Pie in the Sky

How IATA's Fly Net Zero 2050
does nothing to save the climate

badvertising

“Come on, stop calling us polluters!”

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Photo page 1: Laura Vinck

Summary

Realising that politicians and the public demand action on climate change from all sectors, the International Air Transport Association (IATA) has adopted a resolution declaring that the aviation industry will *"achieve net zero carbon emissions by 2050 in support of the Paris Agreement goal"* of limiting global heating to 1.5ºC above pre-industrial levels. But, at the same time, IATA envisages aviation more than doubling by the same year.

Obviously these goals are not compatible. Scrutinising the wording of the commitment clearly reveals that it does not commit to a reduction of emissions, much less to zero by 2050, and therefore cannot be said to be in line with the 1.5°C target. It amounts to nothing more than a dazzling case of what climate activist Greta Thunberg memorably called, *"blah blah blah"*, at the COP26 in Glasgow.

As is common with "net zero" plans, most of the proposed measures are either inadequate, overly optimistic or expected to take place in the future.

In order to bridge the credibility gap, IATA has developed a plan called Fly Net Zero, including highly questionable measures that they claim will be implemented to reach the goal. As is common with *"net zero"* plans, most of the proposed measures are either inadequate, overly optimistic or expected to take place in the future, not now. And that it is demonstrably not in line with achieving the 1.5°C goal.

The first problem is that the resolution and the Fly Net Zero plan ignore the existence of non-CO2 effects from aviation, which experts consider have about the same climate impact as carbon emissions. They are not even mentioned.

Secondly, in the crucial period up to 2035 when global emissions need to peak and decrease by about 50 percent, IATA's pre-eminent and almost sole measure is to *"compensate"* increasing emissions through offsets. Such offsets have been widely debunked by experts as being arbitrary, inconsequential or simply ineffective, not doing what they claim.

Finally, from 2035, the centrepiece of the plan is to successively replace fossil fuels with biofuels, aiming for 100% by 2050. According to IATA, this would require 449 billion litres of biofuels per year, three times the present global production of all liquid biofuels for all purposes.

No account is given of how this would affect other sectors, where the land to grow such biofuels would come from, nor how the world would feed itself with crops diverted from food to airplane fuel tanks. Other, minor elements of the plan, include the use of electric and hydrogen aircraft on short flights, and an alleged increase in efficiency.

IATA calls the plan *"an enormous challenge"*. We call it a pie in the sky.

The result of the plan, if the suggested measures are implemented, would be the same impact on our climate from aviation in 2050 as it has today, taking up an increasing share of the global carbon budget. At the same time, it would endanger biodiversity on a global scale. Even an attempt to produce such volumes of biofuels would put global biodiversity and human development goals at risk.

The IATA resolution and the plan to implement it do not reflect a serious attempt to bring aviation in line with the scientific facts of climate change and the impact the industry is having on our planet. Instead it is greenwash, seemingly in order to enable IATA's imperative: growth.

The aviation industry must realise that flying huge jet airliners at high altitudes across the planet is a thing of the past.

The aviation industry must realise and come to accept that flying a large number of huge jet airliners at high altitudes across the planet is a thing of the past. It is a relic of the fossil age we are leaving and unrealistic in a sustainable society. Continued growth is not an option.

Instead airlines and their stakeholders need to find a socially and financially sustainable way to scale down and find a safe landing for the industry, eventually transporting fewer persons in smaller electric or hydrogen powered aircraft, at lower speed and over shorter distances.

While there are more than 20 "*net zero*" initiatives and commitments in global aviation, the IATA resolution and Fly Net Zero plan is likely to be by far the most influential as governments and the United Nations International Civil Aviation Organisation (ICAO) are pursuing a way to meet the 1.5°C.

It is essential that ICAO members recognise the shortcomings and dismiss IATA's resolution as well as the Fly Net Zero plan. Instead, ICAO should:

- Call for a resolution that is truly in line with the Paris agreement, committing aviation to zero CO2 emissions by 2050, including non-CO2-effects.
- Call for an inquiry under the auspices of the Intergovernmental Panel on Climate Change (IPCC) on the scale of the aviation industry which – allowing for other sectors and aviation's non-CO2 effects – would be compatible with reaching the 1.5°C goal, with realistic short term action in the first decade to create a credible pathway beyond 2030.
- In the meantime governments should take action to limit the growth of aviation through domestic, bi- or unilateral actions, including an embargo on the further expansion of the industry.

Photo: Annie Spratt

Content

Photo: Jo-Anne McArthur

IATA and growth

Many of us have seen the acronym IATA on our passenger tickets for air flights without really knowing what it is. The International Air Transport Association (IATA) is the trade federation for global airlines, representing some 290 airlines in 120 countries. Carrying 82% of the world's air traffic, IATA members include the world's leading passenger and cargo airlines.

The organisation sees it as part of their vision *"to shape the future growth"* of the air transport industry *"that connects and enriches our world"*. To do this they lobby decision makers on a global scale, underlining *"the benefits that aviation brings to national and global economies."* [1]

The forecast made by IATA and the aviation industry, based on the report Waypoint 2050, produced by the aviation think-tank Air Transport Action Group (ATAG)[2] estimates that passenger flights will more than double by the year 2050 compared to 2019. Growth will mainly happen in Asia-Pacific, the Middle East, Latin America and Africa, although there remains significant growth also in North America and Europe.

As one would expect from any federation or company, IATA's mission statement declares that the growth of the aviation industry needs to be *"sustainable"*. The implication is unclear since there is nothing sustainable about aviation as we know it today. Growth and sustainability are incompatible when it comes to aviation, a contradiction in terms, and it has become increasingly obvious that, for IATA, growth is still the imperative, making aviation more and more unsustainable.

It wasn't the sound of glaciers breaking, rivers flooding or flames from fires thundering through our forests that made IATA wake up.

When IATA adopted a resolution *"to achieve net zero carbon emissions by 2050"* at the Annual General Meeting in October 2021,[3] it was a sign of an awakening. But it wasn't the sound of glaciers breaking, rivers flooding or flames from fires thundering through our forests that woke them up.

It was the realisation that people and politicians are demanding a halt to CO2 emissions and climate change, and that the continued growth of their operations was in peril. Member states of the UN-based International Civil Aviation Organisation (ICAO) were making proposals that aviation must follow the 1.5°C target from the 2015 Conference of the Parties (COP21) in Paris and adopt to the conclusions in the 2018 report about 1.5°C warming from the IPCC by setting a long term goal for emission reduction.[4]

Alongside IATA's effort to develop a plan for how aviation can develop in line with the 1.5°C goal, ICAO has had a similar process. An end report[5] was presented in March 2022, conceding that aviation could not reach zero CO2 emissions by 2050, even when excluding non-CO2 effects, stating *"[t]he overall traffic growth rate has an important impact on residual CO2 emissions by 2050 and after."*

Greenwashing aviation

In order to attract passengers and to fend off politicians, IATA, ICAO and other stakeholders in the aviation industry are repeating a number of misleading statements that amount to greenwashing, in order to allow continued aviation growth:

- Aviation's contribution to global emissions and global warming is only 2%.
- Improvements in aircraft efficiency are reducing emissions from the sector.

- Electric aircraft will soon be a viable alternative to jet fuel powered flight.
- Hydrogen aircraft will soon be a viable alternative to jet fuel powered flight.
- Alternative jet fuels such as biofuel, or electro-fuel can be scaled ecologically and economically – without affecting the price of air travel and undermining the business case for airlines.
- Existing and future carbon offset schemes will be effective in reducing emissions.

The IATA resolution and the plan on how to reach the goal of *"net zero carbon emissions"* is based on these misleading arguments and denial of important scientific facts. Pointing to the resolution, the Fly Net Zero plan and repeating the misleading arguments, it is not wild speculation that the aviation industry will likely now claim that they have taken responsibility, and that flying has virtually no climate impact. Subsequently, they will argue that there is also no need for government policies that constrain air traffic growth.

But nothing could be further from the truth.

Photo: Mike Newbry

The resolution

At the 2021 Annual General Meeting of the aviation industry, IATA approved a resolution[6] stating that global aviation would achieve net zero carbon emissions by the year 2050. Indeed, this constitutes a milestone of sorts, since it is the first time the aviation industry has acknowledged the need to eliminate CO2 emissions. However it is a grossly insufficient commitment by an industry that has consistently dragged its feet and opposed real action on climate change.

