there are two major considerations; firstly, that reducing NO_x emissions tends to have a fuel penalty as a technological design trade-off. More efficient engines (for less fuel consumption) tend to have higher temperatures and pressures at the combustor inlet, which enhance NO_x emissions in the absence of additional combustor cooling techniques. Freeman *et al.* (2018) showed that for large reductions (20%) in NO_x that required a 2% penalty (increase) in CO₂ emissions, the net forcing was *larger* than the base case, emphasising that technological trade-offs need to be considered very carefully to ensure a desirable outcome. Secondly, there is the important consideration that the chemical response to aircraft NO_x emissions is highly dependent on background NO_x concentrations from natural and other anthropogenic emission sources. Thus, for the same aircraft NO_x emission scenario, the overall impact varies considerably, depending on background surface emissions of NO_x and other ozone

precursor emissions. More recent developments in calculating the radiative forcing from CH₄ increases (Etminan *et al.*, 2016) imply that the net NO_x ERF decreases as NO_x emissions increase in the future and, depending on background emissions, may change sign to become a net negative forcing (cooling) (Skowron *et al.*, 2021).

Lastly, the uncertainties remaining in the aerosol-cloud radiation impacts are considerable. It is highly likely that the effect on lower-level warm clouds from aircraft sulphur emissions is one of cooling; however, the magnitude of this is highly uncertain. The magnitude of the effect of soot on

upper-level ice crystal clouds is highly uncertain.

In conclusion, from the foregoing it is clear that scientific uncertainties and gaps remain not only in the quantification of aviation non-CO₂ forcings but also in how these forcings may change with future conditions of the atmosphere. There are complex interactions between technological and operational changes, particularly when trade-offs with CO₂ emissions are involved. These non-CO₂ impacts and their interactions need to be better understood for mitigation measures to be implemented that will have “no regrets” or “win win” outcomes. ■

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Non-CO₂ emissions: options for mitigation actions

Piotr Samson

Director General of Civil Aviation for Poland, and Chair of the EASA Management Board

For years, aviation stakeholders have been struggling to reduce the sector's negative influence on the environment. Although much has been gained in this area due to the constant efforts of both the producers and the people responsible for formulating the sector's policies, experts from all around the world are trying to do their best to limit aviation emissions as much as possible.

It is true that Europe, due to implementation of the EU emissions trading system (EU ETS), is one of the leading regions striving to reduce CO₂ emissions from aviation, and that CO₂ is the main anti-hero in the struggle for clean air. But our continent does not limit its work to mitigating the impact of CO₂ only; already, 15 years ago, European Union experts discussed methods for stopping the growing emissions of nitric oxides as well as other chemical substances which, as we know today, contribute to the general increase of temperature levels. Therefore we don't perceive the deliberations on other particles as something absolutely new. Nevertheless, the previous work was carried out when we were only beginning to discover the impact of aviation non-CO₂ emissions on the environment and therefore that knowledge was only the first step towards the start of discussions on this issue. Fortunately, due to the extensive work of experts in the area of emissions, the next decade brought a change and the situation is now much clearer. The work continues today and the search for measures for climate protection offers new and interesting perspectives.

Of course, working on its climate policy, Europe has not forgotten about aviation. In its recent report on the non-CO₂ emissions in aviation and their influence on the environment, EASA, as one of the leaders acting to mitigate the neg-

ative influence of aviation on the environment, not only tried to find an answer to a key question regarding what we know today about the non-CO₂ emissions' influence on air quality and on climate change, but also which factors play a role here. Moreover, in the report, EASA presents various possibilities whose purpose is the mitigation of the negative influence on the environment. However, it should be stressed that we are not at the end of the road; we are still trying to understand this complex issue as well as possible and we still need years to gain fully reliable results that will allow us to take the appropriate practical actions.

As I mentioned before, although it is difficult to define unambiguously the level of influence of all types of non-CO₂ particles on the environment, experts confirm that globally speaking they have an influence on global warming (although we are speaking here about the net impact, as most – but not all – of the emissions have a positive forcing, i.e. they lead to global warming). It should be noted that the most precise estimations regarding the influence on the environment are for nitric oxides (NO_x). These particles do not cause the increase in the average global temperature by themselves but they disturb the chemical balance of the atmosphere – they have an influence on ozone and methane which in turn have an impact on radiation.

One should not forget that gaining knowledge is only the first – albeit a very appropriate – step in the right direction. We have to work intensively on the selection and development of the appropriate methods aimed at reducing non-CO₂ emissions. Fortunately, a lot has already been done. EASA already has environmental standards, which include those related to both the NO_x emissions and the non-volatile particulate matter (nvPM). Those emissions are also measured upon the engine certification process. EASA is also working on the eco labelling project, which will support and promote environmentally friendly activities among the aviation community and the general public.

In many aspects, activities regarding the reduction of non-CO₂ emissions are based on assumptions similar or identical to those related to the reduction of CO₂ emissions in aviation. As a rule, the most obvious factor that will positively contribute to reducing the amount of the NO_x and nvPM emissions in global aviation is technological progress, which will result in the introduction of new technologies such as those related to aviation fuel burn (like, for example, Rich-Burn, Quick-Mix, Lean-Burn (RQL)). In the operational area of e.g. SES and its environmental efficiency indicators, it is also possible to further develop air traffic management so that it takes into account the non-CO₂ emissions.



Nevertheless, aside from activities taken up incidentally, so to speak, there are already ideas which concentrate more on non-CO₂ emissions, which we can ascribe to three categories and that simultaneously engage various elements of the aviation system.

The first category covers various types of fees including, among other things, a fee for NO_x emissions. This would encourage aircraft manufacturers and airlines to investigate various methods to limit the emissions. The selection of a specific method would depend on how profitable from a financial point of view it would be in comparison to the previous solutions.

There is also a possibility to complement the EU ETS system with such a fee. In that case, it would be necessary to adjust the existing regulations at the European level. This would probably entail the need to converse the non-CO₂ emissions levels to CO₂ equivalents, just as is presently done in the case of on-ground installations. Such a solution would not require the development of any new procedures, as it could use the existing measures applied by the ETS. One should remember, however, that because ETS is politically rather vulnerable, such a solution would require further analyses related to the non-CO₂ influence on the climate, which would deliver unambiguous results justifying the use of this and not another solution.

The second category covers fuel producers. Here, the focus is on the process of preparing the fuel and on its chemical composition. In this case, the producers would be obliged to reduce to the greatest possible extent the aromatic and sulphur content in their fuels. In selecting a solution like this one, the producers would have to change the fuel production process by the application of hydrotreatment and by introducing a procedure for constant monitoring of the fuel content to ensure its compliance with the requirements of a potentially implemented international standard. On the other hand, it would be necessary to perform measurements to show how such a process would influence the environment.

In this category, a good idea could also be an obligation to introduce sustainable aviation fuels (SAFs). This could be gained by implementing legal solutions imposing the addition of SAFs to jet fuel. This issue is already being widely discussed and analysed in the context of endeavours to reduce CO₂ emissions in the aviation sector. This solution is beneficial because it influences various types of emissions – not only CO₂ but also nvPM. However, one cannot forget that such a solution will influence the operational costs of SAF users and their producers. It is highly probable that these costs would be transferred to the air carriers' clients, which in turn might negatively

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“Gaining knowledge is only the first – albeit a very appropriate – step in the right direction. We have to work intensively on the selection and development of the appropriate methods aimed at reducing non-CO₂ emissions.”

influence both the air carriers and the whole air transport sector. Cross-subsidisation of SAF from the central EU sustainability or investment funds would therefore be very helpful to mitigate the risk of reduced accessibility of air transport to EU citizens.

When it comes to airspace management, the experts suggest avoiding flights in ice-supersaturated regions (ISSR). Although it might seem peculiar and impractical at first sight, the application of such a solution might lead to a significant reduction of the development of contrail cirrus clouds and this would have a huge impact on all aspects related to non-CO₂ emissions.

According to the authors of the above-mentioned report, a climate fee collected per flight could constitute another solution. This measure would at the same time be the most widely applied but also the most difficult one, and it would probably be introduced later than the other solutions. At present, there is no methodology or legal regulation that would allow the introduction of this idea.

A common element for all the above-mentioned measures is the necessity to perform a thorough analysis and detailed research to unambiguously define the influence of the NO_x emissions on the climate. Some doubts about the impact on the climate have to be definitely clarified. First of all, we still have no uniform and globally accepted methodology of estimating the NO_x emissions during flight. There is a need to develop and estimate a compromise and a relation between the non-CO₂ and CO₂ emissions. The worst possible situation would be if we were to introduce solutions leading to the reduction of non-CO₂ emissions but which increased the CO₂ emissions at the same time. It is not difficult to imagine planning a route for an aircraft that would avoid an ISSR but which would cause increased fuel consumption and therefore the emission of more particles having a negative influence on the environment. Finally, it is necessary to estimate the level of possible fees that would be introduced for the sector.

There is still much to do and most of the solutions depend on a wide range of analyses and deliberations on the feasibility of some of them. The authors of the report assume that one can start implementing some of the proposed measures between the second half and the end of this decade. However, one should not forget that we are closer and closer to defining the actual level of the aviation non-CO₂ emissions' influence on the environment. The aviation sector is therefore very close to implementing new, efficient actions aimed at reducing this negative impact and to taking innovative steps in the area of global environmental protection that would comprehensively take into account the factors influencing the environment in a negative way. ■

Piotr Samson has been Director General of Civil Aviation for Poland since 2016. In 2019 he was appointed chair of the Management Board of the European Union Aviation Safety Agency (EASA) and holds the position of vice-president of the European Organization for the Safety of Air Navigation's (EUROCONTROL) Provisional Council. Since May 2020, he has also been a member of the ECAC Coordinating Committee. Piotr is a manager with over 20 years of professional experience. He graduated from Warsaw University of Technology and Cranfield University (MBA) and studied at the National University of Ireland, Galway.

Zenid – sustainable aviation fuel from air

Interview with **Oskar Meijerink**
Team Lead of the Future Fuels team, SkyNRG



The Zenid entity was established and presented on 8 February 2021 during the High-Level Conference on Synthetic SAF hosted by the Ministry of Infrastructure and Water Management of the Netherlands. This conference highlighted state-of-the-art developments on sustainable aviation fuels, with a special focus on synthetic jet fuel from CO₂ and H₂. The Zenid entity was one of the projects presented to push the Zenid project forward. SkyNRG is one of the project's supporting partners.

What is the Zenid plant?

Zenid is a demonstration facility that aims to produce jet fuel from CO₂ captured from the air, water and renewable electricity. The plant will be powered by renewable electricity. The principle of energy production from air is like a reverse combustion of the fuels we are using today. Burning fuel releases energy and emits CO₂ and water. We are putting these ingredients back together – so CO₂ from air and water – and letting them react in a chemical reactor powered by renewable energy to eventually create a fully circular liquid fuel.

What are the conditions to ensure net-zero emissions from this production principle?

Jet fuel from air is fully circular since the amount of CO₂ released during combustion has been captured before. With a completely decarbonised value chain in the future, the production of the fuel will not emit any CO₂ emissions and will therefore contribute to a net-zero aviation industry.

What is the timeframe for this project?

We plan the commissioning of the plant by 2024. We are currently reviewing the feasibility study to decide on location and size and are

raising the necessary funds to finance the plant. We expect we can scale these technologies to a commercial scale around 2030.

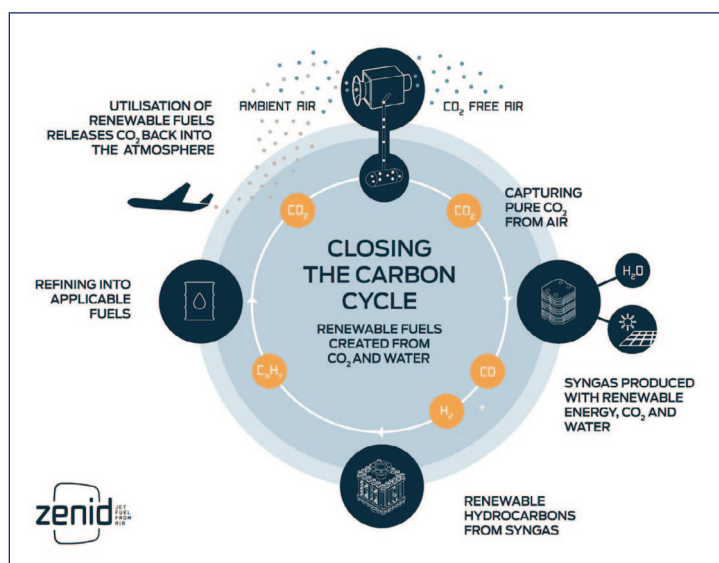
Does this project require heavy infrastructure investment, or can similar projects be implemented at several airports?

A first-of-its-kind project like Zenid will require significant investments. However, the main cost driver for e-fuels, and thus the Zenid project, is the price of renewable energy. Therefore, in the future these projects are likely to be concentrated in areas where cheap and abundant renewable electricity is available. This is likely to be the case in areas with a lot of solar or wind resources.

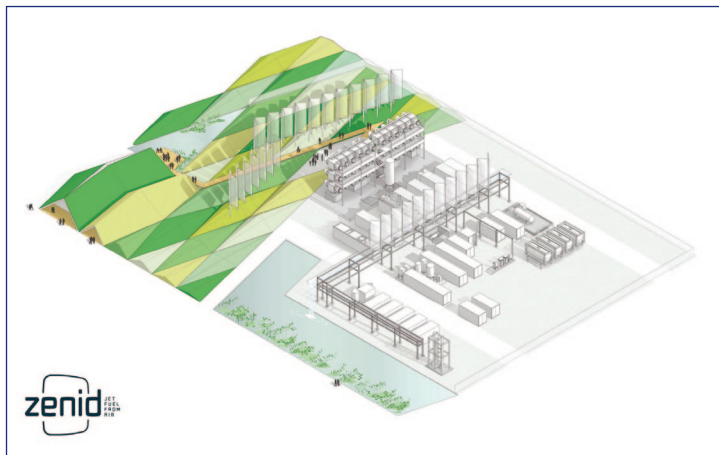
Do you know of similar experiences around the world?

Climeworks, Sunfire and Ineratec (partners of Zenid) have demonstrated that fuels from air can be produced on a lab scale. We are not aware of another industrial-sized production facility using 100% CO₂ from the air in development at the moment. However, several other projects use a similar technology chain but with CO₂ from (a combination of) other sources:

- > **Synkero:**
<https://synkero.com/>
- > **Norsk e-fuel:**
<https://www.norsk-e-fuel.com/en/>



Zenid – sustainable aviation fuel from air



© Image by BlueRoom

What are the expected outcomes of the project?

