impact
ON SUSTAINABLE AVIATION

January 2023

Year in review 2022

impact
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Introduction from Chairperson of impact Board – Ulrike Ziegler

Ulrike Ziegler, Chairperson of impact Board

Dear reader,

It is with great pleasure that I introduce impact e.V.'s first Annual Report on sustainability in the aviation industry. The content of this report reflects months of valuable contribution, intense discussion and strong commitment by impact's members. Whilst our activities have commenced only as recently as early 2022, we have made substantial progress and this is testament to what is achievable if cooperation and joint efforts prevail. With this, I am proud to take you on our sustainability journey.

But first, let me take one step back. In mid-July 2022, the Washington Post published an article by Sarah Kaplan on Bristlecone pine trees; a species which can easily reach an age of 1,000 years and more. The oldest tree on record is more than 4,500 years old. Sarah pointed out that it is their resilience that helped them survive millennia of disruptions and disaster, but "human-caused climate change is proving too much for the ancient trees to bear." This is not just about a species facing extinction, it is a projection on "what will happen as earth continues to warm."

Whilst in comparative terms, the aviation industry is in its infancy, it has similarly proven resilient to a multitude of crises in a fast-paced world, e.g. 09/11, SARS, 2008 Global Financial Crisis, and the 2020 Covid pandemic. But its resilience may now be put to the test. Aviation is an essential thread in the fabric of modern life. It is indispensable, but its survival strongly depends on assuming responsibility for the economic value (as of 2020: USD 3.5tn in global GDP and supporting c. 88 million jobs worldwide) by transforming into an environmentally-sustainable industry.

Like a toddler, we have taken the first steps by improving aircraft efficiency with the launch of new aircraft types, by optimizing aircraft operations, introducing sustainable aviation fuel (SAF) and exploring new propulsion technologies such as hydrogen or electric.

But now is the time to pick up the pace, we must start to run in the right direction, by cutting the industry's CO_2 footprint to reach net-zero by 2050. In preparation for this marathon we, at impact, are acting as a facilitator of change. It is our mission to (i) promote the production of transparent and consistent CO_2 data across the industry, (ii) provide tangible, meaningful and easy to compute KPIs and (iii) develop reporting and documentation standards which support transition finance.

Absent a joint approach and credible standards, regulators are likely to introduce criteria/restrictions which might translate into an impediment to aircraft values.

This could potentially result in a decrease in loan/investment returns, leaving stranded assets and reducing much needed funding for a capital-intensive industry and associated investments into SAF and alternative propulsion technology. Therefore we, as an industry, must proactively manage such risk.

With our Year in Review, we want to encourage a dialogue with industry stakeholders and across the wider financial industry. We are looking forward to welcoming you on our sustainability journey.

Join impact's mission: Take action! Assume responsibility and shape the future of sustainable aviation!

impact members in 2022

Review of impact's first year: impact's networking group

impact holds regular presentations and panel-discussions for members covering a range of topics relevant to sustainability in the aviation industry.

Internal Presentations in 2022

'SAF, Regulation and a Pathway for Aviation'
Emma Giddings, Norton Rose Fulbright;

Emma Giddings, Norton Rose Fulbright

The presentation explored how sustainable aviation fuel (SAF) is regulated both in terms of assessing its suitability as a blend-in jet fuel and also its sustainable credentials. It discussed how the sustainable benefits attributable to SAF depend on an analysis of emissions produced over the lifecycle of the fuel – including the materials and processes used to produce it.

The presentation looked at the challenges in tracing the sustainable characteristics of SAF throughout the supply chain and compared the mass balance system and "book and claim" models. It also looked at the Renewable Energy Directive (Recast) and the new Refuel-EU initiative.

'Aviation Decarbonization up to 2030 – Real Progress or Stranded Aviation Assets?'

Dr. Tom Conlon, University College Dublin;

Dr. Tom Conlon, University College Dublin

Absent technological advances, aviation will remain among the most difficult sectors to decarbonize. Forecasting the contributors to decarbonization, even up to 2030, is challenging. Taking a broad range of plausible assumptions, commercial aviation is shown to exceed the IEA 2030 Net Zero car-bon targets by between 41 and 166Mt. Much of the exceedance results from limited SAF availability, the 'SAF gap'.

Without evidence for self-decarbonization, policy-makers may resolve to enforce decarbonization on the industry. The potential for a rapid, enforced transition increases the potential for stranded assets in aviation; aircraft that are retired before the end of their economic life.

'Sustainable Aviation Fuel'

Dr. Harald Dialer, Chief Commercial Officer of HCS Group;

Dr. Harald Dialer, Chief Commercial Officer of HCS Group

It is commonly accepted among aircraft operators, regulators, academics and NGOs that Sustainable Aviation Fuel (SAF) is indispensable to meeting the ambitious targets set by Fit for 55 and Refuel EU.

HCS Group, a pioneer for sustainable hydrocarbons, aspires to contribute to defossilization and reduced carbon emissions in aviation and has recently announced project "Amelia", a renewable hydrocarbon facility at their Speyer manufacturing centre, strategically located near Frankfurt airport, and operated by the Haltermann-Carless brand.

Starting in 2025, the plant will be designed to produce 60,000 metric tons of SAF, utilizing waste biomass based ATJ technology with a certified supply chain from waste to tip-of-wing.

'Sustainable Aviation Fuel'

Aircraft Finance, Peter Smeets & Jan-Hendrik Petersen;

Jan-Hendrik Petersen,
360 Aircraft Finance

Peter Smeets,
360 Aircraft Finance

Sustainable aviation fuel (SAF) is the pivotal element for achieving aviation's goal to become net-zero by 2050. Over recent years the focus on supporting the scaling up of SAF has increased significantly.

Policy makers and regulators across the globe are now designing and implementing measures to stimulate the supply and demand for SAF. Airlines are now willing to sign significant offtake agreements with SAF suppliers.

In addition to this, various initiatives, coalitions and associations have been formed within and outside the aviation industry to help organise and build SAF infrastructure. However, it will be difficult for aviation to keep its net-zero promise without more being done to support an accelerated roll-out and scale-up of SAF.

'Flying to Net-Zero'

Nicoletta Brazzola, Researcher in Climate Policy, ETH Zurich;

Nicoletta Brazzola, ETH Zurich

In the context of net-zero emissions targets, the promise of future carbon removal deployment has been accused of potentially deterring urgent and radical mitigation action. What is the role of carbon removal for sectors that have limited, and also technologically immature options to achieve climate neutrality, such as aviation?