The commitment

The commitment stated in the resolution is that IATA adopts *"the collective target to achieve net zero carbon emissions by 2050 in support of the Paris Agreement goal"* of 1.5ºC. This apparently straight-forward statement includes a few words and phrases that should be noted and need to be clarified.

"Net zero" is not zero.

The first of them is *"net zero"* which actually means that the industry can continue to release carbon at any rate it wishes as long as the same amount is somehow balanced by reductions somewhere else. In effect, IATA has not stated that carbon emissions from aviation will be reduced. *"Net zero"* is not zero.

Carbon is only half of the problem.

The second phrase which needs to be high-lighted is the wording "*carbon emissions*". This means that the statement only covers emissions of carbon dioxide, excluding non-CO2 climate impacts associated with aviation, such as emissions of nitrogen, soot particles, oxidised sulphur, and water vapour.

Such effects are generally considered to be as important in total as those of CO2 alone.[7] By omitting them from the statement, IATA is, at best, only addressing half of the problem.

Not in line with the 1.5°C goal.

Finally, the phrase claiming that the commitment is *"in support of"* the Paris goal is vague and unqualified. It is based on a similarly vague analysis in the report Waypoint 2050[8] from the industry's think-tank Air Transport Action Group, ATAG. It suggests that the IPCC has published several pathways to the 1.5ºC target requiring a peaking of emissions between 2020 and 2030, followed by rapid reductions to 2050.

While that is to some extent true, it is stretching the truth quite a bit, and it is definitely not the whole truth. The median of all IPCC pathways leading to 1.5ºC with no or limited overshoot, peak around the year 2020, and by 2030 they require close to 50 percent emission reduction.[9] Actions that are in line with the 1.5ºC target require dramatic emissions reductions over the next ten years—starting now.[10] There is nothing in IATA's statement or plan aiming for this.

On the contrary, fact sheets[11] distributed by IATA show that the aviation industry's quest for constant growth implies that carbon emissions are set to increase over the coming years, before levelling-off between 2025 and 2035. While the number of passengers grows by 3.1 percent per year, measures to reduce CO2 emissions will not be introduced at scale before 2035. Only after that year, the introduction of biofuel is expected lead to rapid reductions of emissions.

As a result, CO2 emissions from aviation will not be reduced by 50 percent until 2045, 15 years later than the median IPCC pathways with no or limited overshoot. The cumulative releases from aviation 2020–2050 are a staggering 21 billion tons of CO2, representing eight months of the entire global emissions in 2019[12].

Table 1. Estimated emissions of CO2 per year, reduction through biofuel or other measures (excluding offsets) and amount released to the atmosphere. Average for five-year periods. Million tons.

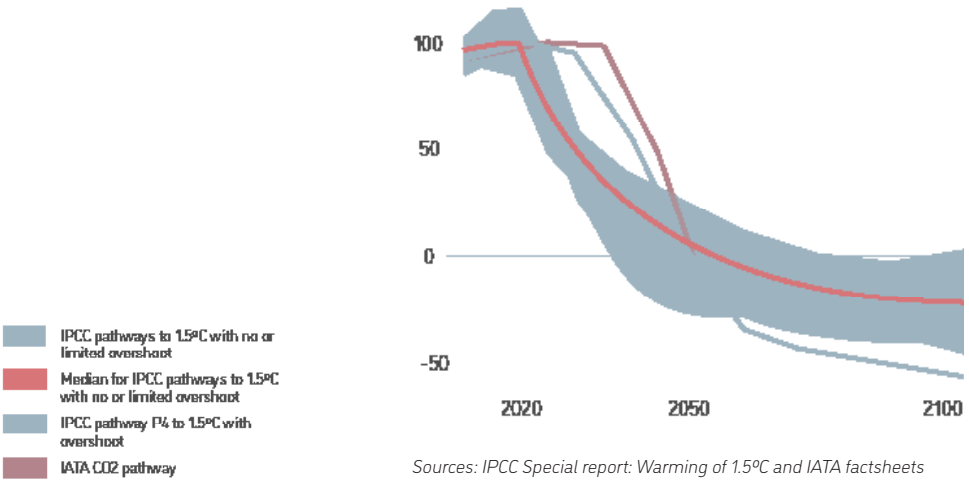
Year	CO2	Abatement	Released
2025	1,100	76	1,024
2030	1,250	196	1,054
2035	1,375	341	1,034
2040	1,500	765	735
2045	1,650	1,231	419
2050	1,800	1,633	167

Figures derived from IATA fact sheets

There is no pathway in the IPCC report resembling the one IATA presents for CO2 emissions.

The resulting pathway is not compatible with the Paris agreement and there is no pathway in the IPCC 1.5ºC report resembling the one resulting from IATA's abatement plan. The nearest is pathway P4, which leads to a large overshoot and temperatures above 1.5ºC that need to be reversed by 2100, requiring massive use of CCS and negative emissions from 2050. It is a very risky pathway putting a heavy financial burden on future generations and endangering the well-being of humans as well as the rest of the planet.

Figure 1. Emission pathways leading to 1.5 ºC according to IPCC and IATA pathway as presented in the abatement plan, percent



Sources: IPCC Special report: Warming of 1.5ºC and IATA factsheets

Adding non-CO2 effects

Despite massive amounts of research showing that aviation is associated with non-CO2 emissions and effects that have an impact on the climate, IATA has never included them in its calculations or policies. This is particularly irresponsible since such emissions and effects are estimated to be as damaging to the climate as the CO2 emissions, possibly twice as much, and are widely accepted by experts, IPCC, authorities and governments world-wide.[13] Still IATA pretends they don't exist.

IATA's resolution only addresses half of the problem, at best.

The resolution taken at the AGM 2021 is no exception. No measures whatsoever are suggested to reduce non-CO2 effects. As a result, the resolution only addresses half of the problem, at best.

Attempting to justify the fact that it ignores these effects, a Q&A document[14] from IATA explains that these effects are excluded since *"the relative scale of their impact is highly uncertain"*, promising to implement them *"when the international scientific community agrees on the emission factors for non-CO2 gases"*. ICAO has the same policy.[15]

Undoubtedly there are uncertainties regarding the exact magnitude of harm these effects are creating, and how the various effects interact. But it is widely accepted that they are as harmful to the climate as the carbon dioxide emissions. Waiting for scientific agreement on the exact factors may mean that they will never be accepted by IATA.

Non-CO2 effects are not only a large and important part of the negative effects aviation has on our climate, they are also difficult to address. While they may be reduced significantly by modification of jet fuel and adjusting flight paths, it would take time and there is no incentive to do so since it would make flying more expensive.[16] Switching to biofuels is unlikely to change that.

Including non-CO2 effects and adding them to the emissions of CO2, shows that the real impact aviation is having on the climate is approximately twice as big as IATA claims (figure 2). Even if all the abatement measures outlined in the IATA plan are successfully implemented, climate impact by 2050 would be slightly bigger than today. The resulting pathway shows a straight horizontal line from 2030 to 2050 (figure 3).

The cumulative climate impact of IATA's plan amounts to two years of total global emissions.

As a result, the cumulative climate impact of CO2 and non-CO2 effects between 2020 and 2050 amounts to more than 60 billion tons of CO2-equivalents, representing two years of total global emissions before the Covid19 pandemic.[17]

Figure 2: Estimated climate impact by CO2 and non-CO2 effects from global aviation 2019 and 2050, before (a) and after (b) CO2 abatement measures according to IATA's Fly Net Zero 2050 abatement plan. Billion tons of CO2 equivalents.