We want to demonstrate that the combination of highly innovative technologies (direct air capture (DAC), co-electrolysis of water and CO₂, modular Fischer-Tropsch) can work in an efficient and fully integrated manner. At today's date, this has not yet been achieved on this scale (several thousand litres of capacity per day).

Do you anticipate that competing demand for renewable energy will be a major problem towards large-scale deployment?

We recognise that other industries will demand renewable energy as well. However, the aviation industry lacks the ability to electrify directly, especially for mid- and long-haul flights. Electricity-based sustainable aviation fuels will play, in parallel to other bio-based solutions, an important role in decarbonising aviation.

Do you see any additional hurdles towards large-scale deployment?

The availability of cheap and abundant renewable electricity is the most important hurdle for the e-fuels pathway. Also, scaling the necessary technologies will take time and (risk-taking) resources.

What kind of supporting policies would facilitate similar experiments and deployment?

We recognise two options: demand-side driven policies (mandates specifically for aviation), or technology-driven policies such as the EU Horizon 2020/EU Horizon Europe or EU Innovation Fund programmes that stimulate the development of these new technologies.

Could this become a unique solution for decarbonising aviation, or is there still a role for biofuels and other sustainable aviation fuels?

We truly believe there is no silver bullet that will solve all issues. Aviation is a very hard-to-decarbonise sector; we will need all the solutions we have on our plate. This also includes less flying where possible, replacing short-haul flights as much as possible by trains. But it also includes the full slate of SAF pathways, including bio-based solutions, of which some are already commercially available and can have a big impact today. E-fuels will play a large role from 2030-2040 onwards in supporting this decarbonisation effort. ■

> SkyNRG

SkyNRG is the global market leader for sustainable aviation fuel (SAF) solutions. Having supplied over 30 airlines on all continents, it is our mission to make SAF the new global standard. SkyNRG sources, blends and distributes SAF, guarantees sustainability throughout the supply chain and helps to co-fund any price gap over conventional jet fuel. At the same time, SkyNRG focuses on developing regional SAF supply chains, e.g. our own dedicated SAF production plant, DSL-01, that offer a real sustainable and affordable alternative to fossil fuels. To ensure we make the right decisions regarding the sustainability of our operations, projects and products, SkyNRG is structurally advised by an independent Sustainability Board, which includes representatives from World Wildlife Fund (WWF) International, the European Climate Foundation, Solidaridad Network and the University of Groningen. Also, SkyNRG's operations are certified by the Roundtable on Sustainable Biomaterials (RSB), the highest possible certification standard for sustainable fuels. www.skynrg.com

Oskar Meijerink is team lead of the Future Fuels team and part of SkyNRG since 2016. He leads SkyNRG's efforts in its pre-commercial supply chain development projects, working together with technology partners to commercialise new sustainable aviation fuels' pathways. In the pre-commercial supply chain development projects, SkyNRG works together with partners from across the supply chain to take the next step, e.g. build a pilot or demonstration scale facility. Oskar studied energy science at Utrecht University and specialised in sustainable aviation fuels. More specifically, he studied investments in the SAF supply chain at Imperial College London during his graduation.

Hydrogen in aviation: the challenges

Carine Donzel-Defigier

*Deputy Head of the Aeronautics Division,
Directorate General of Civil Aviation, France*



Like any other industry, the aeronautical sector has to take its part in the global decarbonisation effort to limit climate change. Europe has one of the leading aeronautical industries in the world, and therefore the ability to have a very significant impact on the decarbonisation of air transport at the global level. In France, thanks to our long-standing public-private partnership, CORAC (Council for Civil Aeronautical Research), a roadmap for the decarbonisation of air transport was defined in a collaborative manner between 2019 and 2020.

The preliminary work involved showed that there would not be a single miraculous solution, but that zero-emission air transport would result from a combination of various solutions with different timelines: optimised operations, sustainable aviation fuels (SAF) (including e-fuels) and technological improvement, from incremental steps to real breakthrough ones, like H₂-powered aircraft. The following elements on H₂-powered aircraft come from this collaborative work.

H₂-powered aircraft offer the tantalising possibility of near zero-emission flight, as the combustion of hydrogen in an engine does not produce carbon dioxide (CO₂) and could, if well controlled, reduce nitrogen oxides (NO_x) emissions by 80%. However, the challenge is impressive: from the aircraft configuration to the airport infrastructures and even the logistics of the “fuel”, everything will have to change.

► Technical challenges of H₂-powered aircraft

Let's take the aircraft first. Hydrogen has an excellent mass energy density: one kilogram of H₂ packs about three times as much energy as one kilogram of kerosene. The problem is that one single kilogram of H₂, at normal

temperatures, represents a volume of 11 m³, that is to say a third of a 20 ft container when the volume of one kilogram of kerosene is about 1.25 litre or 0.00125 m³. Even pressurised at 700 bars, H₂ (which is still under gaseous form) occupies a volume more than seven times greater than that of kerosene for the same energy, and its storage at such pressure levels requires the use of very thick-walled tanks, with a very significant impact on the aircraft's empty weight. For these reasons, a high-pressure hydrogen storage solution can only make sense for small aircraft.

This means that to be used in commercial aircraft, hydrogen has to be liquefied. And H₂ is liquid at very low temperatures: no more than 20° above the absolute zero. H₂-powered aircraft will therefore have to include a cryogenic tank and cryogenic distribution systems. However, the volume of those tanks will remain three to four times greater than that of current kerosene tanks, and their shape will have to be spherical, cylindrical or conical or to resist internal pressures, which excludes any possibility of integrating these tanks in the wings, as for current aircraft. New aircraft configurations must therefore be considered in the case of an H₂-powered aircraft, and these configurations will also have to guarantee the efficiency and safety of hydrogen refuelling operations on the ground.

These tanks and the distribution system represent major technological challenges. For example, H₂ is highly explosive and therefore must absolutely be contained within the tanks and pipes, but as the smallest molecule, H₂ has an unerring capacity to slip away through microscopic gaps in material. Even seemingly mundane tasks need to be rethought: how to measure the amount of liquefied H₂ in a cryogenic tank where there is a mix between gaseous H₂ and liquefied H₂ (physical phenomenon known as “boil-off”)?

A major design problem is to determine where (and how) in the distribution system the liquid H₂ will be transformed into gaseous H₂ to be burnt in the engines. The engines will also have to be adapted, as H₂ does not burn the same way as kerosene: the combustion chamber will have to change accordingly.

Hydrogen can also be used to power fuel cells, which have the advantage of emitting only water vapour, but whose current performance (power density, operating temperature) is too limited to cover the propulsive power requirements of commercial aircraft. Fuel cells are nevertheless being investigated to power regional aircraft. The technological challenges are the same as for “H₂-burn” aircraft when it comes to storage and distribution

Hydrogen in aviation: the challenges



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of H₂. And fuel cells also present specific challenges, such as dissipation of the heat emitted.

To sum it up, to safely use hydrogen on board an aircraft, it is imperative to fully master the new risks associated with this new fuel. This implies establishing new design, monitoring and control principles (for leak detection, fire management, etc.) for key safety systems (storage, distribution, propulsion), and developing new critical technologies for cryogenic hydrogen storage (tank insulation, pressure management, liquid level measurement, etc.), its delivery to the engines (or fuel cells) at the required pressure and temperature conditions (pumps, valves, exchangers, compressors, etc.) and finally, its injection and its combustion into the engines.

► Non-aircraft challenges: contrails and H₂ production and distribution

Aviation is unique in that it releases its emissions into the upper atmosphere. As a result, chemical species other than CO₂, and in particular nitrogen oxides (NO_x), water vapour, and volatile and non-volatile particles, also contribute to aviation's radiative impact through mechanisms such as contrails and induced cirrus clouds, cloud interactions, or ozone formation. These "non-CO₂ effects" seem to have a greater impact than those of CO₂, but significant uncertainties remain in their evaluation, due in particular to the multiplicity and complexity of the physical phenomena to be taken into account and represented, the extent of the physical scales to be integrated, from microphysics to the global scale, and the difficulty in acquiring precise experimental data to feed and calibrate these evaluations. The uncertainty is particularly high when it comes to the impact of contrails, whose appearance is linked with water vapour emissions in specific atmospheric conditions.

As H₂ combustion produces 2.6 times more water vapour than kerosene, its use as a fuel could generate much more frequent and

intense contrails, which could counterbalance the beneficial effect of suppressing CO₂ emissions, or, on the contrary, contribute to dehydrating the upper atmosphere and reducing the natural greenhouse effect. Contrails could therefore constitute a no go for the development of H₂-powered aircraft. However, recent studies indicate that most contrails are created by a very small percentage of flights and that simply altering trajectories to avoid areas where atmospheric conditions are favourable to contrails generation could diminish significantly the quantity of contrails.

In order to assess as accurately as possible the contribution of aviation to global warming and to guide the choice of the best strategies to reduce this contribution, it is now essential to understand and quantify the impacts of each of the physico-chemical mechanisms involved in the generation of radiative forcing. Therefore, an ambitious scientific research programme on the climate impacts of aviation has been launched in France. The results of this work will be widely shared within the scientific com-

munity and will be the subject of a major dissemination effort, thus contributing to objectifying the public debate on the climate impacts of aviation, but also to informing the future decisions of manufacturers, operators and air transport regulatory authorities as to the most effective measures to reduce aviation's climate impacts.

An H2-powered aircraft can perform a near-zero emission flight, but this does not constitute real decarbonisation if the H2 used has been produced in a carbon-intensive manner, which is today the case. Hydrogen can be produced in a nearly completely decarbonised way by the electrolysis of water, provided that the electricity used for the electrolysis comes from renewables or nuclear energy. For the time being, H2 coming from electrolysis costs many times more than kerosene for the same energetic output, and the volumes produced are very limited. Cost and volume of production are of course linked, and production increase will necessarily drive prices down, but it is highly unlikely that the demand from aviation (which represents today a very small part of the demand in petroleum derivatives) will be sufficient to drive down price sufficiently for an H2-aircraft to be economically sustainable for airlines. Therefore, one condition to H2-aircraft appearance in our skies is that other sectors adopt H2 as their primary energy at roughly the

same time, and that the energy industry planifies accordingly the increase in H2 production, taking notably into account the need for low-carbon electricity.

As for H2 logistics, solutions will need to be developed to bring H2 to the airport and ensure refuelling of H2-powered aircraft. Because of H2 tendencies to leak through any material, long-distance transportation through pipelines cannot be considered. H2 will have to be produced near airports, or even on airport's premises.

► Conclusion

The level of technological ambition for an H2-powered commercial aircraft is considerable, and before such an aircraft can fly, very significant exploratory work is required - and has already begun. A better understanding of the impact of contrails on the climate is, however, needed before fully committing to the development of such an aircraft, so as to not lose because of contrails what has been gained thanks to carbon-free emissions. The introduction of H2 aircraft will also depend on the ability of the energy industry worldwide to produce and distribute H2 in sufficient volumes, at costs that are sustainable for the market, and with a minimal carbon footprint, and of airports to adapt their infrastructures.

Research and development on H2-powered aircraft is not exclusive of R&D to reduce the overall mass of aircraft, optimise their configuration so as to reduce drag, or equip them with ultraefficient engines. Future H2-powered aircraft will benefit from all "incremental" R&D as it will incorporate lighter materials for its fuselage, ultraefficient engines adapted to H2 burn, etc. R&D on H2-powered aircraft does not dispense either from R&D on how to improve operations, both on the ground and in the sky, to reduce further the overall fuel consumption. After all, the best energy is the energy you do not use. ■

After a degree in engineering, **Carine Donzel-Defigier** joined the French Directorate General of Civil Aviation as deputy head of the French air carriers and public intervention office. She then moved on to lead the international activities monitoring and operational quality office (Airworthiness and Operations Division) for four years. This office participates in elaborating and implementing the safety oversight policy of French air carriers and is responsible for elaborating and implementing the ramp inspection programme on French and foreign air carriers. As of September 2015, Carine joined the aeronautic division as deputy head. This department is in charge of defining and putting into effect the French aeronautical research and development support policy, and of the secretariat of the Civil Drones Council.



German policies in support of sustainable aviation fuels and power-to-liquids

Stefan Bickert

Policy Officer, Federal Ministry of Transport and Digital Infrastructure, Germany

Aviation is an integral part of a free and globalised world. But alongside the advantages and opportunities of aviation, its climate impacts have to be considered and addressed.

Due to COVID-19, the aviation sector is currently in its biggest crisis ever and there is still a lot to do to achieve a successful recovery. However, this recovery must go hand in hand with accelerating the environmental transition of the sector. The current crisis therefore also offers chances for the sustainable development of aviation. The Paris Agreement, the European Green Deal, in Germany the Federal Climate Change Act⁽¹⁾, the German Climate Action Plan 2050⁽²⁾ and the Climate Action Program 2030⁽³⁾ set ambitious climate goals. Germany aims to achieve a 42% reduction of CO₂ emissions from the transport sector by 2030, compared to 1990, and to achieve greenhouse gas neutrality by 2050. The aviation sector has to contribute its fair share to reach these goals. To this end, and besides technological, operational and market-based measures, sustainable aviation fuels (SAF) are a key measure to fulfil its obligations towards environmental and climate protection.