In this talk, Nicoletta Brazzola discussed the exact meaning and implications of different baselines of climate neutrality for the aviation sector.

She then showed that achieving climate-neutral aviation while avoiding large-scale carbon removal is only possible if it is coupled with radical changes in demand or abrupt shifts to cleaner technologies.

'Key Sustainability Indicators of Aviation Sustainable Finance deals'

Eduardo Mariz, Snr. Analyst, Ishka;

Eduardo Mariz, Ishka

The presentation *Key Sustainability Indicators of Aviation Sustainable Finance Deals* examined trends in publicly announced sustainable finance deals involving airlines or aircraft since the first green bond was issued by an airline in 2018.

Following similar trends in other sectors, sustainability-linked deals in aviation have gained in popularity over green bonds and loans. The key performance indicators (KPIs) and sustainability performance targets (SPTs) of these transactions have also evolved.

Deals in 2020 and 2021 mainly featured SPTs linked to corporate ESG ratings and emission intensity targets, while deals in 2022 have focused on sustainable aviation fuel (SAF) usage and fleet renewal targets.

As of November 2022, sustainable finance features have been applied to aviation unsecured bonds, JOLCO leases, public and private EETC securitisations, operating leases, aircraft pre-delivery payment (PDP) financing, and various other commercial loans.

'TUI Airline Sustainability'

Marco Ciomperlik, Chief Airline Officer, TUI;

Marco Ciomperlik, TUI

TUI has comprehensively addressed the issue of sustainability in all business areas of the company and is committed to a clear strategy (TUI Sustainability Agenda). Like the industry as a whole, TUI is aiming for zero emissions by 2050, at the latest.

The company is committed to science-based targets for hotels, cruises and airlines, which set out a clear path to emissions neutrality by 2050. In the airline sector, TUI is consistently pursuing the path of fleet renewal and the use of SAF.

To this end, it is already acquiring large quotas of SAF for the future in order to ensure that the up-coming ReFuel EU Aviation Directive can be fulfilled. TUI is also committed to a genuine reduction of emissions and rejects offsetting.

'The Impact of ESG on Aircraft Values'

Dr. Stuart Hatcher, Chief Economist, IBA;

Stuart Hatcher, IBA

With the imminent emergence of pro-environmental legislation, European airline operations (as a minimum) will be forced to adopt new practices and measures to comply with emission milestones. This will undoubtedly add to the cost of flying for both the airline and the passenger. In doing so, the impact will be far reaching such that the effect on unit costs, demand, and asset economic life could be considerable.

Based upon his wide experience in valuing aircraft, IBA's Stuart Hatcher presents an opinion on how various scenarios may play out in the years to come.

'Two technologies to decarbonize aviation'

Anna Stukas, Vice President Business Development, Carbon Engineering Ltd;

Anna Stukas, Carbon Engineering Ltd

Decarbonization of the aviation sector will depend on the increased use of SAF; the introduction of new technologies such as hydrogen and electric aircraft and direct air capture (DAC). Based on historic growth of carbon at 2 parts per million (ppm) annually, less than 7 years remain on the "carbon clock" to stay within the 1.5-degree goal.

To counter climate risk, one trillion Tonnes of CO_2 need to be removed from the atmosphere. DAC can help on the path to Net Zero if CO_2 can be permanently removed from the atmosphere and stored safely.

‘Find out why °C is the crucial KPI for your future’

Nicolas Schuerrhoff, Climate Impact Analyst, Right° - right-basedonscience.de;

Nicolas Schuerrhoff, Right°

The Paris Climate Agreement is a °C target – so why measure climate impact in terms of CO_2, ‘Net Zero’ or ‘carbon neutrality’? Nicolas Schuerhoff, Climate Impact Analyst at right° advocates for a more tangible KPI to measure progress towards 1.5°C. Right°s XDC Model expresses a company’s climate impact in terms of °C, making it easier than ever for corporates and investors to calculate their remaining carbon budget and benchmark corporate transition plans against the Paris Climate Agreement.

‘EU Taxonomy and Aviation’

Shane O’Reilly, Director, KPMG Sustainable Futures;

Shane O’Reilly, KPMG

The EU Commission’s technical screening criteria for aviation includes manufacturing of aircraft, leasing of aircraft and passenger and freight air transportation. The European Commission acknowledges that the aviation sector is hard to abate in emissions terms and focuses on a transition path to include zero emission aircraft, increased volumes of SAF and newer aircraft portfolios.

The inclusion of the aviation sector as part of the EU Taxonomy is welcomed. It will contribute to the transition to a lower carbon output for the sector, protect investors from greenwashing and in time provide clear mechanisms to drive greener capital into the sector.

‘Sustainability in Credit Insurance for Aviation Finance’

Andrew Barr, Miller Insurance;

Andrew Barr, Miller Insurance

The insurance industry’s efforts and progress towards sustainability are multifaceted and dependent upon which insurance types are being underwritten by insurers and handled through respective insurance brokers. Employee, shareholder and regulatory involvement is increasing sustainability pressures, but the evolution is in part driven by an insured entity’s efforts at the frontend dictating a pivot.

Credit Insurance is an important risk distribution and capital redeployment tool for banks active in Aviation Finance. Like their bank clients, credit insurers will not support entirely new sustainability-focused technologies without proof of commercial success. The focus in the near-term is towards Sustainability Performance Targets (SPTs) and those assets earmarked for future usage of Sustainable Aviation Fuels (SAFs).

impact has been involved in the following events in 2022

- Ishka ESG - Committing to a Cleaner Future (March)
- ISTAT Sustainability Symposium (May)
- Airline Economics Growth Frontiers Dublin (May)
- Bird & Bird: Environmental Social and Governance Issues in in Aviation and Aerospace (June)
- Ishka Aviation Finance Festival Dublin (June)
- ISTAT Marrakech (Sept)
- Growth Frontiers Europe (Sept)
- Aviation Carbon 2022 (Sept)
- Aircraft Leasing Ireland - Global Sustainability Day (Oct)
- Ishka Investival, North America (Oct)
- International Transport Forum/OECD workshop on "Decarbonising the hard-to abate sectors" Paris (Nov)

Ishka ESG, Committing to a Cleaner Aviation Future, 31st March, London

Ishka Aviation Finance Festival, 8-9 June, Dublin

The Industry View: Claudia Hügel, Lufthansa

Claudia Hügel, Senior Director Corporate Responsibility, Head of ESG Rating & Reporting, Lufthansa Group

What are some of the most challenging aspects of regulatory sustainability monitoring and reporting for an airline group like Lufthansa?