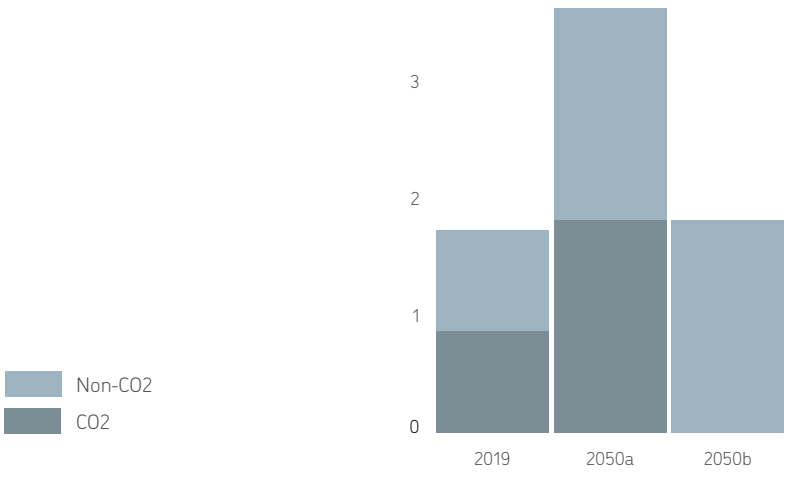
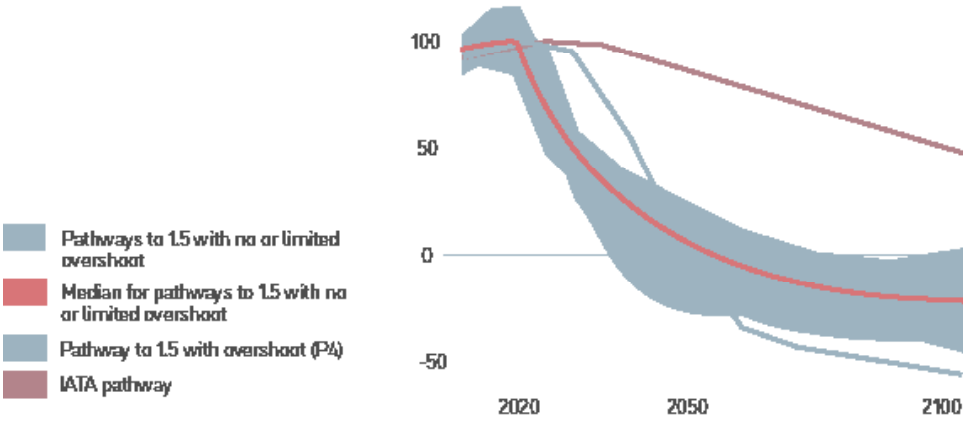


Figure 3. Emission pathways leading to 1.5 ºC according to IPCC and IATA pathway for CO2 and non-CO2 effects, percent.



Source: IPCC Special report: Warming of 1.5ºC and IATA fact sheets

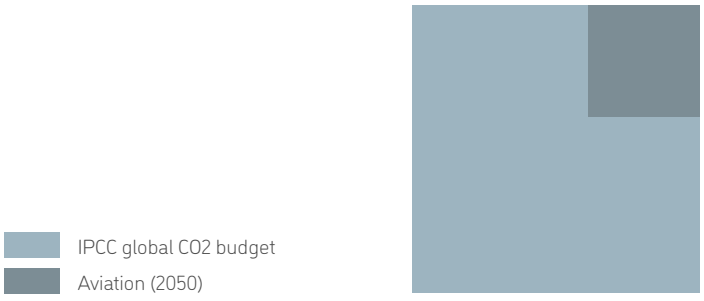
Global carbon budget

This development is in total contradiction to the Paris agreement. The cumulative emissions from aviation alone between 2020 and 2050 would consume 15% of the entire global carbon budget for the whole century. In the IPCC's SR15 report the budget is defined as 570 billion tons of CO2 equivalents, which gives humanity a 66% chance of avoiding temperature rise of more than 1.5ºC.[18] Since the report was published, approximately 160 billion tons have been released, leaving a budget of 410.

While curbing CO2 emissions from aviation is a daunting task, an *"enormous challenge"* as IATA calls it, addressing total climate impact turns the mission of making civil aviation, as we know it today, sustainable into an insurmountable undertaking.

However, turning a blind eye to reality, ignoring science and striving for continued growth at all cost is senseless and will only make the fall harder when it comes.

Figure 4: Global CO2 budget for entire century with 66% chance to stay below 1.5ºC according to IPCC SR15 report, and the share claimed for aviation by 2050 based on IATA's abatement plan.



Sources: IPCC Special report: Warming of 1.5ºC and IATA fact sheets

Photo: Rostyslav Savchyn

The plan

While the IATA resolution only addresses half of the problem, it is described by IATA itself as *"a momentous decision to ensure that flying is sustainable*". However, there is no clear blueprint showing how the goal of decarbonising global aviation will be achieved.

In reference to what measures will be taken to reach the goal, IATA recognises that *"the actual split, and the trajectory to get there, will depend on what solutions are the most cost-effective at any particular time*", meaning that they presently really don't know, but they will use the cheapest options as they go along.

Nevertheless the organisation also presents a plan, or rather, *"a strategy"* indicating how the commitment will be reached. It is called *"Fly Net Zero 2050"* and is based on suggestions in the report Waypoint 2050 from the aviation think-tank ATAG. Even when considering that the proposed measures only aim to reduce CO2 emissions – turning a blind eye to non-CO2 effects – the scenario reveals important shortcomings and a lack of ambition to truly comply with the 1.5 °C target (table 2 and figure 5).

Growth

At the core of the plan lies IATA's paramount ambition: to *"accommodate the growing demand of a world that is eager to fly."* [19] By 2050, IATA wants 10 billion passengers to board airplanes per year, an increase from 4.5 billion passengers in 2019. This means more than doubling the emissions that need to be curtailed and limits the available options. In some scenarios, emissions of CO2 from aviation could constitute 25% of global emissions within a couple of decades.[20]

As a result, the plan is almost entirely dependent on highly questionable mitigation strategies that allow growth. These include offsets of billions of tons of CO2, an enormous production of biofuels and hydrogen, and large-scale roll-out of CCS. If at all feasible, all of these lay far ahead in the future, and entail large risks for biodiversity and development.

Such strategies are frequently termed *"false solutions*", since they are unrealistic and simply delay real solutions. Still, they are often the preferred option of entities that have no real ambition to reduce their climate impact in the present, while claiming lip service to climate action.

To put it mildly, it seems unlikely that all, or any, of the proposed measures, with the exception of the modest improvement in efficiency, will develop and materialise, at least on the scale envisioned by IATA. This is particularly true for the bizarrely huge production of biofuels that IATA envisions, which would also pose a tremendous threat to biodiversity and global development.

Abatement of CO2 emissions

The scenario presented by IATA essentially allows continued CO2 emissions on 2019 levels up to 2035, building on five long-term strategies to abate releases in order to reach the objective of "Net Zero 2050":

- Offsets. Offsetting emissions by compensatory measures. This strategy dominates the plan over the next 15–20 years.
- Biofuels. Switching from fossil fuels to biofuels. The later part of the plan,

from 2035, depends on a massive use of biofuels while offsetting decreases.

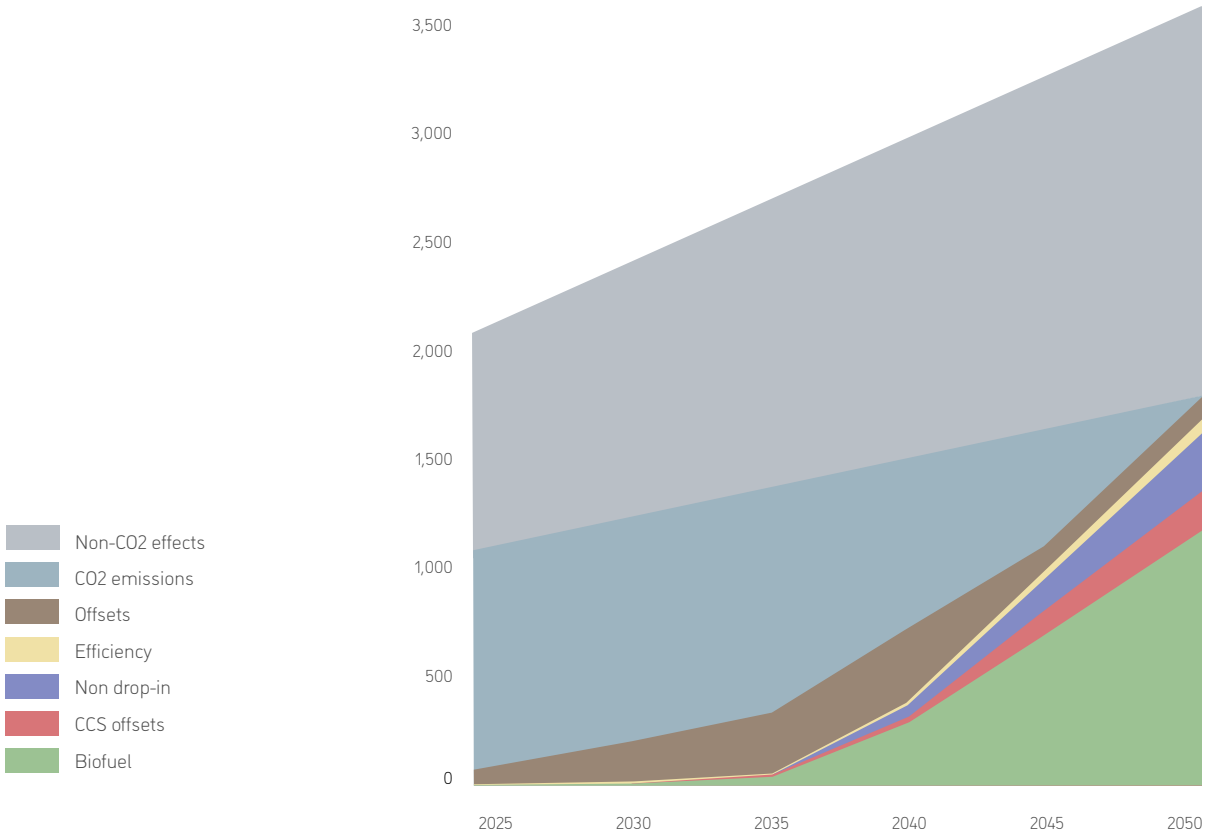
- **Non drop-in fuels.** Also in the later part of the plan, deployment of electric and hydrogen aircraft are expected to increase.
- **CCS.** Offsetting by carbon capture and storage and/or carbon capture, utilisation and storage (CCUS) is considered to be an option.
- **Efficiency.** Throughout the plan, efficiency measures are expected to contribute by 2–3% per year above baseline.