The significant role of SAF becomes clear as research shows that despite all technological developments, air traffic will continue to rely on liquid fuels for the foreseeable future. From the different types of SAF, Germany specifically focuses on kerosene produced from additional renewable electricity, CO₂ and water as synthetic e-fuels – what is known as power-



to-liquid (PtL) kerosene. It is considered that PtL has a very high potential to contribute to the sustainable development of aviation and to reach climate goals. For it to be successful, it is crucial that it is developed in compliance with suitable sustainability criteria. While Germany sees high potential specifically for PtL and for advanced biofuels to reduce the carbon footprint of the aviation sector, the potential of conventional biofuels is considered rather limited since these fuels could, in some cases, lead to negative environmental effects and additional greenhouse gas emissions. Research and development of PtL is mentioned in the German Climate Action Plan 2050 and further specified in the Climate Action Program 2030 with specific programmes and measures to

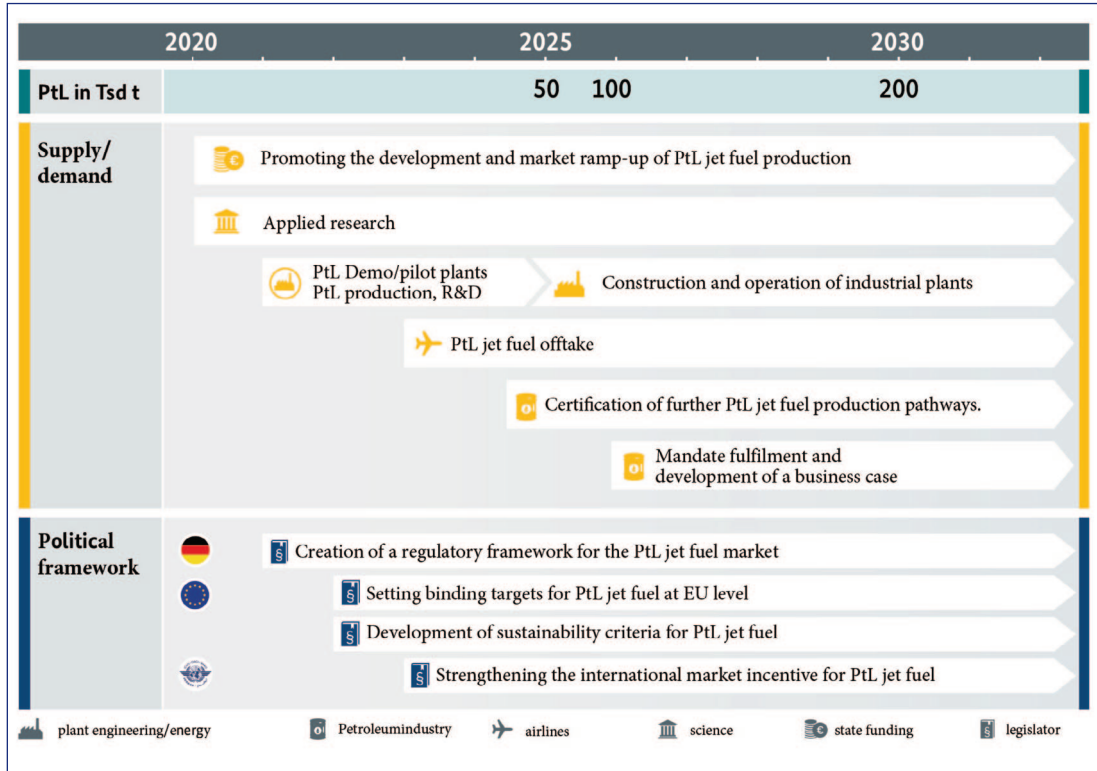
develop climate-neutral e-fuels for aviation. However, despite the promising potential of PtL, it has no business case yet, notably due to high production costs as a consequence of the limited availability of, and thus relatively high costs for, renewable electricity. Although technologies are mature and some production pathways are already certified, their economic efficiency could not yet be achieved, resulting in PtL not being available in the market in sufficient amounts.

To support the market development and facilitate the use of the PtL potential, Germany has among others set up a funding regime for sustainable fuels to support the production scale-up and to bring down the costs. To this end, the Federal Ministry of Transport and Digital Infrastructure will provide funding of up to 1.5 billion euros in the years 2021 to 2024, stemming from the German Energy

(1) http://www.gesetze-im-internet.de/englisch_ksg/englisch_ksg.pdf

(2) <https://www.bundesregierung.de/breg-de/suche/climate-action-plan-2050-728890>

(3) <https://www.bundesregierung.de/breg-en/issues/climate-action>



Envisaged implementation of the PtL roadmap

and Climate Fund and the National Hydrogen Strategy. While these funds cover sustainable fuels across all modes of transportation, a major share will be dedicated to PtL for aviation. Funding policies are currently under development, including dialogues with market actors to efficiently design these policies. Specifically for aviation, funding for investments in, and operation of, PtL kerosene production plants is planned. To foster further research on PtL fuels for aviation purposes, the set-up of a PtL development platform is currently conceptualised with both a research and a demonstration module to allow for the development of market-ready fuels. In addition, a funding call for investments in, and operation of, industrial PtL kerosene production plants is planned to be published by the end of 2021.

Besides national support and funding regimes, regulative measures for the production and use of PtL play a key role for its market development and economic efficiency. Germany aims at an ambitious national implementation of

the EU Renewable Energy Directive (REDII) and foresees a national blending quota for PtL in jet fuel starting from 2026 with 0.5% and increasing to up to 2% by 2030 based on kerosene sold in Germany. With regard to this quota, market distortion has to be considered and avoided. Therefore, Germany advocates for a common European and international approach regarding regulative measures and quotas. In this context, the German government supports the EU initiative “ReFuelEU Aviation” to boost the supply and demand for SAF and PtL in the EU, and advocates for an explicit inclusion of a separate requirement for PtL kerosene.

With regard to national policies, Germany published its National Hydrogen Strategy ⁽⁴⁾ in June 2020 that also builds a basis for PtL in aviation. The strategy provides a coherent framework for the production, transport and use of hydrogen, encouraging the relevant innovations and investments. It outlines that green hydrogen and its downstream products are sus-

tainable solutions to mitigate climate change in areas where direct electrification is not or hardly possible. Within the framework of the National Hydrogen Strategy, investments of 7 billion euros are planned to promote the production and use of green hydrogen and its downstream products in Germany. Additional funds are planned for projects with international partners. An action plan including 38 measures in the first phase up to 2023 focuses on the ramp-up of green hydrogen and lays the foundation for a domestic market. In parallel, essential issues such as research and development as well as international aspects will be tackled. Specifically for aviation, the National Hydrogen Strategy includes measures to incentivise production capacities for PtL. It also outlines the already mentioned quota for PtL in aviation.

As an additional national initiative, the German Federal Government, the “Bundesländer” and stakeholders from the aviation industry, fuel producers and suppliers have developed a joint PtL

(4) <https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/the-national-hydrogen-strategy.html>



roadmap for aviation. This roadmap is considered as another key component of PtL and for facilitating a joint understanding on this matter. It summarises and outlines Germany's views and measures to support the production and use of PtL to ultimately achieve the 2050 perspective of sustainable and largely CO₂-neutral air traffic. With this PtL roadmap, main actors are naming measures and a time plan to build up and expand the production of PtL kerosene in the next years. It is the objective that until 2030 an amount of at least 200 000 tonnes of PtL kerosene is available in Germany to aviation. The following measures support reaching this objective:

- The technological developments of production plants and components needed for PtL production have to be optimised; and simultaneously, in view of their overall technical integration, they have

to interact unimpaired also at industrial scale.

- Sustainability criteria have to be established in a standardised, binding, as well as reliable ecological and social manner.
- The support of the market ramp-up happens through binding targets for the purchase and use of renewable kerosene, regulative measures and frameworks for a self-sustaining market while avoiding market distortion, as well as governmental funding regimes without preference for a certain technology. In addition, the air carriers commit to purchase relevant amounts of PtL kerosene in the next years.

The implementation of this PtL roadmap is continuously monitored. In addition, initiated projects by actors to support PtL kerosene are documented and will be made accessible to a wide public audience.

In addition to SAF and PtL policies at the national and European levels, Germany supports the ICAO activities on SAF and PtL with a focus on its overall sustainability. Germany ultimately aims to achieve an economically efficient market ramp-up for PtL by supporting its production, reducing its costs and enabling its use. To achieve the most efficient results, measures need to be coordinated at international level. ■

Stefan Bickert has worked in the Department of Aviation of the Federal Ministry of Transport and Digital Infrastructure in Germany since January 2019. He is responsible for the department's work on environmental and climate protection in aviation at international level as well as at European and domestic levels. Stefan is the ICAO CAEP member for Germany and Germany's focal point for the ICAO State action plans initiative. Before working for the government of Germany, he worked in the Environment, Air Transport Bureau at ICAO (2014-2018). He started working in research at a university and a research centre focusing on sustainable transport and electric mobility. Stefan studied ecological economics and additionally obtained his doctorate analysing the economic and environmental integration of electric vehicles in Germany.

An example of SAF implementation at airports: the Norwegian experience

Arvid Løken

Senior adviser, Avinor Carbon Reduction Programme, and Avinor Focal Point for Sustainable Aviation Fuels



For more than a decade now, Avinor has been working together with the Norwegian aviation industry to reduce emissions from aviation. We have had full backing from our owner, the Norwegian State, to take on this role. And while at the beginning, spending time and resources on reducing carbon emissions not within the company's own remit was questioned by some, it is now increasingly becoming an integrated part of airport operators' strategy and plans.

► Decarbonising aviation

Aviation is a typical hard-to-decarbonise sector: high-energy density is needed, and at least on the longer routes, hydrocarbons are needed more than in most other sectors. On short to medium flights, however, Avinor considers electrification of aviation as a great opportunity for Norway, with a high share of renewable electricity and many routes that have relatively few passengers per flight. Avinor works to support this development; we will prepare our airports for electrified aviation in time for the first flights and we plan to do the same for hydrogen.

It is commonly acknowledged, however, that for a number of years the aviation industry will depend on sustainable aviation fuels (SAF) to decarbonise. SAF is a turnkey solution. It has been certified for use in civil aviation since 2009 (in blends up to 50 per cent) and can be dropped into the existing infrastructure and hardware.

► An airport perspective

Models vary throughout the world but except for various degrees of ownership of the fuel infrastructure, European airports typically do not have a formal role in the jet fuel value chain from well

to wing. However, there are a number of actions an airport can take. We observe an increasing number of airports that engage in SAF development in different ways, for example through preparing for supplies of SAF, informing passengers and doing some of the preparatory work for SAF production and uptake in their country or region.

Avinor is continuously exploring what an airport operator could do to enhance SAF production and uptake and what kind of incentives an airport operator can give to passengers or airlines that use SAF.

► Fact finding and bringing people together

The main challenge with SAF is that it remains costly and that production is still at a very low level compared with fossil fuels. Many small and big steps could be taken to address that; research and development to mature new production technologies, introduce new types of biomass and approve new technology pathways; ambitious incentives and policies to promote SAF production and uptake; investments, purchase agreements, communication, nudging and preparation at different levels. Some projects out there are of global importance whilst others focus on a local feed-

stock. The impression is that more and more airports, airlines, research organisations and authorities contribute in the development.

Some have been working with SAF for a long time; an example is Scandinavian Airlines System (SAS) that has been active on this topic since the turn of the century. SAS and the regional airline Widerøe have for some time now offered travellers the opportunity to pay the extra cost of SAF. Avinor's work with SAF started with fact finding and bringing the industry and NGOs together in 2007. A process of developing a knowledge base for sustainable aviation and for SAF has created a common starting point for discussions. Every three to four years, Avinor has led a process where the Norwegian aviation industry has published a joint sustainability report with information about societal benefits, greenhouse gas emissions and strategies to reduce emissions. Quite a bit of analysis work has also been done on the topic of SAF: an analysis showed that in Norway, it is primarily biomass from forestry that will be able to contribute quantities in the size we are talking about in a sustainable way. The conclusion was that waste and by-products from forestry could provide enough biomass for 30 to 40 per cent of the fuel demand for Norwegian aviation.

An example of SAF implementation at airports: the Norwegian experience



► Demonstrating usage since 2014

In the beginning, it was a prioritised task to showcase that SAF could actually be used just as fossil fuels, that aircraft could use SAF without any adjustments to engines or fuel-systems and that SAF could be blended into large fuel facilities just like fossil fuel. The first SAF flights in Norway were carried out by SAS and Norwegian Air Shuttle in 2014. In January 2016, Avinor Oslo Airport, in collaboration with AirBP, Lufthansa Group, KLM, SAS, Neste and SkyNRG, became the world's first international airport to blend biofuel into the regular fuel supply system and to offer biofuels on a commercial basis to all airlines refuelling there. In 2017 and 2018, SAF was also provided at Avinor Bergen Airport.

From our point of view, the project was very successful. Challenges were mostly practical issues like getting production time in refineries and obtaining a product with the right specification. We did not have any issues with the infrastructure and felt that the project contributed with yet another little piece of the jigsaw puzzle for a cost-effective SAF supply chain. Passenger perception, documentation and the principle of mass balance were also aspects of the project. A mass balance principle (like when renewable electricity is provided into a grid, all electricity consumers get the same electricity

mix) is applied, meaning all airlines refuelling at the airport get the same mix of green and fossil molecules in their fuel, but only the airlines that pay the extra cost for the fuel can claim SAF usage in their reporting and communication.

► From voluntary SAF blending to mandates and roadmaps

Norwegian authorities were first in the world to introduce a blending mandate for aviation. From 2020, it has been a requirement that 0.5 per cent of all aviation fuel sold in Norway must be advanced biofuels (with the exception of fuels sold to the Norwegian Armed Forces). The obligation is on the fuel suppliers. A greenhouse gas reduction mandate in Sweden is expected to be operational by mid 2021. Other countries and the EU as such (ReFuelEU Aviation) are also discussing similar mandates (blending or greenhouse gas reduction). These mandates are changing demand from being based on voluntary uptake by airlines and fuel suppliers (although in some countries incentivised) to mandated percentage requirements.

► Ambitious airlines

Scandinavian Airlines System, Norwegian Air Shuttle and Widerøe have set quite ambitious

targets for SAF uptake by 2030, and in October 2020 a group consisting of these airlines, the Norwegian Confederation of Trade Unions, the Federation of Norwegian Aviation Industries and Avinor launched a roadmap for Norwegian aviation towards 2050, with the ambition to be fossil-free by 2050. This is a demanding goal that requires close cooperation between the industry and the authorities. 2050 may seem like a distant future, but as technological development both in aviation and in industry takes time, action plans, incentives and a common understanding should be in place as soon as possible. Important milestones are also set for the closer future, and 2030 is in aviation terms right around the corner.

Avinor will together with the industry regularly report on the achievement of targets, and benchmark against other countries where aviation has set ambitious targets.

► Sustainability is key

It is obviously not sustainable when rainforests or other particularly carbon-rich or species-rich vegetation are cut down as biomass for fuel. It is also problematic when the biomass used for fuel could have been used alternatively, such as for food or feed, or if land use is displaced for the production. The Norwegian aviation industry is very clear that the biofuel used at Norwegian airports, both diesel and jet fuel, should meet the EU's sustainability criteria, and that palm oil and palm oil products are unacceptable. The EU's sustainability criteria require a reduction in greenhouse gas emissions from fossil fuels of at least 60 per cent. Biofuels from by-products of Norwegian forestry will typically give a significantly greater reduction in emissions (up to 90 per cent).

Most of the biofuel produced in the world today is conventional biofuel (based on agricultural productions), produced for road traffic. In the EU and the EEA, however, measures are now in force to ensure that an increasing share are advanced biofuels, i.e. fuel based

An example of SAF implementation at airports: the Norwegian experience

on waste and residues. Requiring advanced biofuels avoids the challenges of conventional biofuels that conflict with food and feed production and other land use problems. The biomass used will typically be leftovers and by-products from forestry, agricultural production, household waste and the food industry.

E-fuels has gained increasing attention and confidence over the last years and seems to be included in most plans for decarbonising aviation. It will be interesting to follow the further development on the topic, also regarding sustainability. There are issues to be discussed and clarified when it comes to the source of hydrogen, electricity and CO₂ that are essential to the sustainability of the fuel produced.

► SAF looking forward

The Norwegian aviation industry is currently working on a programme proposing incentives and policy instruments for increased uptake and production of SAF.