The most challenging aspect is fulfilling the manifold different ESG reporting regulations. In the case of the Lufthansa Group, we are a European group of companies obliged to fulfil all current and upcoming European regulations while, at the same time, also observing international regulations that for the time being are not binding. For example, the International Sustainability Standards Board [ISSB, an IFRS foundation established in 2021] is coming in at the same time as other European regulations, with more or less the same goals.

Every one of these initiatives is taking shape at the same time, so I have to juggle them. At the same time, most of these initiatives are still in the drafting stage, so we are also being asked to give our input on drafts that comprise hundreds and thousands of pages.

1) In addition to fulfilling sustainability regulatory compliance, your job also entails upkeeping Lufthansa's ESG ratings. How much do these rating methodologies differ?

They differ very much. In terms of the reporting requirements, unfortunately it is not very straightforward. We produce quite an extensive sustainability report with around 40 pages [see combined non-financial declaration in Lufthansa's 2021 Annual Report] which is then audited. Even CO_2 emissions are audited. We then have our TCFD [Task Force on Climate-Related Financial Disclosures] report, we have the SASB [Sustainability Accounting Standards Board] report, we do an additional factsheet with over 30 or 40 pages, and we do the CDP [Carbon Disclosure Project] which also takes a lot of time. And still, this is not sufficient for the rating agencies. They analyse the information out of all these disclosures and they come to us individually with additional questionnaires. And although the questions look a little bit similar, in the end the answers are quite different, so I can't do a copy and paste.

The ratings results are also expressed very differently, and you can't compare them. One has an A, another has a AAA or a B, another has a number instead. With one rating agency we can have super results, like for MSCI we recently obtained an AA [the second-highest score], while maybe with others we are not so good and the average observer may not know the reasons. Of course, I do know the reasons: one may concentrate on CO_2, another may concentrate on governance, etc..., but every observer needs to be aware of individual methodologies to understand the overall rating. Credit ratings generally only differ by a couple of percentage points, but if you compare them to the ESG ratings, they differ by around 20% or even 30%.

2) impact's central goal is to substantially improve the transparency of aviation sustainability, including by drastically simplifying the metrics used. How can impact's work help you and help Lufthansa?

According to Impact's Three Essential KPIs white paper: "less is more." I really support this – less is more. And this idea is probably of help in coming up with common definitions of sustainability metrics. If we all come up with the same definitions that we, airlines, must adhere to, then of course it will be easier, especially for the financial sector, to compare the progress each airline makes with regards to their ESG performance.

I would not say that airlines will be completely and easily comparable in the future because, like within each and every other business, airlines also have different business models and operate out of different regions. In terms of business models, Lufthansa Group operates on a global scale from short- to medium- to long-haul operations compared to, for example, another very regional carrier or a low-cost carrier. The CO_2 intensity KPIs are different, so a financial analyst must judge them upon the business model. In terms of regional differences, one airline in Australia may have a lot more long-haul flights than short-haul flights, while a European carrier has more short- and medium-haul flights.

So, it will still be difficult to compare airlines from a greenhouse gas emissions perspective. But if you're talking about specific KPIs, for example CO_2 intensity, and if the definitions of these KPIs are at least the same, then it is a little bit more comparable.

Review of impact working groups activities in 2022

Transition Finance Working Group

Aviation is a so-called "hard-to-abate" industry due to the lack of immediately available technological solutions to significantly decarbonize the industry. Hence, the focus of a Transition Finance framework has to be on the pathway to net-zero. This is most likely to be achieved through the development and introduction of more fuel-efficient aircraft along with comprehensive and robust transition finance to underpin it. For aviation, transition finance should be positioned somewhere between Green Finance and Sustainability-Linked Finance.

What should form part of a transition-finance framework?
To formulate a pathway, you must have the ability to measure the status-quo and monitor the development against this. To achieve this, impact will oblige any airline financing counterparty to comply with specific **reporting standards** to be able to benefit from sustainable financing products.

The airline's decarbonization efforts will be measured against three essential KPIs **(Footprint, Intensity, and Decoupling)**. These three KPIs, which impact deems sufficient to assess the decarbonization performance of any airline, are detailed in the impact White Paper published in September 2022.

The next step is to integrate those KPIs into a **benchmark** so that a level of ambition can be established and the performance of an airline can be measured against this ambition. There are currently ongoing discussions within the Transition Finance Working Group on whether the position of each airline can be compared against an annual target curve, or whether it would be better to design a **milestone concept** without time horizons. The multi-level milestones would allow comparison of airlines that have reached certain emissions-decoupling levels. The current thinking is that this might be more robust as the target curve does not need to be adjusted if net-zero trajectory assumptions change.

At the same time, airlines more advanced in their decarbonization efforts would, in theory, start at a higher level than less advanced ones.

The aviation financier members of impact typically take security over the aircraft; hence an important part of the discussion is which **aircraft types** could become eligible for sustainable aircraft financing and under which conditions. Impact's main assumption is that the focus should not be on the aircraft types themselves to qualify for transition finance but more importantly the sustainability framework and targeted CO_2 reduction agreed and pursued by the airline/lessor.

This has the advantage of positioning impact's transition finance requirements as not stricter than sustainability-linked financing structures and avoids any risk of contradiction with EU Taxonomy rules, once they come into effect. However, we do strongly encourage the actual transition to new aircraft technologies, since near-term CO_2 emission reductions in aviation will mainly be achieved by technological (via latest-technology aircraft) and operational efficiency gains.

Furthermore, it has been recognized that **Sustainable Aviation Fuel ("SAF")** will form an important part in any effort to reduce CO_2. More needs to be done in maturing the technology and further analysis is needed on the underlying production pathways and applicable full life-cycle CO_2 emissions. While the preferred way to reduce CO_2 is obviously the avoidance or mitigation of CO_2 emissions, Impact is of the opinion that there is room for certain types of offsetting to address the residual CO_2 volume that cannot be avoided any other way. This still needs more research, but we are currently looking favorably at **Carbon Capture**.

Metrics Working Group

Over the past 12 months, impact's Metrics Working Group has sought to address the opacity and inconsistency of greenhouse gas (GHG) emissions reporting by airlines. The working group has formulated three essential KPIs to address these inconsistencies, and has also made strides in developing a milestone concept to benchmark airline progress against the KPIs.

Opacity and inconsistency of reporting
If the metrics on which environment performance is measured are not appropriately defined, this may create loopholes and, in some cases, open the door to claims of greenwashing. Similarly, if there are too many indicators, this can negatively affect transparency, credibility and ultimately the effectiveness of such measures.