Table 2: Specification of CO2 abatement measures 2025–2050 according to IATA's scenario "Fly net zero 2050". Percent of total abatement.

Year	Offsets	Biofuel	CCS	Non drop-in	Efficiency
2025	97	2	–	–	2
2030	93	5	–	–	2
2035	77.5	17.5	2	–	3
2040	44.5	40	5	7.5	3
2045	24	55	8	10	3
2050	8	65	11	13	3

Source: IATA fact sheets

Figure 5. Non-CO2 effects, CO2 emissions and abatement measures 2025–2050 according to IATA's "Fly net zero 2050". Million tons CO2e. For reference, CO2 emissions in 2019 were about 910 million tons.



Source for abatement measures: IATA fact sheets

Offsets

Global aviation industry has embraced offsetting to compensate for its CO2-emissions since 2016 when ICAO decided to use offsetting for all emissions above 2019 levels. The agreement means that emissions can continue to increase, but every ton above 2019 levels will be *"compensated"* by investments in emission reductions in other sectors. According to IATA these reduction programs include forestry projects, wind energy operations, protection of ecosystems and remote community-based projects to cut emissions.

There are two problems with the compensation approach to climate protection. First, sending money to someone else to reduce emissions elsewhere does not take away the emissions being released when flying. We all need to reduce our impact, and on top of that finance such projects. It's not one or the other, it's both.

Offsets are a guessing game based on a counterfactual hypothesis: what would have happened if we didn't do it?

The second problem is that there simply is no way of knowing if compensation schemes provide what they promise. The only evidence that is available suggests that only a tiny proportion of offsetting schemes can be shown to make a positive contribution. The idea is that the money from passengers and airline companies helps finance a climate project that otherwise wouldn't have taken place. Such as forestry protection, wind farms and solar panels. But there is no way of knowing that. It's a guessing game based on a counterfactual hypothesis: what would have happened if we didn't send the money?

Perhaps a government would have passed a law, or an NGO might have stepped in with money. Or the project may have been launched with loans from a benefactor. Maybe some other entity with a higher social value would have invested? Who knows?

Part of this problem is also that in many cases there are no guarantees that projects will actually be implemented or that they will persist over time. For example, forest protection needs to have a long-term perspective and it's hard to ever be sure an offset will permanently *"absorb"* the emissions. Trees need years to grow enough to absorb the carbon from a flight, and there is no way to guarantee they will be left standing long enough to counteract the emissions from the flight.

Deforestation schemes often generate and sell carbon credits to airlines based on the amount of deforestation they claim to prevent. In order to work out these carbon savings, they predict how much deforestation would have taken place if the project didn't exist. Although the scenario is hypothetical, offsetting schemes use deforestation rates in comparable areas of nearby forest, so-called reference regions, to come up with an estimate.

Unearthed and the Guardian investigated[21] how such projects performed. The key findings that emerged from the investigation were:

- Satellite analysis of tree cover loss in the projects' reference regions, carried out by leading consultancy McKenzie Intelligence Services, found no evidence of deforestation in line with what had been predicted by the schemes.
- The analysis of schemes backed by British Airways, easyJet and United suggest the scale of the carbon benefits they offer is impossible to verify and may be exaggerated.
- The offsetting market may not be fit for purpose because projects calculate

their climate benefit using what some experts viewed as simplistic methodologies that fail to account for the impact of markets and governments on deforestation.

- One environmental expert whose deforestation modelling software was used by many projects said flawed methodologies could generate *"phantom credits"* that represent *"no impact on the climate whatsoever"*.
- Discussing a project backed by British Airways, a government official responsible for reduced deforestation projects in Peru called the calculations behind offsetting schemes a *"Pandora's box"* and *"arbitrary"*.
- Projects are only set to last a short period of time, sometimes only a couple of decades, meaning that the carbon savings claimed by airlines for forest preservation are not guaranteed over the longer term.
- One of the projects was run by two logging companies that cut down ancient and rare trees.

According to a study of offsets through the Clean Development Mechanism (CDM) by Ökoinstitut, only 2% of the projects have a high likelihood of ensuring that emission reductions are additional and are not over-estimated.[22] This was confirmed by a report in 2019 showing that 80 percent of the offset projects being made under the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) scheme would have taken place whether the credits were sold or not.

Certainly some of the projects do some sort of good somewhere in the world, while some are a total scam. But there's no way of knowing, and the main point is that it won't make the emissions from flying go away.

"While they may offer customers some peace of mind, traditional carbon offsets do almost nothing to tackle the emissions from flying,"

Scott Kirby, CEO United Airlines

In an infamous post on the social network LinkedIn, United Airlines CEO Scott Kirby stated that, *"While they may offer customers some peace of mind, traditional carbon offsets do almost nothing to tackle the emissions from flying,"* pledging to fully cut the company's greenhouse gas emissions by 2050. *"And, more importantly, they simply don't meet the scale of this global challenge."*

An additional problem is that the concept of *"compensation"* is entirely based on the condition that some countries have CO2-reductions to sell. That won't be the case in the future when all nations need to minimise their emissions as a consequence of the Paris agreement.

Claiming to abate CO2 emissions by carbon offsetting is questionable at best. It deceives people that flying is OK as long as you pay for it. But there is no way to buy yourself free from climate change.

Biofuels

There are basically two kinds of alternative fuels that may be used to substitute kerosene in the aircraft being used today and over the coming decades.

- Traditional biofuels
- Synthetic fuels, also referred to as electro-fuels or e-fuels

Over the past years these alternative fuels have been referred to by the aviation industry as Sustainable Aviation Fuels, or SAF. Since biofuel production for other uses is an established technology, widely used around the world for heating,

transport, electricity etc., IATA believes that such fuels can be used in aviation as well. Adapting biofuel technology to produce aviation fuel is quite simple and potentially means that they could replace kerosene. This is already happening, even though it is on a very small scale.

While such a substitution is the main strategy for abatement of CO2 from 2035 to 2050, IATA is also considering using synthetic fuels, which is an emerging technology whereby electrical energy is stored in liquid or gas fuels.

Traditional biofuels

Switching from fossil fuel to biofuel will be a key component to make aviation CO2-free according to the scenario presented by IATA, while synthetic fuels are only mentioned as an option. Since production and infrastructure for distribution of biofuels for aviation are very limited in the near future, the amounts available will be small, at least for the next 10–15 years. From 2040, IATA expects biofuel to be the dominant abatement method.

In 2019, the aviation industry used 360 billion litres of fuel.[23] Virtually all of it was of fossil origin. Looking forward to twice as many passengers in 2050, and simultaneously switching to biofuels, IATA estimates that airlines will need 449 billion litres of *"sustainable aviation fuels"*, or SAF.