It seems clear that SAF will remain significantly more costly than fossil fuel, and that there is a need for incentives and international agreements. Norwegian aviation would like to see international measures significantly strengthened, both at the European and global level, including the EU Emissions Trading System (EU ETS) and the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The programme will contain both an update on status and projections for availability and costs for the main types of SAF (biofuel and e-fuels) and describe how production and uptake can be increased.

Competition in international aviation is hard, and margins are low. Without a level playing field with competitors from other coun-



Aviation in Norway; industry report coordinated by Avinor on the social benefit and climate and environmental impact from aviation

tries, it is impossible to remain competitive in the long term. And when talking about SAF, competition will not only be from other airlines. It seems clear that there will be tough competition both from other transport modes and other industries for the biomass and hydrogen needed in the process.

► Value creation and inspiration

Greenhouse gas reductions could definitely be implemented at a lower cost in other countries and other sectors. But Norwegian aviation has taken the Paris Agreement as point of departure and also sees great potential both for the aviation sector and for society; fossil-free aviation will be a key contributor to the mobility of the future and by being early movers in this field, Norwegian aviation can make an impact on reducing greenhouse gas emissions far beyond our borders. At this stage in SAF development and uptake, not yet at percentages of fuel consumption, getting the systems, technologies, incentives and mar-

kets right could be equally as important as quantifiable greenhouse gas reduction numbers. So, also, is information to passengers and other stakeholders about SAF as a way of decarbonising aviation.

Avinor has been supporting research projects on the topic of forest-based fuels over a number of years, and we see a considerable potential for value creation in industry and forestry if we succeed in setting up large scale SAF production; Norwegian industry should already have a competitive advantage based on green electricity and rich biomass sources.

In the longer term, technology for harvesting, cultivation and processing can change and open up other opportunities. Among other things, marine resources such as algae are pointed to as a resource that can be developed to be of great importance to Norway.

Other countries or regions should do their own analysis regarding the best way forward to encourage both uptake and production.

Aviation will be an important part in the mobility of the future, but the goals of the Paris Agreement have to be met. SAF is a turnkey solution and acknowledged to play a key role in decarbonising aviation. ■

► AVINOR

Avinor is a state-owned company that is the national air navigation service provider and owns and operates the majority of airports in Norway. Avinor is engaged in activities to reduce emissions both from the airports and from the Norwegian aviation industry.

Arvid Løken is senior adviser in Avinor's Carbon Reduction Programme and Avinor's focal point for sustainable aviation fuels. Arvid's main responsibilities are sustainable aviation fuels and research and development projects within the field of greenhouse gas reduction from aviation. He has a background in innovation funding and innovation projects in organisations such as Nordic Innovation and the Norwegian Ministry of Trade, Industry and Fisheries. Arvid has a master's degree in economics and resource management and an MBA.



High-Level Conference on Synthetic Sustainable Aviation Fuels, 8 February 2021

Linda van Wamelen-Sibbes

Senior Policy Advisor, Ministry of Infrastructure and Water Management, the Netherlands



During a high-level conference organised by Dutch minister Cora van Nieuwenhuizen, several EU Member States called upon the European Commission to further stimulate and incentivise the uptake of sustainable aviation fuels (SAF), including synthetic fuels, through funding programmes under the existing financial framework. They welcomed the ReFuelEU Aviation initiative as a starting point for further EU coordination, to ensure an integral and effective long-term agenda on sustainable aviation.

On 8 February 2021, the Dutch Minister of Infrastructure and Water Management, Cora van Nieuwenhuizen, organised a High-Level Conference on Synthetic Sustainable Aviation Fuels (SAF). The blizzard howling outside, something we in the Netherlands had not seen in years, tested our adaptability as it meant that the COVID-proof physical meeting had to be cancelled and we had to switch to the complete digital participation of our participants, hosted live from a studio in The Hague.

The main objective of the conference was to speed up the European dialogue on synthetic SAF and offer a stage to present a range of initiatives and relevant themes. We wanted to have an open discussion about the steps that need to be taken and possible hurdles that might be encountered. It is clear that SAF will have a significant role in reducing the carbon footprint of the aviation sector in the coming years. Participants agreed that with the economic recovery of the aviation sector, no backsliding should

occur in the reduction of emissions in the aviation industry. SAF usage will contribute to the necessary CO₂ reduction of the aviation sector in the coming decades.

As explained in an introductory video, one substantial way of achieving the necessary CO₂ reduction in aviation in the coming decades is to use SAF. Well-known and applied SAFs are bio-based fuels obtained from sustainable resources, like waste oils, woody biomass, renewable waste and residual waste sources. A different kind of SAF that is receiving increasing attention is synthetic kerosene. Synthetic kerosene can be classified as an e-fuel, made from hydrogen generated by using green electricity and water and from carbon dioxide captured from refineries, or simply from the air.

Experts from the aviation and fuel production sectors such as Pieter Elbers (KLM), Peter Vanacker (Neste), Pete Harisson (ECF), Maarten van Dijk (SkyNRG), Christoph Gebald (Climeworks), Yuri Sebregts (Shell) and Armin Schnettler

(Siemens Energy) discussed the biggest challenges we face in up-scaling synthetic kerosene from a technology, sustainability and economic point of view. Their conclusion was that the separate technology steps are well advanced, but system integration is key. The sustainability of synthetic kerosene depends on the production process. Using CO₂ from the air, together with water and renewable energy, would be the most sustainable way in the future but this will take time (and a lot of money). Therefore scaling up other CO₂ sources needs to be considered. The costs for the production of synthetic fuel will still be much more than the fossil route. Investment in research and development is needed, together with supportive long-term stable policy, cost reduction of renewable energy and subsequently the production of green hydrogen. All experts agreed that working together to achieve these challenges is very important.



► **World's first passenger flight on synthetic SAF**

The conference also generated a worldwide scoop. During the conference, it was announced that the world's first passenger flight performed with sustainable synthetic kerosene had taken place in the Netherlands. In January, a commercial passenger flight to Madrid was carried out on a mixture of 500 litres of sustainable synthetic kerosene. Shell produced the synthetic kerosene in its research centre in Amsterdam based on CO₂, water and renewable energy from sun and wind. Though this was only a small amount and mixed with conventional fuel, it showed that synthetic kerosene can be produced and that an aircraft can already fly on it. A small step... but is that not the start of big leaps?



Cora van Nieuwenhuizen, Dutch Minister of Infrastructure and Water Management:

"Making aviation more sustainable is an international challenge that we face together. Today, we are taking a great step in the new chapter of aviation. This promising innovation will be of great importance in the coming decades to reduce CO₂ emissions from aviation.

It is great that in the Netherlands we were the first to show that this is possible: a big compliment for all involved. I hope that, in these turbulent times for aviation, this will inspire people in the sector to continue on this course."



Pieter Elbers, CEO of KLM:

"I am proud that KLM has operated the industry first flight using synthetic kerosene made from renewable sources. The transition from fossil fuel to sustainable alternatives is one of the largest challenges in aviation. Fleet renewal contributed significantly to the reduction of CO₂ emissions, but upscaling production and the use of sustainable aviation fuel will make the biggest difference for the current generation of aircraft. That is why we teamed up with various partners some time ago, to stimulate the development of sustainable synthetic kerosene. This first flight on synthetic kerosene shows that it is possible in practice and that we can move forward."

Marjan van Loon, Shell Netherlands President and CEO:

"Shell is an active player in the energy transition and our contribution to this world-first is an example of this. I am extremely proud that we have succeeded in producing 500 litres of jet fuel for the first time based on CO₂, water and renewable energy. It is an important first step and together with our partners we now need to scale up, accelerate and make it commercially viable."

▶ New initiatives

During the conference, the stage was also given to new initiatives and start-ups. For example, the start-up Synkero announced that it is collaborating with Port of Amsterdam, Schiphol, KLM and SkyNRG on the realisation of a commercial synthetic sustainable kerosene factory in the Port of Amsterdam. This project seeks to link with sustainable initiatives in the North Sea Canal area, such as the establishment of a 100-megawatt hydrogen plant where up to 15 000 tons of green hydrogen could be produced with sustainable electricity.

Another initiative is the construction of a demonstration factory for sustainable kerosene using captured CO₂ from the air in Rotterdam. The Zenid initiative, in which Uniper, Rotterdam The Hague Airport, Climeworks, SkyNRG and Rotterdam The Hague Innovation Airport are participating, uses a combination of innovative technologies to focus on CO₂-neutral aviation with sustainable synthetic kerosene.

▶ Government support

Also, several European officials, including the keynote speakers Frans Timmermans (Executive Vice-President at the European Commission) and Adina Vălean (European Commissioner for Transport), the German transport minister Andreas Scheuer and his French colleague French Minister Delegate for Transport Jean-Baptiste Djebbari, underlined the importance of developing sustainably produced aviation fuels to reduce CO₂ emissions. Mr Djebbari stressed the importance of setting clear SAF tar-

gets at the European level as a way to send a strong signal to the market. He also stressed the importance of EU and national funding for SAF projects. Mr Scheuer shared his support for the development of synthetic kerosene and told the audience that Germany had earmarked €1.5 billion for sustainable fuels, part of which will be reserved for power-to-liquid aviation fuels (PtL). On top of that, Germany is considering a national blending quota for PtL up to 2% in 2030.

The European Commission also shared encouraging words. European Commissioner for Transport Vălean stressed the importance of making aviation futureproof and underlined that economic recovery should go hand in hand with decarbonising the sector. SAF should play a major role in this and a long-term policy framework is needed. To strengthen cooperation on SAF, the Commission plans to involve every interested party: airlines, producers, researchers, airports, public authorities, civil society and others, and wants to establish a Renewable and Low-Carbon Fuels Value Chain Alliance. And in the words of the Commissioner: this all with the hope that in the future we will have a whole rock band of new, sustainable, alternative fuels. Executive Vice-President at the European Commission Frans Timmermans shared at the end of the conference that he experienced no reluctance by airlines to decarbonise but acknowledged that the premium of SAF remains a challenge. Furthermore, Mr Timmermans underlined the importance of international cooperation, carbon pricing, the ReFuelEU initiative and the development of the hydrogen sector. Mr Timmermans concluded his contribution with the message that the European Commission is on our side in decarbonising the aviation sector.

▶ Conclusion of the High-Level Conference

A commonly repeated message, also during the governmental statements made by Denmark, Finland, Latvia, Luxembourg, Spain and Sweden, was that all parties need to work together to upscale the production and use of SAF, including synthetic kerosene. As said, also from the side of European Member States, their support to work on this was clearly and repeatedly echoed. At the close of the conference, their commitment was translated into the following joint statement by the representatives of Denmark, Finland, France, Germany, Luxembourg, the Netherlands, Spain and Sweden:

Support the aim of the European Commission to boost the supply and demand for SAF in the EU so as to create favourable conditions in order to ramp up the production and deployment of SAF based on robust sustainability criteria. The potential of synthetic aviation fuels, in addition to advanced sustainable biofuels, is clear. The challenge is to make use of the current momentum by providing for a clear long-term perspective so as to contribute to a scalable SAF marketplace. A European blending mandate for SAF can achieve this.

Call upon the European Commission to further stimulate and incentivise the uptake of sustainable aviation fuels, including synthetic fuels, through funding programmes under the existing financial framework.

Welcome the ReFuelEU Aviation initiative as a starting point for further EU coordination so as to ensure an integral and effective long-term agenda on sustainable aviation.



First row from the left: **Cora van Nieuwenhuizen**, Minister of Infrastructure and Water Management, the Netherlands; **Timo Harakka**, Minister of Transport and Communications, Finland; **Tomas Eneroth**, Minister of Infrastructure, Sweden; **Pedro Saura Garcia**, Secretary of State for Transport, Spain.

Second row from the left: **Benny Engelbrecht**, Minister for Transport, Denmark; **Jean-Baptiste Djebbari**, Minister Delegate for Transport, France; **François Bausch**, Minister for Mobility and Public Works, Luxembourg; **Andreas Scheuer**, Federal Minister of Transport and Digital Infrastructure, Germany.

The statement reflects the view of Member States that the development of sustainable synthetic kerosene in addition to sustainable bio-kerosene, is one of the most promising and effective ways to reduce aviation emissions in the coming decades. At the same time, it was also acknowledged that in parallel, technological innovations that aim at a zero-emission aviation in the long term should be part of the larger sustainable development framework. It is clear that international coordination and cooperation is essential so that we can make a sustainable aviation sector more than just a dot on the horizon. ■

The statement is still open for Member States to join and can be found here: [Joint Statement on Sustainable Aviation Fuels | Publication | The Netherlands at International Organisations \(permanentrepresentations.nl\)](#)

For those who missed this conference or wish to watch the High-Level Conference on Synthetic SAF again, this is possible at the following link: [SAF - YouTube](#)

Linda van Wamelen-Sibbes has been a senior policy advisor at the Dutch Ministry of Infrastructure and Water Management since 2016. In the past, she has worked on EU ETS Aviation, and in the last couple of years has worked mainly on SAF policy for aviation. In that capacity, she was also the project lead for the High-Level Conference on Synthetic SAF held on 8 February 2021. Linda obtained an MA in History at the University of Leiden and an MSc in International Public Management and Policy at the Erasmus University of Rotterdam.



United States' views on aviation climate action

Kevin Welsh

Executive Director, United States Federal Aviation Administration, Office of Environment & Energy, with contributions from Dan Williams and Kevin Partowazam, Office of Environment & Energy

On day one of the Biden-Harris Administration, President Biden took action to rejoin the Paris Agreement and made tackling the climate crisis a top priority of the United States. Through executive action, the president established climate change as a central element of United States foreign policy and committed to put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050. The urgency and priority for action aligns the United States with many governments, non-government organisations, and the private sector in recognising the threat of climate change and the need for urgent action.

The United States has a long track record of taking action to address the climate impact of aviation, and in line with the Biden-Harris Administration's commitment on climate, we will establish ambitious aviation targets, accelerate actions to reduce aviation emissions, and pursue a global approach to tackle this global challenge. We are not waiting to act, and we are working diligently to develop a comprehensive aviation climate action plan to set out not only the overall aviation climate objectives of the United States, but also the specific actions and steps we will implement to achieve our vision. This article shares initial views on how the FAA and the United States seek to tackle the aviation climate challenge.

▶ A bold vision for aviation

Many governments, including the United States, have committed to mid-century, net-zero targets, sending an important signal of the level of ambition and scope of action needed to tackle the climate challenge. Further still, many airlines have committed to achieving net-zero carbon emissions by 2050, and some governments support an aviation-specific net-zero goal. In a 25 February 2021 joint



statement between the United States Department of Transportation and Transport Canada, our two governments committed to developing a shared vision towards reducing the aviation sector's emissions in a manner consistent with the goal of net-zero emissions for our economies by 2050.