The Metrics Working Group examined all sustainability reports that airlines have published since 2016, for data and definitions, and found two surprising results:

- Less than 15% of airlines worldwide publish emissions data;
- the few airlines that do report GHG Emissions use an extensive range of differently defined and thus non-comparable metrics.

Three essential KPIs for the aviation industry
The high degree of opacity makes targeted decarbonization strategies and their monitoring, reporting and adjustment all the more difficult. Based on extensive analysis, the metrics working group has reduced the large number of available metrics to just three essential metrics for the industry;

- firstly, there is the *absolute carbon footprint* of an airline or a portfolio of aircraft;
- secondly, the *efficiency (intensity)* with which an aircraft can produce a given transport service; and;
- thirdly, the degree by which the *evolution of CO_2 is decoupled from the evolution of capacity*.

This has the advantage of positioning impact's transition finance requirements as not stricter than sustainability-linked financing structures and avoids any risk of contradiction with EU Taxonomy

In addition to the three proposed KPIs, which are viewed as essential for the industry, precise scope and simple definitions of the underlying metrics are also proposed.

The working group suggests not to use forecast-based benchmarks to track the progress of decarbonization of individual airlines or other portfolios. All the forecasts that have been considered are based on inaccurate assumptions and would require constant readjustment, which would lead to the need to renegotiate with financiers and airlines regularly. In addition, these forecasts usually refer to the development of the entire airline industry and not to individual airlines. Intensity metrics are widely used but this could, potentially, be misleading, e.g. an airline which has a young fleet and adds RPKs looks operationally efficient while its overall CO_2 footprint still increases.

The Milestone concept:
The working group recommends using different levels of increasingly difficult-to-achieve thresholds for a simple and transparent rating system ("milestones"). The three essential KPIs are to serve as the basis for defining the threshold values. In principal, once an airline has accomplished a particular threshold, its sustainability rating rises accordingly.

No assumptions or forecasting models are required to set appropriate thresholds. The milestone rules will be completely transparent, and the thresholds remain constant over the entire credit period and ideally as far as 2050. Airlines that have developed and made further progress on their sustainability strategy than others, from the outset, have significantly better chances of reaching the thresholds earlier than less ambitious competitors.

What next?
The working group is developing the simplest set of rules for calculating these thresholds as well as stress tests to prove the robustness and significance of the milestone concept.

Reporting Working Group

impact's Reporting Working Group was created this year to help coordinate and drive engagement, internally with members, and externally with stakeholders. The early working group meetings revolved around considerations such as the tone of messages, form of engagement with the public and stakeholders, and coordination and oversight on other working group streams.

As the year progressed, the working group came up with the idea of an annual review, which would summarize impact's activities for the year, and from that, the 'Year in Review' was conceived. The planning for the 'Year in Review' started back in April this year, but was heavily reliant on the content and input from internal working groups, Impact members and thought leaders/experts in the industry.

As well as the Year in Review, the working group is looking at making a newsletter for members, as well as regular thought leadership pieces, which will inform the industry on key issues and also allow impact to express its position as an organization. Going forward, the Reporting Working Group would look to establish a calendar of publications for the year; covering newsletters, thought leadership pieces, white-papers and culminating in the 'Year in Review'. We believe a significant amount of regular engagement is necessary to drive progress on decarbonization and sustainability in aviation.

Know-How Management Working Group

The Know-How Management working group set itself the goal for 2022 to ensure a smooth flow of information within and outside the organization. The focus was on establishing a Members' Area to share content to members, setup a corporate LinkedIn page an create a website.

Creating a website
The impact website has emerged from the know-how management working group. It provides information about impact and publishes important documents such as white papers or impact publications and announcements in the download area. In addition, the log-in protected Members Area for impact members can be accessed via the website. A revised version of the website with more information about developments in impact's first year is planned for 2023.

Establishing a Members Area
The impact Members Area serves as a platform for the exchange of information, files, and know-how among members. Members can access a collection of files to familiarize themselves with sustainability topics for financing and thus be up to date with the latest developments. In addition, a database containing reported CO_2 data and airline traffic data will be made available free of charge to impact members via the Members Area in the coming year.

Developing a corporate LinkedIn page
The know-how team has also set up a corporate LinkedIn Page to inform interested external parties about developments at Impact and to expand the reach of impact.

Aviation Decarbonization up to 2030 – Real Progress or Stranded Aviation Assets? Dr. Tom Conlon, University College Dublin

Commentary by Dr. Tom Conlon, University College Dublin

Dr. Tom Conlon, University College Dublin

Executive Summary

Without significant ramp-up in production of sustainable aviation fuel, commercial aviation stands a substantial chance of failing to meet short-term, IEA net-zero targets. Against a backdrop of decarbonization across other sectors, the aviation sector may become a greater focus for policy makers and regulators.