First, let's consider the magnitude of these numbers: 449 billion litres of fuel is slightly more than all of the petrol, diesel and renewable fuels used in the EU28 in 2019.[24] It is also more than three times the present global production of liquid biofuels, 138 billion litres.[25] That's quite a lot of fuel.

Going from 100 million litres of biofuel per year to 449 billion, means increasing production 4,490 times.

To put this in further context, the global production of aviation biofuel today is approximately 100 million litres. Going to 449 billion litres means increasing production 4,490 times. Living in a constrained world where biodiversity is dwindling, population is growing and food is scarce in parts of the world, it's reasonable to ask where this biofuel is going to come from.

Secondly, what environmental criteria will the airlines use? There are literally hundreds of different standards floating around. Some of them, like the criteria used by ICAO in the context of CORSIA, are very weak, allowing fuels that are actually more damaging to the climate (and biodiversity) than fossil fuels.

So far, the only assurance IATA has given is that the fuel will be sourced from feedstocks *"that do not degrade the environment or compete with food or water"*[26] and that the fuel needs to result in greenhouse gas savings of at least 60%.

That doesn't really say a lot. For example, it doesn't state what baseline airlines will use when assessing greenhouse gas saving. Does it include indirect land-use change or not? And what does it mean to *"not degrade the environment"*?

IATA does not give us an answer. They stop at calling it a *"tremendous challenge"*. We call it a pie in the sky.

But it's a dangerous pie. Biofuel production uses biomass for the feedstock: agricultural crops or waste from farms, municipal waste from cities, inedible animal fats, or used cooking oil. All of these resources are already being used in households, industries and transportation. Any attempt to increase the global production to that scale amounts to incredible risks for biodiversity and land-grabbing.

Palm oil and its by-product PFAD are likely to be in high demand for aviation biofuels if sustainability criteria are lax. According to Cerulogy, the climate impact of PFAD is 2–3 times greater than from fossil fuel.

Photo: Nazarizal Mohammed

Aviation biofuel is not a scalable solution without causing increased global food prices, deforestation, drainage of peatland, loss of biodiversity, and land-use change emissions (the emissions generated when carbon stored in vegetation and soils is released e.g., when forests are converted to agricultural land). The use of large quantities of aviation biofuels will thus exacerbate the climate and ecological emergency.

An EU report (contributed to by Airbus, Boeing, BP, Shell, and easyJet) states that *"biofuels' reliance on feedstock, changes in land use, high water use, and/or monoculture (i.e., the production of a single crop) means that the aviation industry will be competing with other interests that need the feedstock for other purposes."* [27]

For such reasons, the production of biofuels is increasingly focused on using *"waste"* products. Waste has become the Holy Grail for everyone who wants to protect the climate and still keep on consuming. Animal fat, cooking oil, residues from forestry and plant processing, saw dust and cutter shavings, tall oil, black liquor... The entire biofuel industry is based on the belief that there is an abundance of *waste* that can be turned into fuels.

Virtually all of the materials called waste are already being used for something else.

Except: there is no such thing as waste. Virtually all of the materials labelled as waste are already being used in one or other process. Sawdust is, for example, used for heating in industry; glycerol has more than 1,500 different applications in the chemical industry; animal fats are a feedstock in cosmetics and medicines as well as being used for pet food and animal feeds; palm fatty acid distillates (PFAD–a by-product from processing palm oil) is used in cosmetics, soap and live-stock feed, etc.[28]

Biofuels and climate

When combusting fuels made from biomass, carbon dioxide is emitted. It is exactly the same molecule as is released when combusting fossil fuels, but biofuels have traditionally been considered to have no direct climate impact since the feedstock takes CO2 out of the atmosphere, creating a 'loop'. This is called the carbon cycle.

This theory has become well established throughout the world and has led to policies and practices of replacing fossil fuels with biofuels in a large scale.

What has not been considered is that this loop – the time it takes for the biogenic carbon dioxide being emitted to the atmosphere and its absorption by new plants or animals – may take decades or up to a hundred years. In the meantime, the carbon from biomass present in the atmosphere causes exactly the same climate change as carbon from fossil fuels.

Since we have a very limited time frame to limit the amount of carbon in the atmosphere, it is of limited relevance whether the carbon being emitted will be absorbed in 20, 50 or 100 years or not, at least in the short term. In order to reach the 1.5°C target calls are being made to stop all carbon emissions, whatever the source.

What is defined as waste by one industry is a valuable asset for another. If these streams are redirected to being used as biofuel for airliners, they will be replaced by other products in the processes where they were previously used. In some cases the alternative is fossil fuels, in others it will probably be replaced by palm oil or other vegetable oils. In turn, there will need to be an increased production of those to fill the hole created by aviation, causing more land use change etc.

The impact of using certain waste products for aviation biofuel has been assessed by Cerulogy and the International Council on Clean Transportation .[29] It found that the result would be increased emissions of CO2 outside the aviation sector for most of them when using the modelling in the EU Commission Globiom report and that none of them complied with the EU requirement of a 65% reduction of greenhouse gases (table 3). In fact, most of them had higher emissions than fossil fuels.

Table 3. Estimated indirect emissions for certain biofuels produced from waste, depending on baseline: no indirect land use change, EU REDII and EU Commission Globiom, gCO2e/MJ. Emissions from kerosene fuel jet are 87–89 gCO2e/MJ. CO2e savings of 65% is set to 31 gCO2e/MJ.

Feedstocks	No ILUC	REDII	Globiom
Animal fats derived FAME	66	76	100
Tall oil derived HVO	52	57	66
Tall oil pitch derived HVO	93	93	93
Sawdust and cutter shavings derived FT diesel	93	93	93
Distillers corn oil derived FAME	30	74	141
PFAD derived HVO	47	92	221

More than 87 gCO2e/MJ
More than 31 gCO2e/MJ
Less than 31 gCO2e/MJ

Source: Cerulogy/ICCT

In particular, palm oil and PFAD is a concern since they are inexpensive oils with huge climate impact, causing significantly more emissions than the fossil fuels they replace. At the same time, they are also very accessible. Neste, one of the world's biggest producers of biofuels, has invested heavily in palm oil and PFAD production and has been lobbying EU, trade organisations and WTO to "*improve palm's image*" in order to get palm oil and PFAD past the EU RED II regulation.[30]

Sustainability criteria may be defined at international level through ICAO, by bodies such as the Roundtable for Sustainable Biomaterials, or regionally and locally through schemes such as the European Union's RED II and California's LCFS.[31] Currently it's anyone's guess.

Synthetic fuels

There is a wide range of emerging technologies to produce liquids that store energy from electricity, also called e-fuels, power-to-liquids, power-to-gas, e-gas, electrofuels etc.

To produce e-fuels, electricity, preferably renewable, is used to split water into hydrogen and oxygen. The hydrogen is then combined with carbon dioxide to make drop-in hydrocarbons like diesel, gas (methane), or jet fuel. While e-fuels can be

very low-carbon if made from new, additional renewable electricity, they can't be low-cost at the same time. The e-fuels production process is inherently inefficient, converting at best half of the energy in the electricity into liquid or gaseous fuels.

Even if production of synthetic fuels is funded and scaled, the inefficiency of the processes involved would require huge quantities of renewable energy. The electrical energy required to produce enough fuel to displace current worldwide annual aviation fuel consumption would exceed the entirety of global renewable energy generated today.[32]

Non drop-in fuels

Airliners need huge quantities of energy to fly. A Boeing 747 weighs more than 400 tons, while the Airbus A380 has a maximum weight of 575 tons. Getting all of that weight off the ground, and to make it climb to an altitude of approximately 10,000 metres, requires thousands of litres of fuel.

The energy consumed by a ten-hour flight is about the same as that needed to power 1,000 homes for a year.

On average, a 747 burns four litres of fuel every second, and a ten-hour flight consumes approximately 150,000 litres of kerosene. The energy consumed is about twice the amount delivered by a modern wind-mill in a year, or the amount needed annually to power 1,000 homes in Europe.

Using electric engines, supplied either from batteries or hydrogen, and hydrogen powered aircraft, is sometimes mentioned as a way of decarbonising aviation. It is also one of the strategies suggested by IATA in the "Fly net zero 2050" scenario. Unfortunately the option has several limitations that means it will not be realistic for large commercial airplanes over long distances, at least not in the time frame and deployment necessary to halt climate change. IATA estimates that these technologies could abate CO-2 emission by 13 percent by 2050, but virtually nothing by 2030–2035.