These high-level commitments are critical to establishing the level of ambition needed to tackle the climate impacts of aviation, but are insufficient without action. In addition, a bold vision for aviation must mobilise actual actions and resources to meaningfully reduce aviation emissions and put the sector on a pathway to achieve an ambitious target. While the COVID-19 pandemic has dealt a serious blow to the global economy and the aviation sector, the sector is forecast to return to a substantial growth trajectory once it recovers. In light of expected future growth, governments and industry must recognise

the challenge of meeting ambitious targets and define aggressive actions that they can implement to reach them. The United States intends to establish a vision for aviation that sets ambitious targets and accelerates action to reduce emissions.

▶ Accelerating action

We will build on a strong foundation of action and accelerate our efforts in the areas of technology, sustainable aviation fuels (SAF), operations, and policy to effectively tackle the aviation climate challenge. These actions will require a comprehensive and collaborative approach among United States agencies, industry, non-government organisations, and international partners.

“ A bold vision for aviation must mobilise actual actions and resources to meaningfully reduce aviation emissions and put the sector on a pathway to achieve an ambitious target. ”

› *Technology*

Improvements in aircraft technology have always been at the forefront of aviation environmental protection, and the United States intends to pursue an aggressive plan for technology research and development to improve fuel efficiency and reduce CO₂ emissions from aircraft. Technology developments over the next decade are particularly critical because they will likely be incorporated into the next generation of single-aisle aircraft – aircraft that currently make up over half the global market in terms of airplane value, and nearly half of global commercial aviation CO₂ emissions.

To enable this technology development and deployment, the United States plans to continue strong investment in our aircraft technology development programmes. This summer, the FAA is launching the third phase of the Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, a public-private research partnership with industry focused on maturing cleaner and quieter technologies. In parallel, the FAA has expanded its portfolio of aircraft technology research into the ASCENT Center of Excellence, and plans to continue efforts in this area to mature technologies at all technology readiness levels and share this knowledge throughout the industry. Efforts within these programmes are scalable, meaning that additional investment can grow the scope of technologies being pursued and thereby reduce overall efficiencies and CO₂ reduc-

tions influencing the environmental performance of next-generation aircraft.

› *Sustainable aviation fuel*

SAF present the most promising near- to medium-term tool to dramatically reduce aviation emissions with the potential to reduce life cycle greenhouse gas emissions by 80 per cent or more. These fuels are referred to as “drop-in”, meaning they meet stringent specifications for jet fuel and can be used in existing airplanes and engines without modification. Over the last 15 years, the FAA has led efforts to support the development and deployment of SAF, including through testing, analysis and coordination between government and the private sector. Recently, SAF production has scaled up with over 4.6 million gallons produced in the United States in 2020, but commercial production is still limited.

The United States will prioritise the development of SAF as a key aviation climate priority and establish a cross-agency effort coordinating and focusing investments to reduce cost, ensure that fuels meet accepted international sustainability criteria, and expand their production. We will continue to collaborate closely with the private sector through the Commercial Aviation Alternative Fuels Initiative and other opportunities. We will also increase our international collaboration on SAF to ensure a coordinated approach and help ensure its global availability.

› *Operations*

Improving the efficiency of aircraft operations in the United States is critical to get the full benefit of new technologies and fuels. The future of air traffic services in the United States will happen in a shared information environment. Broader data distribution, information connectivity, delivery of actionable information to decision-makers, and persistent situational awareness will enable improved performance of the airspace system by distributing decisions and allowing stakeholders to best manage their operations. These improvements will contribute to fuel and emissions reductions by allowing operators to more regularly fly their preferred, optimal trajectory. The FAA will continue to enhance efforts to improve the efficiency of operations, and identify opportunities to work with partners internationally to achieve enhanced benefits for long-distance flights.

› *Policy*

Effective policy measures are also critical and complement actions on technology, SAF, and operations. Ensuring the effective implementation of the International Civil Aviation Organization (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is one key policy measure, and the United States will continue to implement CORSIA for United States' operators, while we work at ICAO to broaden participation and ensure continued global

United States' views on aviation climate action

implementation. By design, CORSIA is an interim measure to provide the aviation sector with a mechanism to address aviation emissions through carbon offsetting, while allowing time for technology, SAF and other in-sector measures to mature. CORSIA will also put in place internationally agreed sustainability criteria for SAF and will help further accelerate their development and deployment.

In addition to CORSIA, the United States will explore other complementary policy measures to reduce aviation emissions in line with our vision.

► Non-CO₂ effects

One area affecting climate that is less understood are the non-CO₂ climate impacts of aviation emissions. The impacts of other gases and particles are short-lived and vary in space and time. The FAA is currently funding research using the latest scientific models and realistic emissions scenarios to improve our understanding of the short-lived, non-CO₂ climate forcers from aircraft, and we plan to conduct further investigation on this topic.



► A global approach

Pursuing a global approach is another essential element for addressing aviation's climate impact. Not only does climate change require a global response, but international aviation represents a significant and growing source of global emissions. Since ICAO's founding in 1944, countries have recognised the essential role of international collaboration to ensure a safe and interoperable international aviation system, and expanded this mission to include environment. Countries come together at ICAO to set the standard for a safe, secure, and environmentally responsible international aviation system, and we are committed to working collaboratively at ICAO to achieve ambitious action on climate change. Looking ahead to the 41st ICAO Assembly, ICAO has the opportunity to both develop a long-term climate goal

for international aviation and an opportunity to strengthen and refine CORSIA through its periodic review. Doing so will require multilateral cooperation and effort. Outside of ICAO, we will work bilaterally and in other multilateral settings, as appropriate, to ensure continued progress on this important issue.

► Conclusion

Addressing climate change is a global challenge. No country, no industry, and no individual can solve it on their own. Aviation must do its part. In the United States, we recognise the enormity of this challenge, but we are eager to work with our industry and international colleagues through a variety of means to enable aviation to do its part in addressing climate change – the greatest challenge of our times. ■

Kevin Welsh is Executive Director of the Office of Environment & Energy at the Federal Aviation Administration. In this role, he leads the development of aviation environmental and energy policies, goals, and priorities, and oversees research, engineering and development projects and initiatives. He also represents the United States at the International Civil Aviation Organization's Committee on Aviation Environmental Protection (CAEP) to develop recommendations for international standards and policies for aviation environment and energy issues.

ACAO's role in environmental protection



Abdennebi Manar

Director General, Arab Civil Aviation Organization (ACAO)

Since its inception, the Arab Civil Aviation Organization (ACAO) has sought to contribute to protecting the environment in the field of civil aviation whilst coordinating positions between Arab countries and defending the interests of the Arab region in international forums.

ACAO's environmental priorities include the following:

1 | Strengthening environmental legislation and institutions for Arab countries

Today, protecting the environment represents a new challenge for Arab countries. Some, such as the Gulf countries, are quite advanced in environmental protection, while others are experiencing difficulties in regulating this activity.

A diagnosis of these countries reveals common difficulties relating to the lack of a legal framework for environmental protection, the need to strengthen the entities in charge of environment within the civil aviation authorities, and the lack of managers and subject-matter experts.

Within this framework, ACAO provides assistance to these countries by calling upon the committee and the group of environmental experts at ACAO, through the exchange of experiences, the establishment of guidelines on regulations, and executives' capacity-building initiatives.

2 | Increasing the number of Arab countries participating in phase 1 of CORSIA

Today, among the 88 States participating in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) from 1 January 2021, a few Arab States volunteered to participate in CORSIA from its outset. This is a commendable initiative, destined to become pervasive among all Arab Member States.

In comparison to other organisations (such as the African Civil Aviation Commission (AFCAC), ECAC or the Latin American Civil Aviation Commission (LACAC)), the participation of Arab countries in the pilot phase and the first phase is still in its early stages. This participation is bound to increase to reflect the importance of Arab air traffic.

Among the 88 States participating in CORSIA, we notice the strong participation of ECAC Member States (50% of the global participation in CORSIA), which implies a comprehensive approach at European level.

These facts are challenging Arab countries and driving us to consider working hand in hand with AFCAC, since we have ten common member countries. This cooperation will allow us to identify common programmes and priorities, enhance capacity, avoid duplication and consolidate the efforts in the region

In this context, in the coming two years ACAO plans to increase Arab countries' participation in CORSIA to reach 60%. To achieve this goal, ACAO is committed to providing an opportunity for Arab States to share their existing readiness to implement CORSIA and to assess assistance needs. We will also consider negotiating bilaterally with Arab countries that have the potential to participate in the first phase.



ACAO's role in environmental protection

3 | Encouraging countries to submit their carbon reduction action plans to ICAO

According to ICAO statistics, 120 States representing 97.39% of global RTK (Revenue Tonne-kilometres) have voluntarily submitted their State action plan (SAP) to ICAO. Among those 120 States, 8 Arab States have submitted their SAP.

For this reason, the way forward and the next step for ACAO in 2021 is to improve the national capacity of the States to establish, update and implement a SAP on CO₂ emissions reduction from international aviation in accordance with ICAO standards, and to pursue its work with the ICAO EUR/NAT Regional Office in order to assist Maghreb countries (Algeria, Morocco, Tunisia) to establish their SAP.

4 | Enhancing capacity-building activities and strengthening regional cooperation

In the interest of ICAO's "No Country Left Behind" initiative, ACAO, in close cooperation with ICAO and other bodies, has carried out a number of capacity-building and assistance activities. These assistance activities are often related to the State action plan and CORSIA.

ACAO signed an arrangement with the ICAO EUR/NAT Regional Office on 19 Mars 2019, and with ECAC in May 2019, with the objective of increasing synergies and identifying common programmes and priorities, enhancing capacity, avoiding duplication and consolidating efforts in the region.

For this reason, ACAO will continue to work with international regional organisations such as the Arab Air Carriers' Organization (AACO), ECAC and ICAO to organise activities in favour of Arab members. The objective is to establish an environmental group of experts.

In 2021, we will organise the first Arab Forum on Environment; it will be an opportunity to share progress in terms of environmental protection in the Arab region. ■

Abdennebi Manar is Director General of the Arab Civil Aviation Organization (ACAO). He is a civil aviation engineer from the National School of Civil Aviation in Toulouse, France (ENAC). Prior to his appointment as the director general of ACAO, he held several roles including: acting director general of the Moroccan Civil Aviation Authority, civil aeronautics director, air navigation director, airport quality, security and safety director, acting air transport director, Moroccan representative to the Mixed Committee for the Implementation of the Agreement on the Liberalization of Air Transport between Morocco and the European Union, ACAO Executive Council member and Moroccan representative at the ICAO Council.

AFCAC's environmental priorities towards sustainable air transport for Africa



Frankline Omondi

Environment Expert, African Civil Aviation Commission (AFCAC)

► The scene

In 2018, at the 30th AFCAC Plenary, African Member States reaffirmed the importance of environmental protection as a key pillar to the sustainable development of air transport in Africa. A key strategic objective of AFCAC, we address the challenge to support our Member States towards compliance with international standards and best practices in environmental protection. We are specifically keen to foster the implementation of the ICAO Standards and Recommended Practices (SRPs) in Annex 16 to ensure the sustainable development of air transport in Africa.

This support is to ensure that African States include environmental considerations in their national aviation planning. In the face of the COVID-19 pandemic and with a strong desire to build back the African aviation industry better and sustainably, AFCAC has been at the forefront in finding innovative ways to collectively achieve this in the short and long term.

► The actions

1 | Targeting development or updating State action plans for CO₂ reduction by African States

With immense support from the African Development Bank as part of the bigger project of air transport liberalisation and sustainability, the environment component plans to support African States to update or develop new State action plans on CO₂ reduction activities. Other partners, including the

EU and United States Federal Aviation Administration, are considering the same approach to work with AFCAC in capacity building and technical assistance to African States. The States' action plans are a good opportunity for States to showcase measurable actions towards addressing the pressing issues of CO₂ emissions and climate change. It is also our strong belief at AFCAC that those States will move forward and implement specific projects under this framework that will further demonstrate a green and sustainable pathway for African aviation development.

2 | CORSIA implementation

AFCAC Plenary resolution in 2018:

“Encourage all Member States to volunteer and to fully participate in CORSIA from the onset as part of early preparatory actions for the continent.”

AFCAC, through its Member States, supports the implementation of CORSIA as the global market-based measure to address CO₂ emissions from international aviation. This resolution from the AFCAC Plenary mandated the AFCAC Secretariat to embark on

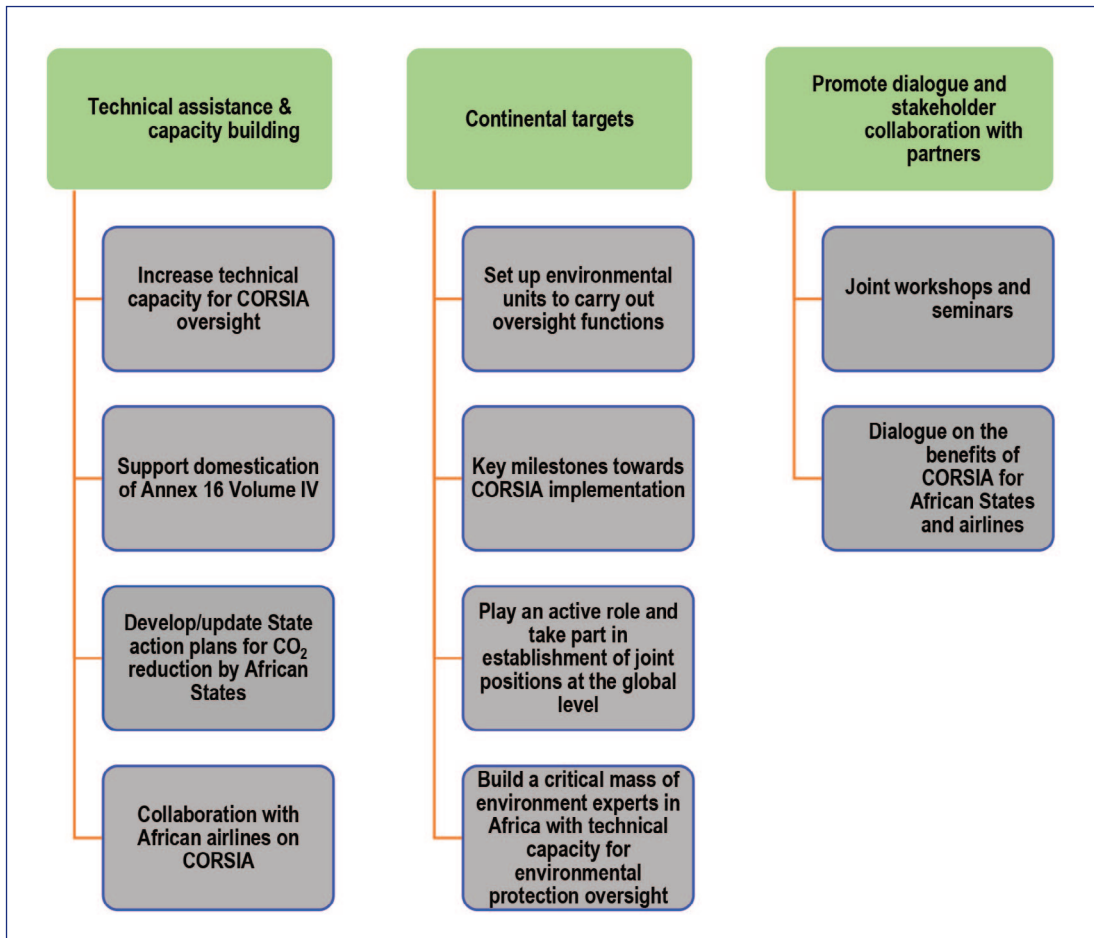
capacity building and technical assistance to States in order to build a critical mass of environment experts in States and African airlines to support CORSIA implementation in Africa.