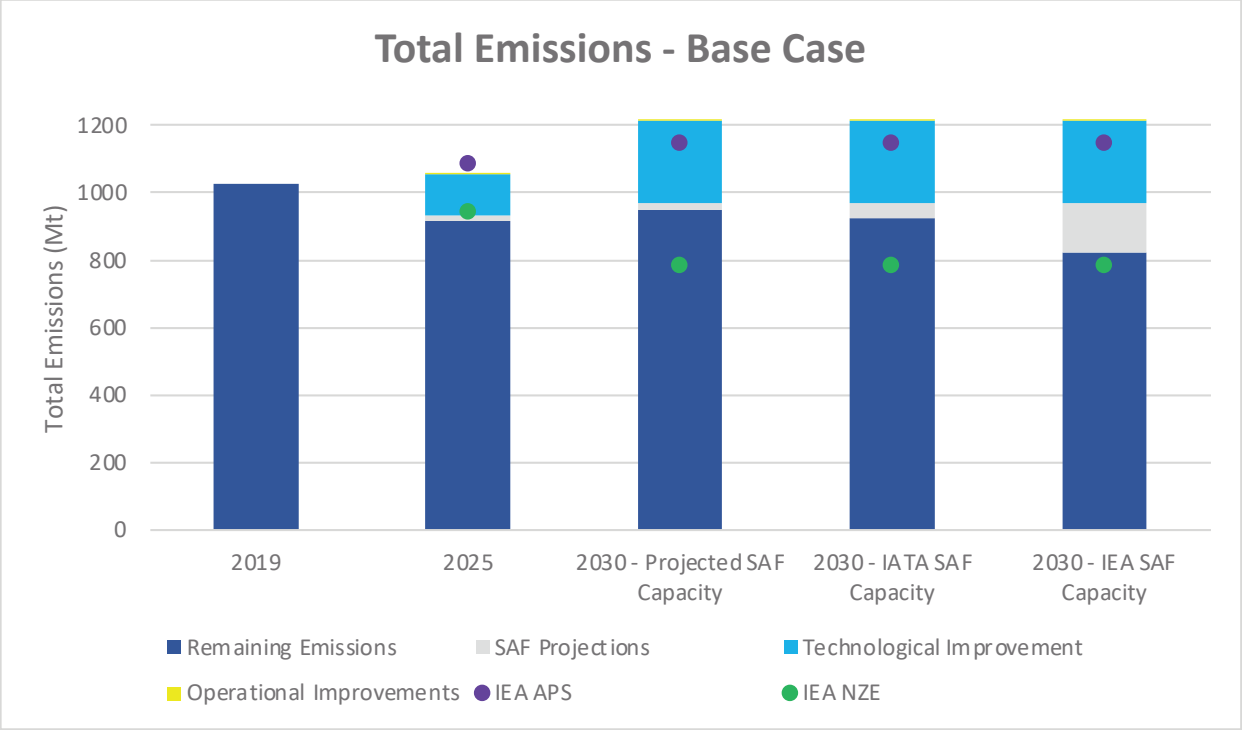
Overview

The aviation industry has set the challenging target of achieving net-zero emissions by 2050. This research looks at the possible pathways to net-zero, with a focus on forecasted emissions reductions by 2030, and their implications.

Given a range of expert projections about aviation growth, described below, technology improvements and developments in sustainable aviation fuel (SAF), aviation emissions up to 2030 are estimated. Carbon emissions for the median growth case are shown below. In the absence of any abatement, gross emissions in 2030 are forecast to be 1.2 Gigatonnes, an 18.3% increase on 2019 levels.

Examining the drivers of emissions reductions; technology improvements (the replacement of older aircraft by new engine option aircraft) will account for emission improvements of 242 Megatonnes, contracting 2030 emissions to a level slightly below 2019. However, IEA net-zero targets (IEA NZE) are much more ambitious, requiring a reduction on 2019 levels of 244 Megatonnes, or a 23.8% drop.

After including emissions reductions from projections for sustainable aviation fuel (SAF) availability, 2030 aviation emissions would fail to meet these targets by between 41.26 Megatonnes (IEA) and 140.46 Megatonnes (IATA).



Under more demanding aviation growth scenarios, the shortfall in emissions reductions expands to as much as 225 Megatonnes. In a scenario where, other sectors are decarbonizing rapidly, limited progress in aviation may well be interpreted by policy makers as a market failure. As already emerging in a European context, through the proposed taxonomy for aviation, limits on growth are becoming an accepted policy tool, supported by investor bodies such as Principals for Responsible Investment.

One possible implication of missed decarbonization targets followed by growth restrictions and demand management, is stranded aviation assets. Already commonplace in other industries, this refers to the notion of scrapped assets before the end of their useful economic lives. While focus would likely be on older aircraft with higher emissions, demand restrictions may have wider implications for the pricing of aircraft. An enforced, accelerated decarbonization of aviation is a significant but known tail risk.

Projection assumptions

ICAO forecasts a median scenario of 2.6% growth in aviation RPKs up to 2028, followed by growth of 3.3% over the following 10 years. In this scenario, RPKs are anticipated to return to their pre-Covid level by 2024, expanding by about 18% in the 6 years to follow. Improvements from evolutionary technology are expected to contribute 2% per annum in carbon emissions reductions up to 2030, according to ICAO, with only marginal progress from operational efficiencies. Revolutionary technology such as hydrogen or electric aircraft are unlikely to make a meaningful contribution until after 2040.

Image by Alan Radecki / CC BY 2.0; https://commons.wikimedia.org/wiki/File:Co-747-N33021-040108-05.JPG

SAF, a form of drop-in fuel that requires no major infrastructure changes has the greatest potential for short-term aviation decarbonization. Current global SAF production is estimated as 1.13 million liters (April 2022), much less than 1% of total jet fuel demand. By 2030, this is projected to grow to 13.6 million liters (ICAO, July 2020). These projections stand in sharp contrast to those of IATA and the IEA, at 24 million and 72 million liters, respectively.

Industry-Expert Views - Sustainable Aviation Fuels (SAF)

What role can sustainable aviation fuel play in decarbonizing flight?

Commentary by Eduardo Mariz, Senior Analyst at Ishka

Eduardo Mariz, Ishka

What role can sustainable aviation fuel play in decarbonizing flight?
Sustainable aviation fuels (SAF) made from renewable feedstocks are one of the most important short and medium-term options to significantly reduce aviation's carbon footprint and, at the same, time also reduce dependency on the petroleum industry. These fuels are well-positioned to be used as a near-term fuel, as they are currently the most convincing and achievable method for decarbonizing aviation.

SAFs have the same physical, chemical and volumetric energy characteristics as kerosene (Jet A/Jet A1) and their usage in the aviation supply chain causes limited disruption in the 'tank-to-wing' path, as they utilise the same infrastructure already in use (tanks, wells, pipes, etc.) Through policy initiatives and regulation, demand for SAF is expected to grow for decades while alternative propulsion technologies are developed and become commercially viable.

Sustainable Aviation Fuel consists of three key elements

- **Sustainability** in this context is defined as something that can be continually and repeatedly resourced in a manner consistent with economic, social and environmental aims, specifically so mething that conserves an ecological balance by avoiding depletion of natural resources, not con tributing to climate change and avoiding competition or displacement of feedstocks used as food crops. At a global level, the thresholds for what SAF can be considered 'sustainable' is set by ICAO through CORSIA[1].

- It is **alternative**, in this case non-conventional or advanced fuels, and includes any materials or substances that can be used as fuels, other than conventional fossil-sources (such as oil, coal, and natural gas). It is also processed into jet fuel in an alternative manner. Feedstocks for SAF are varied; ranging from cooking oil, plant oils, municipal waste, waste gases, and agricultural residues – to name a few.

[1] https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%2005%2-%20Sustainability%20Criteria.pdf

- **Fuel** means jet fuel that meets the technical and certification requirements for use in commercial aircraft.

The potential GHG emissions savings can be considerably higher than 10%, as high as 80% for several advanced feedstocks, and over 85% for synthetic electrofuels.

How 2022 changed the SAF adoption outlook

Although now a viable kerosene alternative, global SAF output is expected to ramp up at very limited levels to 2025, as cost remains relatively high coupled with biofuel producers optimising biofuel production for the transportation market. According to IATA, as of mid-2022, investments were in place to expand SAF annual production from the current 125 million liters (100,000 Tonnes) to 5 billion (4 million Tonnes) by 2025.