Table 4. Estimated potential of electric or hydrogen powered aviation 2025–2035

Year	Engine	Seats	Flight time
2025	Electric	9–19	<60'
2030	Electric or hydrogen	50–100	<90'
2035	Hydrogen	100–150	<120'

Source: IATA fact sheets

According to the report Waypoint 2050 published by ATAG, it is expected that small electric and hydrogen powered aircraft for short-haul flights may appear at the end of 2020's and slightly larger aircraft, possibly for regional medium-haul flights may emerge during the 2030's.

Electric aircraft

In an electric aircraft electric motors drive conventional propellers or sets of small fans. Electricity is stored in batteries, which adds to the weight of the aircraft and puts a limit to the range.

CO2 emissions during flights are zero for full electric airplanes, but indirect releases of CO2 depends on the energy mix of the electricity being used. If fully

Photo: Jasper Wilde

Impacts of climate change are the primary culprits behind decreased farming output and rising hunger worldwide.

renewable sources are used, they could be close to zero as well. An additional benefit of electric propulsion would be the eradication of most non-CO2 effects (such as contrails and NOx emissions).

Small electric aircraft up to 9 seats are flying in test flights and aircraft with up to 19 seats may be ready for operation in the late 2020's, while slightly larger airplanes could come on the market in the 2030's.

About 80% of emissions come from passenger flights further than 1,500 km and electric flight cannot compete at that range.

About 80% of aviation emissions come from passenger flights further than 1,500 km and electric flight cannot compete at that range. Additionally, at such distances public transport options such as rail, coach, or ferry services should generally be favoured. Therefore, even if electric flight is used for some niche cases where ground transport options are poor, it's scope to decarbonise aviation emissions is very limited.

Hybrid

Hybrid-electric aircraft concepts combine traditional combustion and electric engines, much like a hybrid car. While the combustion and electric propulsion systems can be used in combination during take-off to provide maximum thrust, the combustion engine can be throttled back in cruise flight or descending.

Hybridisation is considered to be a necessary intermediate step for larger airplanes towards a pure electric propulsion system according to IATA, claiming that hybrid-electric aircraft can contribute to achieving CO2 emissions reductions of up to 40%.[33]

This is highly unlikely. Attempts with hybrid-electric technology at Rolls-Royce showed that any theoretical improvement was largely cancelled out by the additional weight associated with technical systems.[34]

Hybrid-electric aircraft will still burn vast amounts of jet fuel and should be viewed as an aircraft efficiency improvement that may reduce the quantity of fuel burned and emissions produced per passenger mile. As described below, it is uncertain if such efficiency improvements alone will result in reduced emissions.

Hydrogen

Hydrogen is a carbon-free fuel that can be used as a fuel in two ways:

- for combustion in conventional engines, replacing jet fuel
- in fuel cells as an electrical power source

The weight of hydrogen is three times lower than that of jet fuel with the same energy content, but its volume in liquid form is four times larger. Much larger tanks as well as fundamental changes in the aircraft fuel system are therefore needed.

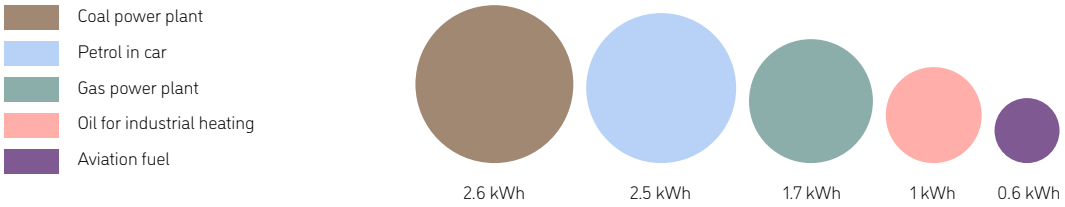
These size, shape and weight requirements of hydrogen will require a re-design of medium and long-haul aircraft fuselages (the body of the aircraft). For example, the storage tanks must be cylindrical or spherical, which makes it very difficult to store the fuel within the wings as per conventional aircraft design. This will require either increased aircraft size, increasing drag at a given flight speed; or a reduced number of passengers on each aircraft. Both of these options will increase the cost of flying.

The biggest challenges for hydrogen use in aviation is its limited worldwide availability at large scale, the need to produce large amounts of *"green"* hydrogen and the lack of supply infrastructure. Production of green hydrogen is also extremely energy intensive, making it expensive.

The electrical energy required to produce enough green hydrogen to displace the UK's current annual aviation fuel consumption would exceed the UK's current levels of annual renewable energy generation .[35] This is clearly not likely to be politically or commercially acceptable.

Whilst renewable energy generation is growing every year, it is likely to be a limited resource also in the future. This energy (and green hydrogen) is needed for decarbonising other sectors of the economy. In most applications 1 kilowatt of renewable electricity achieves more CO2 reduction than in aviation. Using 1 kWh of renewable electricity to replace coal is four times as effective.

Figure 6. Amount of fossil fuel that can be replaced by 1 kWh renewable electricity



Source: Mike Berners-Lee, There is no planet B

As outlined above, the short and medium-term potential is nowhere near the dimensions of aviation today, and long term potential is also limited, even if inherent difficulties are overcome. Fuel cell powered commuter or regional aircraft are likely to happen within the 2030's but will probably be limited to less than 1,000 kilometres of range and again, are unlikely to be widely utilised within airline operations until later decades since the time-line for replacing aircraft is long. Less than 5% of global aviation emissions are caused by regional and commuter flights

Credits from carbon capture and storage

In order to reach the objective of abating all CO2 emissions from aviation, biofuels, efficiency measures and new propulsion technologies (non drop-in fuels) are not sufficient. IATA's scenario therefore includes a large amount of traditional offsets, such as forest conservation, even up to 2050. But such offsets are bound to become scarce in a world where all nations need to reduce emissions to comply with targets commonly acknowledged in the Paris agreement.

As a consequence, IATA struggles to find other ways to abate emissions while hell-bent on increasing *"the freedom to fly"* for millions of people across the globe. One such strategy, recommended in Waypoint 2050, is to buy carbon credits from the next generation of offsets: plants for carbon capture and storage (CCS) and possibly CCUS, where some of the captured carbon is used.

While CCS has been around for a long time, and proponents have been advocating its virtues tirelessly, it has never taken off. The concept is to separate carbon from emissions of major CO2-sources such as power plants and cement produc-

tion, and to store the carbon underground, for example in abandoned oil fields in the North Sea.

In theory, the technology seems a perfect fit for industries that have difficulties to adapt their unsustainable businesses to the reality of climate breakdown, since it implies that they can keep on doing what they are presently doing, and making money from it.

However, the number of plants using CCS is small. In September 2021 there were 27 instalments in operation globally and two under construction. Together they had a capacity to capture 36.6 million tons of carbon per year.[36] Referring to CCUS, IATA believes that it, *"is a long way from being fully-scaled up but it is nevertheless an exciting technology."* [37]

Like the other abatement strategies outlined in IATA's scenario, the proposal to buy CCS carbon credits stems from the report Waypoint 2050, published by the aviation think-tank ATAG. The authors of the report forecast that the use of CCS will increase dramatically between 2030 and 2050 and that operators of CCS plants will be able to sell carbon credits on the market.

In essence, buying carbon credits from CCS plants is just another way of offsetting emissions and adds to the offsetting done with traditional methods.

In essence, buying carbon credits from CCS plants is just another way of offsetting emissions and adds to the offsetting done with traditional methods. Together these two schemes are expected to abate 21% of the CO2 emissions from global aviation in 2050. The amount of CO2 being *"compensated"* through traditional measures and carbon credits from CCS is approximately 380 million tons per year, more than all of the emissions from the United Kingdom.

The abatement strategy is based on very shaky grounds and very hypothetical. There is no way of knowing whether CCS will actually develop in the manner expected by ATAG and IATA, or that there will be carbon credits to buy.