To achieve this, AFCAC, working with its partners, is showing progress and reaching remarkable milestones. It is encouraging to see that the number of African States has grown from 8 at the time of the resolution in 2018, to 15 currently. Further AFCAC efforts on CORSIA are best depicted in this framework

3 | Framework for African aviation clean energy strategy

The *African Union Agenda 2063 flagship projects* of the Single African Air Transport Market – SAATM, African Continental Free Trade Area – AfCFTA and the African Passport and Free Movement of People are major enablers of African air travel.

It is expected that these projects will spur African air travel. With this increased growth comes the need for sustainable aviation fuels with low or zero CO₂ emissions. Together with the African Union, AFCAC looks forward to the development of an African aviation clean energy strategy to coordinate and leverage on opportunities provided by clean energy. AFCAC is encouraged by the ICAO-EU project that saw the installation of solar plants in Cameroon and Kenya. We intend to expand this project to more African airports and we will be looking to partnerships with the EU and other partners to achieve this.



AFCAC's pillars to support CORSIA implementation in Africa

► The expectations

Climate change, CO₂ emissions and the need for the sustainable development of air transport require concerted efforts. Enhancement of capacity in the African region is required. We therefore expect that our interventions will:

- Build a critical mass of environment experts in Africa with technical capacity for environmental protection oversight.
- Support initiatives that promote CORSIA implementation in a collaborative way with our partners.
- Increase the number of African States joining the CORSIA scheme.
- Position the African aviation industry to benefit from opportunities of sustainable aviation fuels. ■

Frankline Omondi is an aviation and environment specialist with a focus on climate change policy, air transport liberalisation, sustainability and efficiency at the African Civil Aviation Commission (AFCAC). He is also the AFCAC observer at ICAO's Committee on Aviation Environmental Protection (CAEP) where he coordinates environmental protection activities on behalf of the African aviation industry. In African air transport sustainability, Frankline currently supports the environmental components of the key African Union Agenda 2063 flagship projects of the Single African Air Transport Market (SAATM) project on behalf of AFCAC, the executing agency, in order to ensure the sustainable development of air transport in Africa. Frankline has over ten years' experience in the aviation industry covering airline policies and operations, and the civil aviation regulatory landscape.

LACAC's environmental priorities

Jaime Binder

Secretary of the Latin American Civil Aviation Commission (LACAC)

Edwin Giovanni Tobar Guzmán

Regional Manager for Air Transport and Environment of the Central American Corporation for Air Navigation Services (COCESNA)



Latin America and the Caribbean is a region that contains about 60% of the planet's terrestrial life and contains rich biological diversity (Convention on Biological Diversity, 2016). It is precisely because of this characteristic that a collective awareness has been developing about the need to take care of the environment and decisively face the phenomenon of climate change.

In this context, the Latin American Civil Aviation Commission (LACAC), a space for cooperation and coordination of civil aviation activities in the Latin American region, has created an environment for permanent discussion on environmental and aviation issues.

Among different activities, LACAC has participated in coordinating initiatives mainly on matters of noise, local air quality, airport planning and management, voluntary presentation of action plans for the reduction of emissions, and the implementation of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). In addition, within this coordination, the adoption of ICAO Standards and Recommended Practices on the matter and the active participation of the Member States in the ICAO Assembly, where every three years it seeks to improve the applicable resolutions on issues of environment, has been promoted.

On the other hand, it is relevant to highlight the "buddy partnerships", an initiative within the framework of the ACT CORSIA from ICAO, as a complement to the implementation of this mechanism in Latin America, which has also had the valuable collaboration of the

States of Canada, Italy, Spain and the United States, as well as the agencies AESA, CASSOS, COCESNA and SENASA.

Regarding the priorities for the next two years, LACAC, through the State of Guatemala, focal point on environmental matters, while proactively listening to the needs that arise from the industry, will focus its work on the following three areas:

1 | Implementation of CORSIA in the region

To this date, seven LACAC Member States have expressed their interest in participating in the pilot phase of CORSIA, namely: Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Jamaica and Mexico. The other LACAC States, on their end, have maintained a determined action in the phased-in implementation of the referred mechanism.

However, it should be noted that there is a high level of concern generated by the uncertainty caused by the COVID-19 global health crisis. In turn, this causes the inescapable need to generate a discussion within the LACAC group of specialists on the importance of defining metrics that are more

adjusted to the new reality, in balance with the economic sustainability of the sector – all of the above without jeopardising compliance with the environmental objectives defined by ICAO.

2 | Promote the Latin American region in the development of sustainable aviation biofuels (SAF)

After the discussions on the origin of biomass of the first, second or third generation for the production of biofuels, and this being one of the vital measures for the reduction of emissions, it is substantial to promote initiatives similar to those developed by States such as Argentina, Brazil, Colombia, the Dominican Republic and Mexico. Other measures of action that put the development of sustainable aviation biofuels (SAF) in the foreground must also be identified.

3 | Development of the emission unit market in the Latin American region

Of the total number of projects registered in the Clean Development Mechanism (CDM), less than 12% correspond to Latin America. In this sense, it is necessary to stimulate the design of mechanisms so that

LACAC's environmental priorities

investments in infrastructures or technology projects carried out in the region, in which the reduction of emissions is determined, can be incorporated into compliance with the reduction metrics and/or compensation of the airline sector as such.

Finally, seeing the light at the end of the tunnel of this lengthy crisis, the worst in the history of commercial aviation, allows us to predict the recovery of a resilient aviation that is committed to the environment. ■



Jaime Binder is a lawyer and Magister of Public Policy and Management from the University of Chile. For 16 years, he was an officer in the Ministry of Transport and Communications of Chile where he held various positions, among which as counsellor for the Civil Aeronautics Board and then, after selection through a public tendering, as the general secretary of the same organisation. Jaime was a professor of public policy and aeronautical law at the University of Chile and the University Adolfo Ibáñez. After a public tendering, he was appointed Secretary of the Latin American Civil Aviation Commission, assuming the role on 2 January 2019.

Edwin Giovanni Tobar Guzmán is currently Regional Manager for Air Transport and Environment of the Central American Corporation for Air Navigation Services (COCESNA). He also serves as titular representative of the University of San Carlos of Guatemala in the National Council of Climate Change of his country and is responsible for the environment macro-task of the Latin American Civil Aviation Commission (LACAC). He has also been the vice-minister for the environment of Guatemala and under-secretary of economic planning of the presidency of the Republic of his country. He writes a weekly opinion column "Lugar Hermético" in the El Siglo newspaper and technical articles in specialised magazines.

ECAC's environmental capacity-building programme

César Velarde

*Climate Change and Capacity-Building Specialist,
ECAC Secretariat*



For more than a decade, the ECAC Environmental Work Programme has supported ECAC Member States' efforts to implement ICAO and European aviation and environmental protection policies. It has also facilitated information sharing, developing scientific knowledge concerning the environmental impacts of aviation, and helped to build competences among ECAC Member States.

The 2016 *Bratislava Declaration* prioritised capacity building in the environmental field through the commitment to address needs that would arise from States requiring technical assistance in relation to implementation of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). ECAC Directors General have agreed to give further impetus to environmental capacity building through the recent recruitment of an ECAC climate change and capacity-building specialist to take forward a programme over the next three years.

Since 2010, ICAO Member States have committed to develop action on climate change through the adoption of international aviation aspirational goals for CO₂ emissions reductions: improving fuel efficiency by 2 per cent per annum and keeping the net carbon emissions from 2020 at the same level (carbon-neutral growth). Since then, tackling aviation CO₂ emissions has become an increasing political priority as well as a technical challenge to implement an effective "basket of measures" to progress towards these goals.

At the 2013 ICAO Assembly, this commitment was reaffirmed through the strategy of addressing CO₂ emissions reduction measures through a combination of technological and operational improvements, market-based mechanisms and new sustainable aviation fuels.

The definition and implementation of such measures required developing significant technical capacity and scientific knowledge in Member States and in industry, to adapt the different options to the specific circumstances and priorities of each country. All ECAC Member States have committed to turn those global aspirational goals into a reality.

► CORSIA challenges and the Bratislava Declaration

The adoption by ICAO in October 2016 of the CORSIA turned international aviation into the first industry sector to adopt a global market-based scheme to address climate change, in alignment with the objectives and mechanisms of the Paris Agreement to keep the global temperature rise below 2°C, and even to strive for 1.5°C. Civil aviation committed to contribute to achieving this goal through ICAO's action at the global level, and ECAC's actions in the European context.

CORSIA implementation in a worldwide harmonised manner and with the same level of consistency in all Member States required an enormous technical challenge and capacity effort, first to build up and adopt a new global ICAO standard (the Annex 16 Volume IV, adopted by the Council of ICAO on

27 June 2018) and then to implement it in all ICAO States as done before with many other ICAO Standards and Recommended Practices (SARPs).

Through the 2016 Bratislava Declaration, ECAC Member States expressed their intention to implement the ICAO CORSIA scheme to compensate international aviation CO₂ emissions from its very beginning, in 2021. The declaration included the commitment to address needs that would arise from States requiring technical assistance and capacity building in relation to the implementation of CORSIA.

Already in 2012, the inclusion of the aviation sector in the European Union's Emissions Trading System (EU ETS) had generated very valuable knowledge in European Union States on the functioning of a market-based mechanism applied to air transport operations, as well as technical capacity within the national authorities for its harmonised implementation and oversight.

Such technical capacity has significantly contributed to supporting ICAO in the development and global implementation of CORSIA and should be a valuable asset to promote States' partnerships to respond to the Bratislava Declaration's commitment to provide technical assistance.

ECAC's environmental capacity-building programme

► ICAO ACT-CORSIA: a coordinated approach for assistance and capacity building on CORSIA

After its adoption in 2018, the global implementation of the international aviation CO₂ emissions monitoring, reporting and verification (MRV) requirements as per the CORSIA SARPs, were to become applicable on 1 January 2019. This implied the enormous challenge of supporting capacity building and incorporating the SARPs provisions into national regulations in a large number of States in a very short timeframe.

For that purpose, the ICAO Council endorsed the ACT-CORSIA (Assistance, Capacity-building and Training for CORSIA) Programme, launched in July 2018. The Council also emphasised the need for a coordinated approach to undertake this global capacity-building initiative, and that any bilateral or multilateral partnerships among States should be informed and coordinated with ICAO, so that the progress of such efforts could be monitored. In this regard, the Council encouraged the establishment of "buddy partnerships" among States to help each other build capacity for CORSIA implementation.

The "buddy partnerships" promoted by ICAO are an example of successful global cooperation among States. After its first year of application, 98 States had already received training to implement CORSIA. Today, the number of States receiving capacity-building support has raised to 118, from 16 supporting States. Four of the supporting States are European and have assisted 51 different States worldwide, mainly in Africa, Latin America and the Caribbean and also in Europe.

The ECAC Regional Workshop on CORSIA Implementation hosted by the Turkish Directorate General of Civil Aviation in Istanbul in December 2018 under the ACT-CORSIA framework, and organised in



ECAC Regional Workshop on CORSIA Implementation, Istanbul, 13-14 December 2018

cooperation with ICAO in partnership with the German Environment Agency, provided training and support to seven European States.

► The ECAC Environmental Capacity-Building Programme, beyond CORSIA

At the DGCA/150 meeting of May 2018, Directors General agreed to give further impetus to environmental capacity building by recruiting an ECAC climate change and capacity-building specialist to take forward this work, starting on 1 December 2020.

The ECAC work programme recognises the need for environmental capacity building as a priority, and its environmental tasks already support States in sharing information and building capacity through the ECAC Environmental Forum, and by harmonising European positions for the ICAO discussions in the European Aviation and Environment Working Group, co-chaired with the European Commission.

This additional impulse to environmental capacity building seeks to enable Member States not only to deliver their environmental obligations and develop their action plans for improving the environmental performance in aviation, but also to build on previous capacity-building success in the aviation security and facilitation fields to further strengthen the competencies and knowledge of staff dealing with environment matters in ECAC Member States.

This way, States that wish to go beyond the strict regulatory fulfilment and develop more ambitious environmental strategies should have the capability to do so, and to be able to share and draw on best practices in order to make the most of ECAC's collective expertise.

Overall, the outcomes should bring both collective and national benefits. While States develop stronger environmental capabilities to address their own needs, this capacity-building programme should increase the level and availability of European expertise, both for the purpose of promoting understanding and information sharing within Europe, and also to promote the European views in global forums and discussions as well as individual ECAC States' outreach activities and international visibility.

► Identifying needs and planned ECAC activities

To better target States' needs and priorities, as a first step ECAC Member States have already been invited to identify their focal points on CORSIA and State action plans and to complete a survey to set out information on their own organisation's capabilities, perceived needs, priorities for support, and openness to build up partnerships with other ECAC Member States.

Thirty-eight of ECAC's forty-four Member States have participated in the survey, which resulted in identifying promising cooperation opportunities within Europe.

Notably, almost 70 per cent of respondents were willing to build capacity-building partnerships with other countries, from which approximately 40 per cent as supporting States and 60 per cent as requesting States. The survey has also highlighted that about 40 per cent of respondents do not have dedicated environmental structures within their organisations and a similar proportion do not have technical staff engaged in ICAO environmental policy discussions. It is remarkable that almost 70 per cent of respondents (about 60 per cent of all ECAC Member States) would be willing to develop further environmental capacity within their organisations.

ECAC will follow up on these initial steps by establishing bilateral contact between the Secretariat and some States to get a clearer sense of identified needs and to develop a more detailed three-year work programme that would comprise, but not be limited to:

- the development of guidance and training material on climate policies and mitigation measures for the benefit of ECAC Member States;
- the organisation of multilateral capacity-building events such as webinars, workshops and familiarisation sessions;
- promotion of partnerships among ECAC Member States, which might include training, secondment, shadowing, joint activities, administrative support and other initiatives, including continued follow-up support.