Beyond 2025, the capacity scale-up is expected to accelerate further with the start of operations of major facilities currently in planning or under construction. In preparation, and to support the financing of those plants, airlines have been signing a record number of off-take agreements with SAF producers. Publicly announced SAF offtake deals in 2021 (approximately 10 million Tonnes) amounted to around seven times the volumes signed off in preceding years combined, and that number is set to be surpassed again in 2022 (13.7 million Tonnes as of 31st October 2022).

However, and despite the increase in SAF offtakes, the contracted volume of these multi-year deals (some as lengthy as; 10, 15 and 20 years) remains a minute portion of future demand projections. The Air Transport Action Group (ATAG) estimates some 450-500 million Tonnes of SAF will be needed annually by 2050. Projected capacity with committed investment also remains far below this estimate.

Policy initiatives take off in 2022

After years of slow progress in the adoption of biofuels in the aviation industry, policy-driven demand and price mechanisms are gaining favour. A number of jurisdictions made strides this year or are expected to announce meaningful policy packages by year-end. In the US, the Inflation Reduction Act of 2022 (IRA) was signed into law in August, introducing, among other things, tax incentives for low carbon jet fuels with the goal to supply 3 billion gallons (9 million Tonnes) by 2030. The IRA also provides $245 million in complementary grant funding for SAF projects.

In the UK, the government is aiming to have at least 10% SAF in the UK jet fuel mix by 2030 and to see at least five commercial-scale SAF plants under construction in the UK by 2025. To achieve the increase in SAF use, the government is studying the introduction of a SAF mandate focused on greenhouse gas- (GHG) savings. A new industry consultation on the mandate's implementation is expected by the end of 2022.

Meanwhile, the EU has proposed a minimum of 5% SAF as a drop-in fuel by 2030 and a minimum of 63% of SAF in a conventional kerosene/SAF blend by January 2050. In addition to this, the European Commission is also interested in pushing the usage of synthetic SAFs (RFNBO - Renewable Fuel of Non-Biological Origin) and is currently proposing a minimum share of 28% of jet fuel to be supplied from this type of SAF by 2050.

The European Commission is currently in "trilogue" discussions with the European Parliament and the Council of European Union, which have proposed amendments to its initial proposal, and a final EU position is expected by the end of 2022. In addition to the SAF mandate, revisions to the EU ETS (phase-out of free carbon allowances for airlines, potential inclusion of extra-EEA flights) and the end to a jet fuel tax exemption are also on the cards. The initiatives could help reduce the price differential between conventional jet fuel and SAF.

The policy initiatives in the US, UK, and EU aim to reduce SAF production investment risk and send a strong policy signal supportive of SAF, particularly those produced with advanced feedstocks resulting in high lifecycle GHG savings. Following ICAO's adoption in October of a long-term global aspirational goal (LTAG) for international aviation of net-zero carbon emissions by 2050, more national aviation decarbonization policies are expected to follow next year, including policies supporting SAF.

Current perspective on Sustainable Aviation Fuels; Dr. Antoine Habersetzer, Bauhaus-Luftfahrt

Commentary by Dr. Antoine Habersetzer (Bauhaus-Luftfahrt)
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In the context of increasing GHG emissions by aviation, improved technological and operational efficiency can have a substantial impact on limiting fuel demand, but will ultimately not be sufficient to bring aviation on track to net-zero emissions. In order to transition to a path towards climate neutrality, the introduction of renewable energy carriers is, without a doubt, necessary. Renewable energy carriers not only reduce the carbon footprint of aviation fuel use, but are also burn cleaner than fossil fuels, reducing air pollution and non-CO_2 effects.

In light of the challenges ahead, aviation actors from industry, politics and civil society have laid out strategies and targets aiming at net-zero emissions by 2050, (ATAG 2021, NLR and SEO 2021). Within these pathways, radical technologies and new energy carriers (such as hydrogen or electric batteries) may substantially contribute to reducing aviation's climate Impact in the long run.

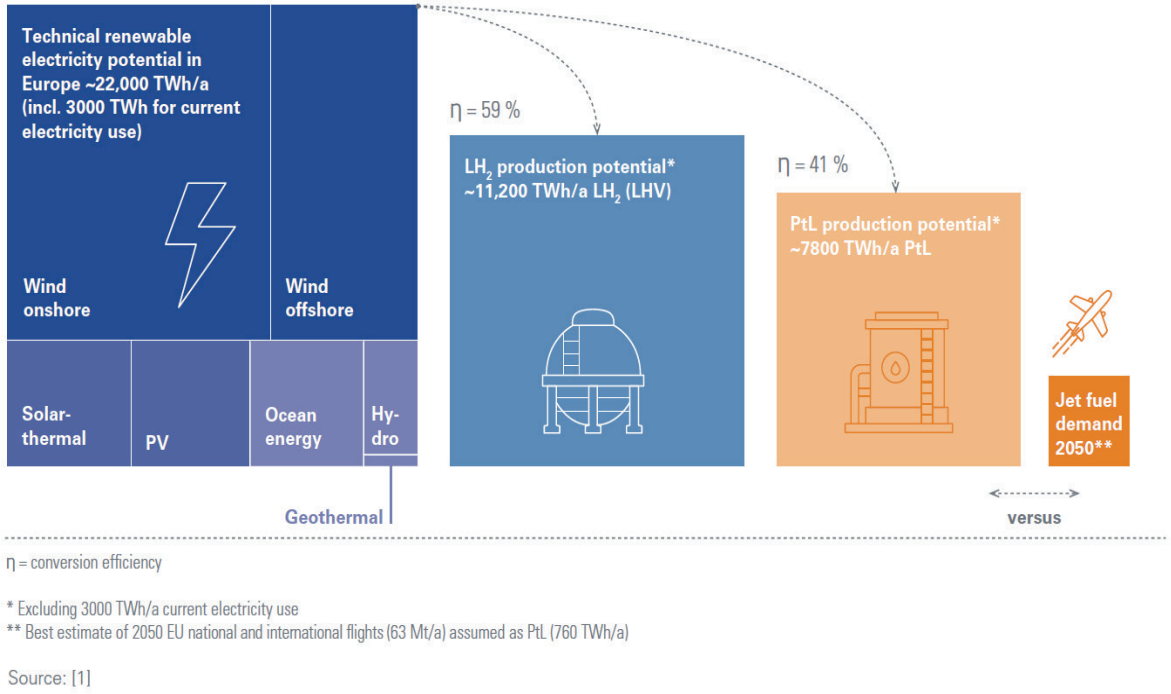
However, as aircraft development and production cycles can span decades, they are seen as long-term solutions. Thus, renewable and scalable drop-in fuels are key for ensuring a more sustainable future of aviation, especially in the next 20 years. Such drop-in fuels should not only achieve a high performance in terms of GHG footprint, but also show minimal Impacts regarding other environmental indicators, such as land use or water demand.