Efficiency

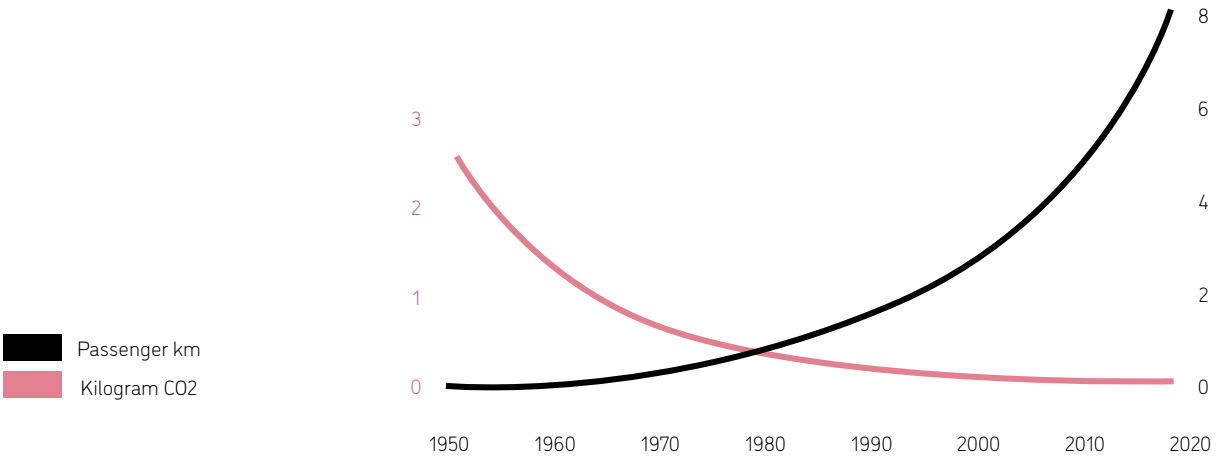
Getting more out of less is always a good idea, and is often the outcome of technical improvements triggered by competition and development. As a result, most products in society become more energy efficient, be it cars, refrigerators, light bulbs or steel mills. In general, the rate of energy efficiency improvement is about 1–2% per year.

Typically such improvements are more than offset by increased consumption. That has also been the case for aviation over the past decades. While modern aircraft are much more efficient than the ones used 20–30 years ago, traffic growth has outweighed this development and led to increased emissions.

As a consequence, aviation's impact on the climate has increased even as aircraft become more efficient. This is quite natural since the key metrics for climate change is the amount of emissions and cumulative CO2 in the atmosphere – not emissions per passenger kilometre.

Over time efficiency improvements in aviation are becoming more difficult to achieve, with the rate of improvement decreasing. The lowest hanging fruit have already been picked and it is increasingly difficult to make improvements, barring a completely new aircraft concept. Currently the estimated rate of improvement is 1–1,5% per year.

Figure 7. Kilograms of CO2 per passenger kilometre and revenue based passenger kilometers, trillions, 1950–2020.



Source: Our World in Data, 2020

IATA has the ambition to top the efficiency improvements that the aviation industry is expected to deliver, with 2–3% per year from 2025 to 2050. In the plan, such improvements are called "operations and infrastructure" and could consist of:

- Retro fitting winglets
- Lightweight seating
- Fuel efficiency management systems
- Reduced engine taxiing
- Air traffic management programs such as Single European Sky and NextGen

While such measures are welcome, it should be asked whether they really constitute improvements above the baseline of 1–1.5% that the industry is expected to deliver. Many of them, if not all, include energy savings and would probably happen anyway as part of spontaneous development. There is clearly a risk for double counting.

For example, retrofitting of winglets is already taking place. According to Waypoint 2050 over 9,000 aircraft have already been retrofitted. Similarly, replacing standard seats with lightweight, slimline models is already happening.[38]

It should also be noted that a likely result of efficiency improvements may be additional growth of the market and increased emissions, not a reduction. Therefore, efficiency gains will not result in total emissions or energy savings, and cannot be relied upon in isolation without measures to address demand. IATA's claim that increased efficiency will lead to less emissions is highly questionable.

The key takeaway here is that efficiency improvements may be used to grow the market and increase emissions, not reduce them.

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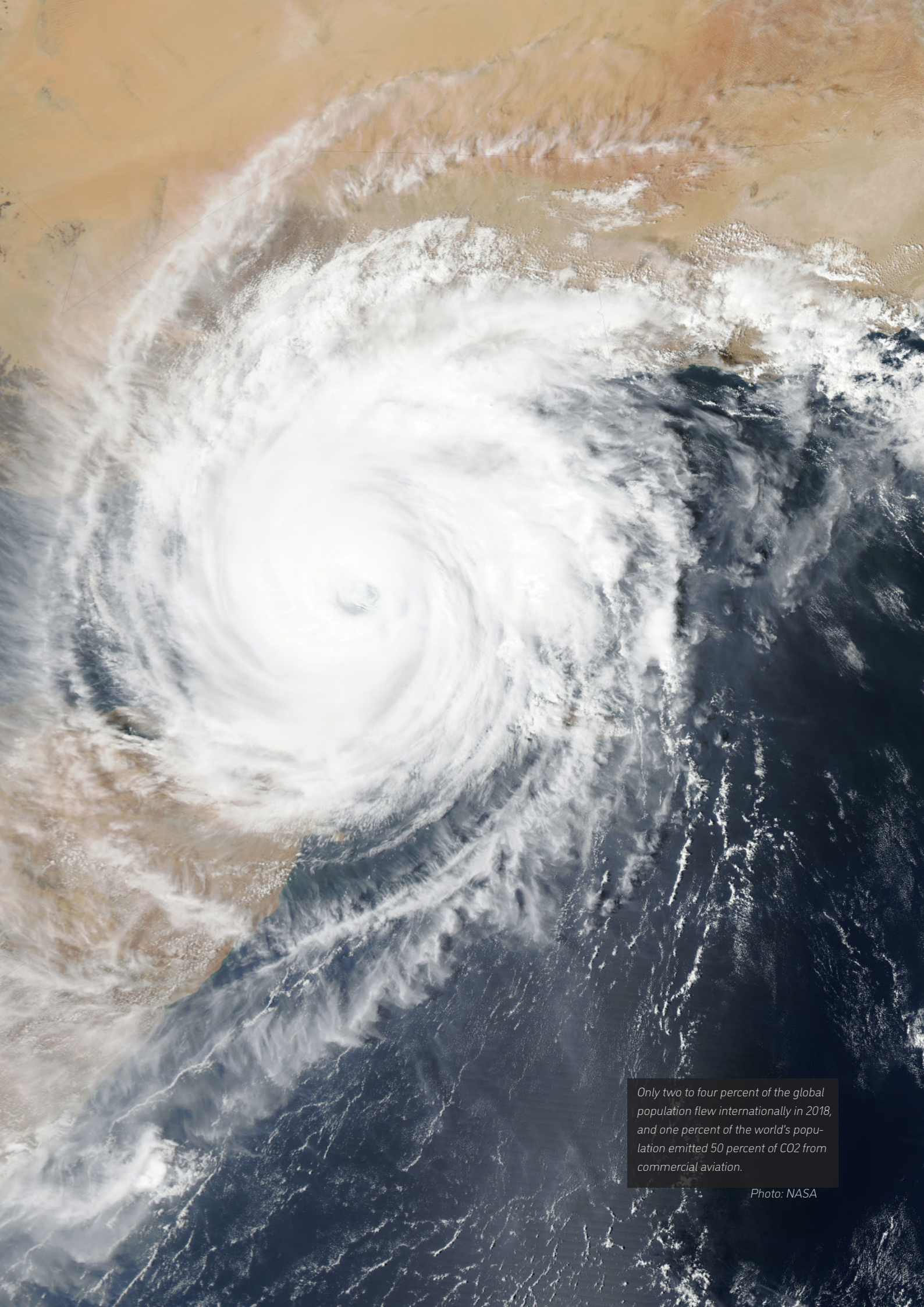


Only two to four percent of the global population flew internationally in 2018, and one percent of the world's population emitted 50 percent of CO2 from commercial aviation.