► Main thematic focus areas

The first overall objective of the capacity-building effort will be to support ECAC Member States' own efforts to fulfil ICAO environmental policy and regulatory requirements, particularly:

- updating State action plans (SAP) for CO₂ emissions reductions from international aviation, which the last ICAO Assembly asked to be submitted preferably by the end of June 2021; and
- implementing CORSIA from the beginning of its pilot phase (2021) as per the Bratislava Declaration.

For State action plans-related support, the ECAC/EU Action Plans for CO₂ Emissions Reduction Task Group (APERTG) was reactivated in December 2020 to update and provide guidance material to Member States. An information seminar was organised with States' focal points for action plans in March and others are planned for mid 2021.

To support CORSIA implementation, a plan of activities will be developed under the ACT-CORSIA initiative targeting ECAC Member States' identified needs, which will be developed and implemented in close cooperation with ICAO and to boost development of the "buddy partnerships" among ECAC Member States.

A proposal for a capacity-building programme is currently under development including a second overall objective to promote and support information sharing, policy awareness and personnel empowerment in ECAC Member States. The ECAC 2021 work programme already identified the need to share information and best practices relating to sustainable aviation fuels, in order to facilitate a good understanding of the challenges of its commercial scale-up and to encourage ECAC Member States' active engagement in its deployment. Additional areas of support are expected to be addressed as needs are identified.

Progressing towards decarbonising air transport is vital for the sector, and in the current extremely difficult COVID-19 pandemic times, the green recovery of aviation has been announced as a priority for industry leaders and a number of regulators. Such an ambitious goal can only be achieved through close public-private cooperation and partnerships; building scientific and technical knowledge and human resources capabilities is fundamental to identify and address the most cost-effective solutions to boost aviation's post-pandemic sustainable development. ■

César Velarde has been Climate Change and Capacity-Building Specialist in the ECAC Secretariat since December 2020. Before joining ECAC, he was environmental advisor at the Spanish Aviation Safety Agency (AESA) and ICAO CORSIA capacity-building consultant. He was co-rapporteur of the Fuels Task Group (FTG) at ICAO's Committee on Aviation and Environmental Protection (CAEP) and has been involved in several sustainable aviation fuels (SAF) initiatives worldwide. Between 2014 and 2018 César was based in Jakarta (Indonesia) as ICAO's environmental capacity-building expert and project coordinator.

EAEG Action Plans for Emissions Reduction Task Group



Interview with

Stefan Bickert

Federal Ministry of Transport and Digital Infrastructure, Germany

Magnus Gislev

DG MOVE, European Commission

Co-chairs of the ECAC/EU Action Plans for CO₂ Emissions Reduction Task Group (APERTG)

ICAO Resolution A40-18, adopted at the ICAO Assembly in October 2019, encourages States to submit to ICAO voluntary action plans outlining respective policies and actions to reduce international aviation CO₂ emissions. The ECAC/EU Action Plans for CO₂ Emissions Reduction Task Group (APERTG) is one of the specialist groups supporting the ECAC/EU European Aviation and Environment Working Group (EAEG), which helps European States by providing guidance material with a recommended common European approach for them to follow. Stefan Bickert (Federal Ministry of Transport and Digital Infrastructure, Germany) and Magnus Gislev (DG MOVE, European Commission) are the appointed APERTG co-chairs and below they jointly explain the background and objectives of the task group's work.

1. What are APERTG's objectives?

APERTG aims to support an effective and harmonised submission of action plans for emissions reduction from all 44 ECAC Member States to ICAO, in accordance with the ICAO Assembly Resolution A40-18, to show Europe's determination to fight against climate change while making common efforts to do so.

To achieve this, the ECAC Directors General decided to develop and further update common ECAC/EU guidance material for the provision to ICAO of those action plans from European States, with a recommended common European approach for States to follow.

2. Who participates in the APERTG group, and how does it relate to others working on this topic?

APERTG is intentionally a small group with members from States (Germany, Portugal, Spain and Switzerland), the European Commission, EASA and EUROCONTROL.

EASA and EUROCONTROL are key technical contributors on the estimation and update of a common European baseline scenario, which is intended to reasonably represent the fuel consumption and traffic that would occur in the absence of action. APERTG then assesses what the expected benefits from the different CO₂ emissions reduction measures considered are.

The group also works in close cooperation with the ICAO EUR/NAT Regional Office, as it follows ICAO guidance material, and interacts with the European focal points for State action plans appointed by ECAC Member States to ICAO.

3. What is the group's current focus and what are its expected outputs in 2021?

ICAO asks States to submit or update their action plans once every three years. In this context, the ECAC guidelines to support European States therefore also need to be regularly updated. The last edition was made in 2018 and currently we are working on providing a revised 2021 version to support the submission of the action plans preferably by the end of June this year, as requested by ICAO.

For every three-year round of updates, APERTG is reactivated and six to seven meetings are normally necessary to update the European common section for the action plans. For the current update, the group has been working since December 2020. The main expected outputs to be delivered by May 2021 are:

- updated European common section for European States' action plans, describing actions taken collectively at the European level;
- updated European baseline scenario;
- assessment of the benefits of common measures to tackle aviation CO₂ emissions.

4. What have the main challenges been?

The main challenge we addressed in this update cycle was how to reflect the COVID-19 impact in a CO₂ emissions baseline scenario, which should forecast emissions from 2020 till the 2050 long-term time horizon. There is much technical work under development worldwide to address how this crisis could impact future traffic, but because we needed to deliver our update in the first months of 2021, the level of uncertainty was still really high. It was decided to reflect the impact in the short- and mid-terms with the limited information available at this time, indicating that this would be revised in the next update, since in three years' time from now we could expect that a more accurate analysis would be possible.

Another challenge for the future will be how to assess the emissions reductions that can be achieved in the future thanks to disruptive new aircraft technologies and new energy sources, about which our knowledge today is still limited.

5. What are the next steps until the submission of action plans by States?

By May 2021, the European updated common section should be submitted to ECAC Directors General for endorsement, in accordance with the ICAO guidance that encourages States to submit action plans preferably by the end of June 2021.

The European focal points will be invited to incorporate the information of the common section into their State action plans, noting that they are also recommended to add a national section presenting the way in which they implemented the common measures, as well as providing a quantified assessment of their own additional national measures.

Information seminars with European focal points are planned in order to present the work on the ECAC guidelines, including the common section, to support States in that process.

6. Some final words?

APERTG's ultimate objective is to give visibility to mitigating actions taken collectively throughout Europe, including those led by the European Union, via the submission of State action plans to ICAO by ECAC Member States. So, our aim is to support all ECAC Member States in that endeavour, with the very valuable technical support of the EASA and EUROCONTROL teams, as well as the inputs from the European Commission and the precious expertise from States in developing and updating previous action plans. It is an important step in demonstrating European commitment to sustainable aviation at ICAO level. ■

Stefan Bickert has worked in the Department of Aviation of the Federal Ministry of Transport and Digital Infrastructure in Germany since January 2019. He is responsible for the department's work on environmental and climate protection in aviation at international level as well as at European and domestic levels. Stefan is the ICAO CAEP member for Germany and Germany's focal point for the ICAO State action plans initiative. Before working for the government of Germany, he worked in the Environment, Air Transport Bureau at ICAO (2014-2018). He started working in research at a university and a research centre focusing on sustainable transport and electric mobility. Stefan studied ecological economics and additionally obtained his doctorate analysing the economic and environmental integration of electric vehicles in Germany.

Magnus Gislev has a degree in chemistry and business administration from the University of Karlstad, Sweden. He started in the European Commission in 1995 and joined the Environment Directorate-General in 1999. Since August 2019, he has been working in the Aviation Policy Unit of the Directorate-General for Mobility and Transport, on environmental matters, in particular within ICAO.

► Directors General consider the path to recovery at the annual ECAC Forum

9 December 2020

Over 80 high-level delegates from 39 Member States, EASA, EUROCONTROL, the European Commission and the ICAO EUR/NAT Regional Office assembled with special guest speakers for the 13th annual Forum of ECAC Directors General, held virtually on 9 December 2020. Addressing the theme “COVID-19 crisis – from survival to recovery”, the Forum considered the current situation and explored how the crisis can drive innovation and make the sector more resilient for future crises. Eamonn Brennan (EUROCONTROL) set the scene in an opening presentation outlining a series of updates and forecasts on air traffic in the European skies, and looking at trends a year ago and how the sector could aim to get back to pre-COVID levels in the future.

The first session, moderated by Raúl Medina Caballero, Director General of Civil Aviation of the Spanish Ministry of Transport, Mobility and Urban Agenda, was dedicated to risk management and in particular to the various risks associated with human factors in different fields, such as safety and security. Eric Plantaz (Inmarsat Aviation) presented data on changing passenger habits, and Erick Ferrandez (EASA)

addressed the impact of the crisis on the safety landscape and how to map and mitigate safety risks for a safe return to operations. Carla Pinto (CAA Portugal) and Nina Smith (UK CAA) together looked at the insider risks from an aviation security perspective, and Crispin Orr (UK Air Accidents Investigation Branch) spoke about managing risk to enable effective safety investigations during a pandemic.

Moderated by Levan Karanadze, Director of the Civil Aviation Agency in Georgia, the second session focused on building more resilience in the aviation sector for a sustainable recovery. Eliska Mamdaniova (European Commission) explored the role of state aid in aviation, and Dalton Philips (DAA) addressed the financial resilience of airport operators. Florian Guillermet (SESAR Joint Undertaking) looked at securing ATM modernisation, while Michel Wachenheim (ASD Europe) addressed the importance of investments in new technology and innovation.

Closing the Forum, ECAC President Ingrid Cherfils underlined that harmonisation, adaptation, connectivity, investment, vision and innovation are fundamental in the efforts by all actors to overcome the crisis.

► Summary of activities in 2020 and objectives for the coming years

10 December 2020

ECAC's 155th meeting of Directors General of Civil Aviation reviewed the organisation's 2020 activities and the work priorities for 2021 in the following domains: external relations, safety and accident investigations, security, facilitation, environment, economic and legal matters and Remotely Piloted Aircraft Systems (RPAS).

ECAC President Ingrid Cherfils presented ECAC's activities on external relations, highlighting the discussions with key international partners, and notably the cooperation agreement with Kazakhstan. On cooperation with regional organisations (ACAO, AFCAC, LACAC), Ms Cherfils spoke of the regular exchanges on relief measures adopted in each region, the sharing of ECAC documents linked to the crisis, and discussions on the status of ratification of protocols amending the Chicago Convention on International Civil Aviation.

Directors General endorsed the proposal for the 2022-2024 work programme noting that it will be presented for formal adoption at the next Triennial Session ECAC/39 (12-13 July 2021). A mid-term review of the implementation of the 2022-2024 work programme will be conducted by the EMTO Task Force in mid 2023. Directors General also agreed on the princi-

ples underpinning the proposed 2022-2024 budget and related Member States' contributions.

Directors General were briefed on the main outcomes of the 221st session of the ICAO Council (26 October – 13 November 2020) and the European priorities in ATM and safety for the ICAO 2021 high-level event. Marina Koester (Germany) provided an update on the achievements of the German Presidency of the European Union, thanked all Member States for their good cooperation, and wished Portugal a successful Presidency. Luis Ribeiro (Portugal) presented the priorities for the forthcoming Portuguese Presidency of the European Union in 2021, namely: policy debate on refuelling aviation, social responsibility on the COVID-19 recovery, Regulation (EC) No 261/2004 on passenger rights.

Patrick Ky, Executive Director of EASA, briefed the meeting on recent initiatives taken by EASA to support the aviation system during the pandemic, while Eamonn Brennan, Director General of EUROCONTROL, gave an update on the traffic situation in Europe and provided an overview of EUROCONTROL's activities for the coming year, focusing in particular on innovation, and its cooperation activities with international partners.

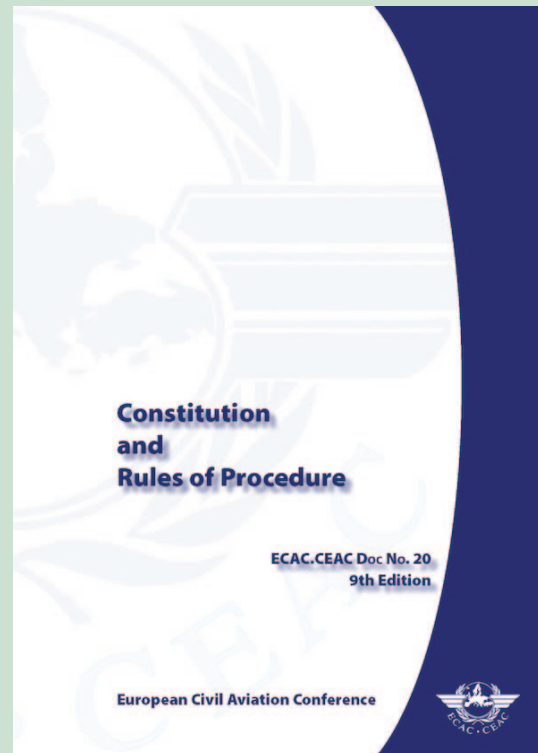
► Amendments to the ECAC Constitution

10 December 2020

Two amendments to the ECAC Constitution (8th edition/August 2019) were adopted at the 38th ECAC Special Plenary Session, convened to incorporate recent decisions taken by ECAC Directors General, in particular regarding the legal and administrative separation of ECAC from ICAO.

The Session adopted an amendment to Article 13 of the Constitution to insert a reference to the agreement signed between ECAC and EUROCONTROL on 26 March 2020 on the provision of services to ECAC by EUROCONTROL.

The second amendment adopted by the Session refers to the Terms of Reference of the ECAC Focal Point for Remotely Piloted Aircraft Systems (RPAS), which are included in the ECAC Constitution. The term “Remotely Piloted Aircraft Systems” was replaced by “Unmanned Aircraft Systems” throughout the Terms of Reference. The adoption of this amendment *“could reflect more accurately the most commonly used terminology and would also be more consistent with the draft ECAC 2022-2024 work programme”*, stated ECAC Executive Secretary Patricia Reverdy.



► ECAC President addresses Arab Civil Aviation Organization’s 25th anniversary celebration

7 February 2021

The importance of strong regional cooperation in fostering implementation of international requirements and promoting the interests of civil aviation was at the heart of ECAC President Ingrid Cherfils’ address at the 25th anniversary celebration of the Arab Civil Aviation Organization, held virtually on 7 February 2021.

Speaking in a second address at the conference, Ms Cherfils underlined how much ECAC valued the

close and fruitful relationship with ACAO. She emphasized that regular communication on policy matters of common interest to both organisations, and enhanced cooperation on capacity building were key to strengthening their partnership in order to meet the future challenges to aviation caused by the current unprecedented crisis and to foster a sustainable recovery of the sector.