Power-to-Liquid (PtL) Fuels
Due to their scalability, Power-to-Liquid (PtL) fuels are a key technology for carbon-neutral aviation. Bauhaus Luftfahrt and Ludwig-Bölkow-Systemtechnik (LBST) summarised the great potential of PtL in terms of technical, economic, and environmental aspects in the background paper, "Power-to-Liquids – A scalable and sustainable fuel supply perspective for aviation." The paper can be downloaded here - Power-to-liquids_aviation_2022[2].pdf.

The paper reviews the basic principles for typical routes to PtL fuel production as well as resource and production potentials. To meet the required scale, PtL fuels need to be primarily produced from solar and wind energy. In this case, the technical production potential within Europe exceeds the European jet fuel demand significantly. The ramp-up of PtL fuels for aviation depends on a rapid expansion of renewable electricity generation.

While significant cost reductions are expected, long-term PtL fuel production costs remain comparably high, in the range of €1,170 to €1,740 per tonne. On the other side, PtL fuels are much more resource-efficient in terms of land and water demand than biofuel production from energy crops.

[2] https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/background_paper_power-to-liquids_aviation_2022.pdf



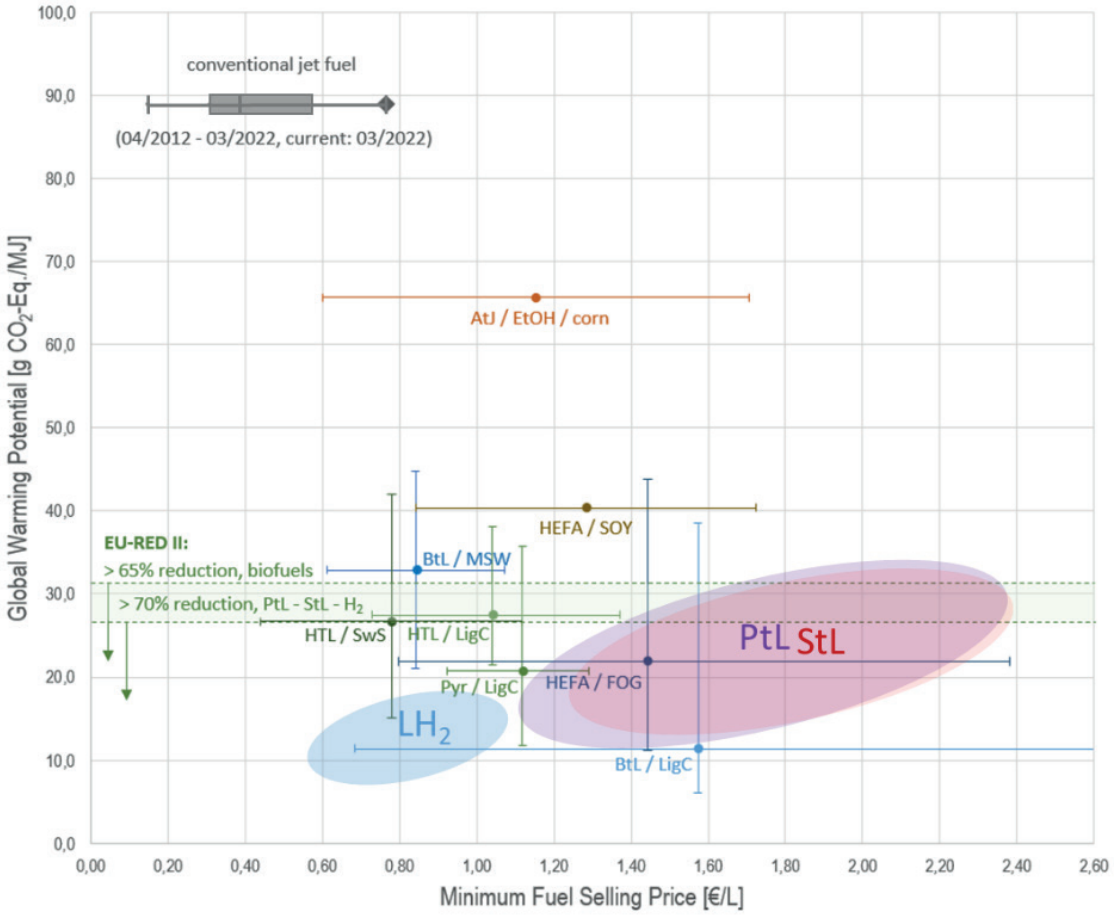
Renewable power potentials and potential SAF demand in 2050 in Europe; *The technical production potential of PtL fuels in Europe is mainly based on wind and solar energy. It exceeds the future European jet fuel demand by about one order of magnitude.*

Global warming potential and production costs of renewable aviation fuels

In order to compare different fuel production pathways more holistically, the evaluation of production costs and global warming Impacts is key. Bauhaus Luftfahrt compiled insights from the scientific literature of the past years, and condensed its key insights into the figure below. The figure shows the global warming potential of different renewable aviation fuels against their production cost.

As a reference point, conventional jet fuel is represented (top left corner) with its typical global-warming-potential and the jet fuel price range between 2012 and 2022. The light green area in the bottom half of the graph represents the threshold global-warming-potential (GWP) values from the European Renewable Energy Directive (EU-RED II). In other words, if fuels want to be accountable within the EU-RED II framework, they need to achieve a lower GWP performance than indicated here by the two green lines. It is worth noting that ICAO default emissions for most first-generation biofuel pathways, e.g. AtJ (Alcohol-to-Jet) from corn ethanol, HEFA from soybean oil, exceed European threshold values for minimum GHG emission reductions.

HEFA (hydro-processed fatty acids) fuels from waste fats, oils, and greases usually meet GHG requirements, but their scalability is limited by feedstock availability. Biofuel conversion pathways for advanced feedstock - Biomass-to-Liquid, (BtL); Hydrothermal liquefaction, (HTL); and pyrolysis could unlock significant additional feedstock potentials, but further research and development is required to commercialise these advanced biofuels.



Global warming potential versus production costs of key options for renewable aviation fuels, in relation to conventional jet fuel prices.

The projected production costs and GHG emissions of synthetic fuels from CO_2 and H2O (PtL; Sunlight-to-Liquid, StL) and liquid hydrogen (LH2) depend critically on the renewable resource potential at the plant location. At a given location, costs and emissions for LH2 production (without transport) will be significantly lower compared to PtL and StL due to a higher conversion efficiency and the need of a carbon source for kerosene synthesis. These uncertainties explain the high range of possible global warming potential (GWP) and cost performances for these pathways.

Conclusion

In conclusion, it is important to emphasize that clean fuels, efficient aircraft and optimized operational procedures are needed to address the full climate Impact of aviation. In light of the limitations of each emission mitigation option, this will require large quantities of synthetic kerosene in the next decades. Considering the limited production potentials of truly sustainable 1st generation biofuels, the bulk part of fuel demand is likely to be met by scalable SAFs (e-fuels, solar fuels, advanced biofuels) which achieve a favourable GHG emission intensity. It would be counter-productive to focus on easily available, but ultimately unsustainable biofuels in the short term. Instead, the development of advanced SAF production pathways that can significantly contribute to the goal of reducing global warming by aviation, should be prioritized from an early stage on.

The challenge consists in keeping the formative phase of production capacity scale-up as short as possible. During this phase, characterized by high technological and market uncertainty, supportive policies are crucial. *Once the formative phase transitions to the diffusion phase, self-reinforcing market dynamics typically lead to fast technology diffusion and cost reductions, as can currently be observed with renewable electricity technologies.*

Finally, hydrogen can gain momentum during the transition to climate neutrality as an additional technology to reduce the climate Impact of aviation. However, the full potential of hydrogen would really only appear in the long-term, and is dependent on technology development, entry-into-service dates of hydrogen aircraft, and fleet renewal dynamics.

Ultimately, it is almost certain, that no single technology will be able to to bring aviation to climate neutrality in aviation on its own. Rather, carefully aligned technology, market and policy strategies, coordinated among the relevant aviation stakeholders, are necessary to bring aviation to climate neutrality by the mid-century, while at the same time securing a lasting business model.
The coming years will be crucial for this endeavour, promising interesting avenues for further research and discussions.

Conclusion and recommendations

Looking back on 2022, it is clearly evident that we have witnessed more engagement on the subject of Sustainability in Aviation. More and more conferences are dedicated to the subject or have made it one of their focuses. In light of the ambitious net-zero 2050 goal in the industry, it is now high time to make progress and see maximum commitment from all industry stakeholders. Let us take a moment to reflect on some of the key developments witnessed this year.

The **41st ICAO Assembly** adopted a long-term global aspirational goal ("LTAG") for international aviation of net-zero carbon emissions. As ICAO rightly states, it is a historic agreement, as it is the first one of its kind on a global basis. No other industry, to date, has issued a similar commitment. Whilst acknowledging the difficulties around a global industry alignment, it is the aviation industry's obligation to move beyond aspirations. We do not have the luxury of waiting much longer. Climate change is translating into more frequent and costly natural disasters. While it is a great aspirational goal, we have yet to see the unveiling of a timeline and subsequent steps for the LTAG.

Sustainable Aviation Fuels ("SAF") should probably be nominated as "Word of the Year" in the aviation space. No conference or panel discussion could go without mentioning it and the aviation industry will be unable to achieve decarbonization without it. The discussions around feedstock, off-take agreements, technology and prices are numerous and necessary, but equally, we must see the ground-work for meaningful investment be put in place.

Designing the right policies is paramount to incentivizing investment. The US Government has chosen to support SAF projects through tax credits and loan guarantees via its so-called "Grand Challenge" program. In contrast, the EU's strategy is mainly driven by mandates to take up sustainable fuel. Needless to say, that investment appetite and risk approach differs from region to region and the solutions may look different as a result. The concerns around SAF supply and price might prove to be exaggerated as it is likely that prices will fall with economies of scale.

Could dedicated and strategic investment and/or financing by industry participants ranging from; airlines, lessors, investors, insurers and banks, lure the necessary funding towards SAF projects?

How can this pan-industry strategy be driven and strengthened?

Aircraft Leasing Ireland ("ALI") signed its Sustainability Charter in October 2022. By doing this, it recognized the importance of sustainability; to employees, to capital providers, to shareholders and to society in general.

With more than 50% of the global aircraft fleet owned by lessors, such alignment is essential. ALI is engaging with policymakers to help chart a pathway to net-zero 2050. It will support its members on their paths towards dedicated ESG strategies and is also developing a three-year strategic plan to determine priority areas for action. Following conversations at the ALI Sustainability Event we sensed that some lessors may even be contemplating investments into SAF. This would resonate well with our thoughts, as outlined above.

Let us close by looking at the **achievements of Impact** during 2022. Within months of inception, we published our first White Paper; "Less is more: Three essential KPIs to guide aviation into a decarbonized future." It was well received by the broader aviation community and achieved the purpose it was intended for; namely, increasing dialogue in the aviation industry and providing some guidance on the key KPIs to guide decarbonization. The creation of this whitepaper by the metrics workstream was only made possible through strong contribution from the impact members and numerous constructive discussions within and across the member-groups. This proves that subjects can progress if willingness, determination, and cooperation prevail.

Our second White Paper, on substituting widely-used transition finance benchmarks is in the making, with more to come. Above all, it makes us particularly proud to have achieved a wide recognition across the various stakeholder groups and to have established a meaningful, industry-wide network.

impact's ultimate goal is to provide the industry with tools to measure and track the CO_2 footprint. This would be done through the implementation of standardized KPIs and through the design and adoption of lending standards which are not discriminatory but, instead, holistic enough to move the needle. By doing this, we will be able to provide more assurance on the availability of funding to cover the industry's basic needs, which is predominantly the financing of aircraft. We must not underestimate the relevance of such commitment to financiers and investors into new technology, e.g. SAF, hydrogen, electric.

Closing remark: All industry participants must look beyond a one-two year horizon when it comes to revenues, profits and returns. In aviation, typically, the finance or investment horizon is in the mid- to long-term. The overarching question we must then ask ourselves is; "What is the cost of late or limited action?"

impact

ON SUSTAINABLE AVIATION

impact is a non-profit platform for investors in- and financiers of airlines and aviation infrastructure aiming to be at the forefront of a new reality in aviation finance. impact is comprised of five collaborative working groups designed to deliver a credible and transparent roadmap to reduce CO_2 emissions from aviation to net-zero by 2050. impact is funded by the pro bono contributions of members, including a group of leading global financiers in aviation.

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