► Environment experts attend fourth ECAC Environmental Forum

19-21 January 2021

The fourth annual ECAC Environmental Forum, organised virtually this time, explored a broad range of topics, beginning with a long-term aspirational goal for international aviation that featured an introductory scientific presentation and a review of the decarbonisation commitments already taken by stakeholders, States and organisations (including ATAG, ICAO, OECD-ITF). Recent significant developments on the non-CO₂ impacts of aviation, including a set of concrete proposals for mitigation actions, were also presented and discussed.

The meeting attracted 170 environment experts from a wide spectrum of stakeholders and geographical scope, and was launched with an opening address by ECAC Focal Point for Environment matters, Rannia Leontaridi, Director General for Civil Aviation, United Kingdom, and chaired this year by Michael Lunter (Netherlands).

CORSIA was the focus of the Forum's usual exchange of practical experience, and for the first time ECAC's three sister regional organisations, ACAO, AFCAC and LACAC, and Singapore, were represented and shared their experiences.

A closed session for European members only was held in the morning of the last day. The afternoon open session featured presentations on ambitious policies in support of hydrogen in aviation (including e-fuels). The main part of this session was dedicated to improving the mutual understanding of the respective environmental priorities of ECAC's partners, notably Canada and the United States, as well as organisations (EASA, EUROCONTROL and ICAO) and some ECAC Member States (Ukraine and United Kingdom).

The fifth Environmental Forum is scheduled to take place at the end of the year.

► Adoption of new ACC guidance on accident investigation during a pandemic and material on general aviation accident investigation

January 2021

A key focus of the activities of the ECAC Air Accident and Incident Investigation Group of Experts (ACC) is to exchange experiences on investigation methods, the evolution of investigation techniques and tools, and the challenges encountered during investigations. At the last ACC meeting (ACC/52, 21-22 October 2020), the ACC members agreed to produce a paper on general aviation accident investigations, using as a basis the material presented during the ACC Workshop on General Aviation Accident Investigation held in Valletta on 13 November 2018 and capturing the best practices

that were identified at that workshop. This paper is available for Directors General and members of ACC to download from the secure ECAC website.

In 2020, due to the challenges faced by air accident investigators during the COVID-19 crisis, the group developed a draft guidance note on best practices for investigations during a pandemic. This proposal was approved by the group in December 2020 and has now been endorsed by the ECAC Directors General. It is publicly available and can be downloaded from the *ECAC website*.



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▶ COVID-19 discussions in the European coordination meetings continue in 2021

Directors General of ECAC Member States and representatives of DG MOVE, EASA and EUROCONTROL continue to meet virtually in 2021 to discuss the latest developments surrounding the COVID-19 pandemic. Seven meetings have been held since the beginning of January offering a platform for the participants to share information on traffic updates, economic relief measures, travel requirements and restrictions, testing and quarantine measures, and exit strategies, among other pertinent issues.

In January, the European Commission and EASA briefed the meeting on the Council of the European Union's position on vaccination programmes and on the protocols on testing strategies jointly produced with the European Centre for Disease Prevention and Control. Member States shared information on the roll-out of their national vaccination programmes and emphasised the usefulness of continuing to have these transparent exchanges on the current travel conditions. The participants pointed out that the summer period should provide an opportunity for the aviation and tourism sectors to restart, and the important role aviation plays for the economy at large. They acknowledged that while Member States were taking the necessary mitigation measures to stop the spread of the virus, the aviation sector needed an exit strategy to "save the summer" and to have some certainty in order to prepare for a restart of operations.

There were regular discussions and updates on the ICAO CART work, much of which has focused on acceptance and validation of testing and vaccination certificates and their implications for passengers. The meeting noted that the CART III process had come to a close with the presentation of reports to the ICAO Council on 12 March. On vaccinations, the reports concluded that they should not be a precondition for international travel.

The participants were joined by a guest speaker from the OECD on 11 March to present the *COVID-Free International Mobility Initiative*, developed in consultation with ICAO (CART III and CAPSCA), the World Health Organization, the UN World Tourism Organization and the European Commission.

On economic matters, the ECAC Secretariat provided regular updates on the responses to the survey on economic and financial relief measures across the ECAC region. This survey will form the basis for a larger study by the Secretariat to analyse and assess the economic consequences of the pandemic in the ECAC region, which is expected to be finalised over the summer.



▶ Expanded European Aviation and Environment Working Group debates net-zero emissions plans

26 March 2021

The first meeting of the European Aviation and Environment Working Group (EAEG) (Expanded) with European stakeholders following the recent initiative to strengthen the engagement of all ECAC Member States in the group, focused on the *Destination 2050 Report: A Route to Net Zero European Aviation*. The *Destination 2050* initiative was presented by the five associations engaged in it (A4E, ACI EUROPE, ASD, CANSO and ERA), along with the authors of the supporting study from the Royal Netherlands Aerospace Centre (NLR) and SEO Amsterdam Economics.

The online meeting gathered more than 100 participants. It offered a great opportunity for the 32 ECAC Member States represented to have a better understanding of this initiative, including the set of commitments developed by the five associations to reach net-zero emissions, on the basis of the report, as well as of the identified need for support from European policymakers to create the appropriate policy frameworks and provide the necessary assistance when needed. Participants demonstrated particular interest in the assessment work undertaken in that context, and the assumptions behind it.

This initiative to strengthen and widen the engagement of States in the group was taken by the Environment Programme Management Group (EPMG), led by Rannia Leontaridi, the ECAC Focal Point for Environmental matters. With the nomination of representatives from Albania, Bulgaria, Croatia, Lithuania and Slovenia, this group now includes 35 ECAC Member States.

The closed meeting of EAEG (Expanded) which followed in the afternoon of 26 March was dedicated to exchanges of views and information between the 80 participants from ECAC Member States and European organisations regarding the feasibility of a long-term aviation goal, and significantly progressed preparations for the 156th meeting of ECAC Directors General (DGCA/156) on 5 May.

► Appointments

ECAC Coordinating Committee and Focal Point

DECEMBER 2020 | Directors General elected by acclamation **Damien Cazé** (France) as a new member of the ECAC Coordinating Committee.

JANUARY 2021 | Damien Cazé (France) was appointed by the Coordinating Committee as ECAC Focal Point for Economic matters.



New chairs

DECEMBER 2020 | Directors General appointed, for a first mandate of three years: (pictured from the left) **Maria Teresa Antunes** (Portugal) as chair of the Facilitation Working Group, **Laurent Noël** (Switzerland) as deputy chair of the Facilitation Working Group, and **Diantha Raadgers** (Netherlands) as chair of the Sub-Group on Immigration.

FEBRUARY 2021 | Directors General appointed **Marie Hauerova** (Czech Republic) as chair of the Facilitation Sub-Group on the Transport of Persons with Reduced Mobility, and **Christine Mucina-Bauer** (Austria) as co-chair of the European Coordination Group on Economic matters, both for a first mandate of three years.



► Events to come

MAY 2021

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| <p>5/ 156th meeting of Directors General of Civil Aviation (DGCA/156)</p> <p>11-12/ 52nd meeting of the Guidance Material Task Force (GMTF/52)</p> <p>19 & 26/ 40th meeting of the Study Group on Cyber Security in Civil Aviation (Parts I and II) (CYBER/40)</p> <p>19/ 38th meeting of the European Aviation and Environment Working Group - Expanded (EAEG/38-Expanded)</p> <p>20/ 38th meeting of the European Aviation and Environment Working Group (EAEG/38)</p> <p>20-21/ 47th meeting of the Training Task Force (TrTF/47)</p> <p>26-27/ 34th meeting of the EAEG Aircraft Noise Modelling Task Group (AIRMOD/34)</p> <p>27-28/ 32nd meeting of the Security Forum (SF/32)</p> | <p>9-10/ 29th meeting of the Behaviour Detection Study Group (BDSG/29)</p> <p>11/ 39th meeting of the European Aviation and Environment Working Group (EAEG/39), and meeting with stakeholders</p> <p>16/ 40th meeting of the European Aviation and Environment Working Group (EAEG/40)</p> <p>16-17/ 33rd meeting of the Explosive Detection Dogs Study Group (EDD/33)</p> <p>24-25/ 41st meeting of the European Aviation and Environment Working Group (EAEG/41)</p> <p>29-30/ 79th meeting of the Technical Task Force (TTF/79)</p> <p>30/ 54th meeting of the Air Accident and Incident Investigation Group of Experts (ACC/54)</p> |
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JUNE 2021

- 3-4/** 25th meeting between the ECAC Coordinating Committee and the US authorities (CC/US/25)
- 8/** 21st meeting of the European Safety and Air Navigation Coordination Group (ESANCG/21)
- 8-9/** 9th Familiarisation Course for Directors General

JULY 2021

- 1/** 42nd meeting of the European Aviation and Environment Working Group (EAEG/42)
- 12-13/** 39th Plenary (Triennial) Session (ECAC/39)
- 13/** 191st meeting of the Coordinating Committee (CC/191)
- 20-21/** 50th meeting of the CEP Management Group (CEP-MG/50)

News from the JAA Training Organisation (JAA TO)



ASSOCIATED BODY OF ECAC

► Editorial

Paula V. de Almeida, JAA TO Director

Dear readers of ECAC News,

Heading towards normalisation in 2021. This is the year companies and businesses are looking to start getting back on track and to restoring some sense of normality. But ambivalent developments across Europe and the world still impede progress in many public – and private – spaces. Vaccine rollouts, lifting of travel restrictions and the population's peace of mind with air travel are going to be defining factors in the return to "back-to-normal". Aviation viability and sectoral recovery became more vulnerable and volatile again due to the discovery of COVID-19 variants.

Precisely these challenges have also left their mark on JAA TO and, after careful deliberation, prompted the organisation to extend its HQ closure for another period.

But we will fly again. JAA TO's virtual training activities offer the quality alternative needed in these special times – training facilitation is on-trend to answer new needs sustainably and effectively. Expanding the virtual portfolio even more over the coming months, JAA TO continues to provide state-of-the-art virtual classroom training to capacitate professionals in old and new missions. The encouraging positive resonance and feedback from trainees and trained organisations fuels JAA TO's ambitious recovery strategy for the coming months.

Despite the business challenges, JAA TO remains dynamic and proactive in new course development. To



highlight this is a newly developed ICAO Training Package (ITP) for the virtual classroom in the category of unmanned aircraft systems (UAS)/drones. With the introduction of pioneering sets of training activities on drone-related topics, so-called UAS diplomas, JAA TO intends to facilitate training to ECAC Member States on ever-emerging topics with a new twist. With this initiative, JAA TO remains the pioneer regulatory training provider setting milestones with international standards.

On 8 March 2021, the UN entity for gender equality and women's empowerment, UN Women, heralded women's leadership in all its forms. Speaking from experience, JAA TO joined the global celebration embracing its diverse DNA and inclusive work culture. After 12 months, with JAA TO staff fully operational in home office settings, the virtual employee events have become vital routines forging togetherness and team spirit in the digital age.

Going into the second quarter of the year, JAA TO continues to provide the extra experience as a contribution to building back better the European and global aviation sector in an anticipated post-COVID-19 era.

► Green aviation – antithesis or achievable reality?

Aviation and the environment are inevitably linked as much of today's air transport domains are consuming much of the earth's available environmental spaces. Inherently, many key stakeholders (e.g. ECAC, IATA, ICAO, UNEP, airlines and many more) have made the environment/environmental protection part of their strategic objectives and goal plans. In the past, much of aviation's concern with environment was reduced to noise; but soon, aspects of ICAO's environmental work were conducted in cooperation with the ICAO Committee on Aviation Environmental Protection (CAEP) that included a more wholesome approach to defining improvement on goals pertaining to the

environment. As with the topics of this magazine, these include aircraft/engine technologies, new certification standards, operational improvements, sustainable alternative fuels (SAF), emission reductions/air and water quality, decarbonisation and market-based measures (MBMs).

Similarly, ECAC's high-level meetings with regional partners and organisations, and agenda-setting through its own Environmental Programme Management Group (EPMG), provide the conscious frameworks for environmental topics.

By conducting environmental studies, CAEP assists the ICAO Council in formulating new policies and

adopting new Standards and Recommended Practices (SARPs). Their guidance can trigger thought-provoking impulses to other global and regional aviation stakeholders who guide and oversee compliance measures themselves (“Building a Path to Net-Zero Aviation” as introduced at the World Economic Forum, Davos).

External factors such as urbanisation, accelerated mobility, competition with civilian demands on airspace, and increasing environmental activism and public discourse pose new dynamics to the adherence and innovation of the above-mentioned goals.



► Environment training at JAA TO

JAA TO's first environment course was the two-day “Aviation and Environment” from 2009, which introduced trainees to the main environmental issues at that time (noise and emissions). In 2017, JAA TO expanded its training offer in the field, adding two extra courses, “Climate Change Awareness” and “ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)”. Reacting to ICAO's adoption of the CORSIA scheme, JAA TO's training was the only course dedicated to aviation emissions available at that time. A novelty not only for JAA TO's portfolio but that set forth the seriousness of global training, implementation (Resolution A40-19, ICAO SARPs - Annex 16 Volume IV) and compliance. This key ICAO initiative is further highlighted by ACT CORSIA (Assistance, Capacity-building and Training), an implementation plan for CORSIA-related emissions monitoring plans, offset requirements, eligible fuels, and finally verification.

Currently, as an ICAO Training Centre of Excellence (TCE) – the only one in Europe – JAA TO now also facilitates the “ICAO TRAINAIR PLUS - CORSIA Verification” course as a virtual classroom session, leveraging verification and educating a global critical mass of aviation environmental professionals. Registration is possible via the following link on JAA TO's website: <https://jaato.com/courses/937/icao-trainair-plus-corsia-verification-virtual-classroom/>

► Environment as a priority

Ironically, the absence of air traffic during the COVID-19 pandemic put clear skies and an improvement in emissions and air quality side by side with an aviation sector suffering from challenges to business continuity. While aviation and aerospace will continue to innovate key technologies, considerations about environment aspects should not impose barriers to innovative advancements. Environmental trends in aviation will shape business operations, technology advancements and consumer consciousness for the next decades while envisaging the most sustainable future for all. The increased importance placed on the environment by aviation stakeholders sets in motion technology and regulation to reduce emission/greenhouse gases (GHG), for CO₂ standards, sustainable fuels, aircraft noise, land/water-use management, wildlife management and climate change adaptation.

Achievements and progress rely on cooperation and leadership among the aviation community. An emphasis on modelling and databases to better estimate aviation's impact on the environment helps to align current technology paths with regulation, public opinion and the competing trades of environmentalism, design, operations and business. JAA TO facilitates training that not only supports safe and secure regulation but that also includes a sustainable aviation future.

For more information on JAA TO's environment training, visit our website: www.jaato.com

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