Photo: NASA

Freedom to fly

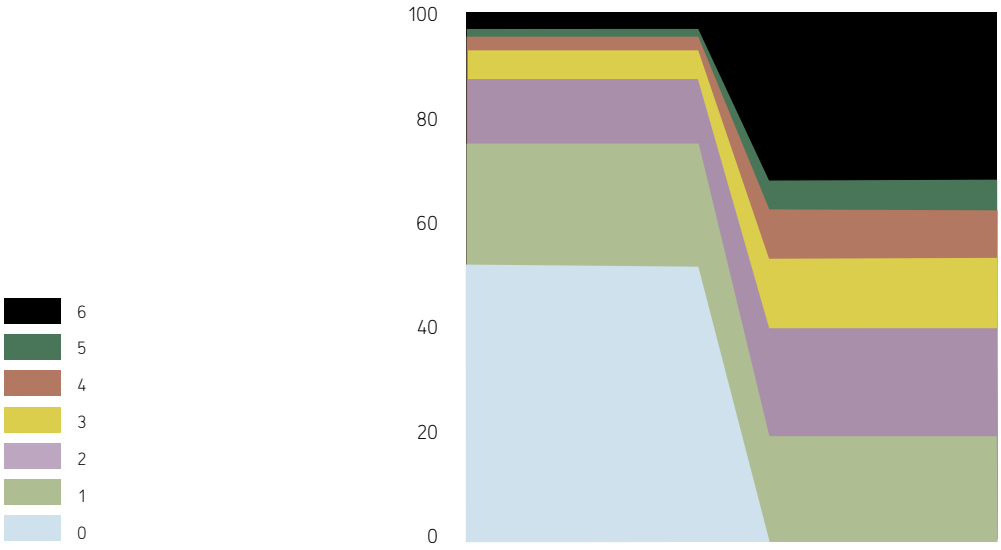
According to IATA, governments must be active partners in achieving net zero by 2050. The costs and investment risks are too high otherwise. The Director General of IATA, Willie Walsh warns that *"retrograde and punitive taxes would stifle investment and could limit flying to the wealthy. Incentives are the proven way forward. They solve the problem, create jobs and grow prosperity."* [39]

Globally it is a very small number of people who fly regularly and produce the vast majority of aviation emissions. It is estimated that only 2% to 4% of the global population flew internationally in 2018, and that 1% of the world's population emits 50% of CO2 from commercial aviation.[40]

The inequity is true between nations, where citizens of wealthy nations fly more than those in developing countries. A mere 10 countries account for about 60% of total aviation CO2. But it is also true within nations. Wealthy people in all countries fly more than their fellow citizens with average or low income.[41]

This socio-economic distribution of emissions is important in light of the principles of equity and fairness introduced by the 2015 Paris Agreement. Given that aviation is an energy- and emissions-intensive activity, which is utilised by a relatively small group of generally high-income individuals and organisations, countries should be slow to encourage further emissions from this industry, because of the inequitable impact.

Figure 8. The proportion of the population in the UK who took international flights a certain number of times per year (left) and the proportion of total flights by the same groups, right. 2015–2017. Percent and number of flights.



Source: Possible.

Willie Walsh's philanthropic claims for the aviation industry need to be seen in light of the fact that he is the Director General of IATA and his job is to make more people fly. The more, the merrier. But, as outlined above, the growth he envisions is not compatible with the boundaries of our climate.

The problem is not that only the wealthy can fly, rather it is that the wealthy fly a

lot and need to fly less. A lot less. So perhaps *"punitive taxes"* or other measures, that make aviation prohibitively expensive for frequent flyers, are in fact necessary policies.

Aviation's present share of global greenhouse gas emissions is estimated to be 4–5%, including non-CO2 effects. If aviation grows to the extent expected by IATA, and if all their plans were successfully implemented, that share would increase threefold, giving humanity more opportunities to fly, but a 'freedom' for one sector that simultaneously forces others to reduce their emissions disproportionately more, or simply mean missing the 1.5ºC target.

Contrary to what IATA seems to believe, there is no "freedom to fly" according to the UN Human Rights law.

Contrary to what IATA seems to believe, there is, in fact, no *"freedom to fly"* according to the UN international Human Rights law. However, since 8 October 2021 there is a human right to a healthy environment, and IATA's plans are in stark opposition to it.[42]

Additionally, article 2 of the UN Paris agreement – signed by 192 nations plus the European Union, states that the agreement *"will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."* The interpretation of this is that national contributions must be fair in the light of the size of emissions and reduction potential.

Obviously aviation is not a nation. If it was, it would rank among the global top ten emitters. However, since flying is closely related to rich countries, it is their responsibility to reduce emissions. There is no right of Freedom to fly, but there is definitely a responsibility for rich nations and individuals to fly less – a lot less – instead of promoting an unsustainable lifestyle

Conclusions and recommendations

The IATA resolution adopted in 2021 has no relevance to the agreement of Paris 2015. It is not remotely aligned with it, consisting of vague and misleading language, apparently phrased to underpin industry greenwashing instead of real change. Omitting non-CO2 effects means it only addresses half of the problem and pledging *"net zero"* by 2050 means nothing since it allows unabated emissions from aviation as long as they are somehow *"compensated"*. This is a far cry from being in line with the Paris Agreement.

The IATA plan is based on a thorough assessment of all existing and potential technologies to reduce emissions from aviation: battery electric aircraft, hydrogen, synthetic fuels, biofuels and hybrids. It finds that only traditional biofuels have the potential to replace fossil fuels to any large extent within the timeframe.

To achieve the stated objective, Fly Net Zero hinges on two preeminent measures: Until 2035, emissions will be *"compensated"* through debunked offsets. From that year, IATA envisions that global aviation be converted to a huge use of biofuels, eventually replacing aviation fossil fuels by 2050. To cover the demand, aviation alone will need 449 billion litres of biofuels, more than three times the present global production of all liquid biofuels.

Even if the plan succeeds, the fact that IATA aims to double the amount of passengers and flights by 2050 while ignoring non-CO2 effects, results in aviation having the same impact on the world's climate in 2050 as it has today.

The cumulative emissions from aviation alone between 2020 and 2050 would consume 15% of the entire global carbon budget for the whole century, amounting to two years of global emissions before the Covid-19 pandemic.

The resolution and the plan for how to implement it, do not reflect a serious attempt to bring aviation in line with the scientific facts of climate change and the impact the industry is having on our planet. Instead it is greenwash in order to enable the imperative: growth.

The aviation industry must realise that flying huge jet airliners at high altitudes is a thing of the past. It is a relic of the fossil age we are leaving and entirely unrealistic in a sustainable society. Continued growth is not an option. Instead airlines and stakeholders need to find a socially and financially sustainable way to scale down and find a safe landing for the industry, eventually transporting fewer persons in smaller electric or hydrogen powered aircraft, at lower speed and over shorter distances.

There is no other way.

A pathway for aviation which is truly consistent with the Paris 1.5°C target must follow the median of IPCC's pathways with limited or no overshoot. This requires that passenger kilometres in aircraft powered by fossil fuel peak now and that CO2 emissions and non-CO2 effects decrease by 50% by 2030 and ultimately are eliminated by 2050.

Needless to say, this will have a great impact on the aviation industry, but is by no means impossible. Considering that IATA's vision is *"to shape the future growth"* of aviation this will however not happen by itself or from voluntary measures by the airlines. Instead, there is a need for governments to implement national and

international measures to limit demand, especially from frequent flyers, and to assist aviation in its transition to truly comply with the 1.5°C target.

As noted above, the Director General of IATA, Willie Wilson, warns that *"punitive taxes would stifle investment and could limit flying to the wealthy. Incentives are the proven way forward. They solve the problem, create jobs and grow prosperity."* Given that endless growth is an imperative for IATA, perhaps *"punitive taxes"* are exactly what is needed. Taxes, looked at differently, are actually one of the best incentives.

While there are more than 20 *"net zero"* initiatives and commitments[43] in global aviation, the IATA resolution and Fly Net Zero plan is likely to be by far the most influential as governments and ICAO pursue a way to meet the 1.5°C goal. However, IATA's proposed plan cannot be executed without the support and participation of governments. This is particularly true in the area of aviation biofuels, where governments are urged to support channeling feedstocks towards aviation and not to other sectors.

Therefore it is essential that ICAO members in the quest to find a long term aspirational goal in line with the 1.5°C Paris target, recognise the shortcomings of IATA's resolution as well as the Fly Net Zero plan and dismiss them as inadequate and dangerous. Instead, ICAO should:

- Call for a resolution truly in line with the Paris agreement, committing aviation to zero CO2 emissions by 2050, including non-CO2-effects.
- Call for an inquiry under the auspices of the Intergovernmental Panel on Climate Change (IPCC) on the scale of the aviation industry which – allowing for other sectors and aviation's non-CO2 effects – would be compatible with reaching the 1.5°C goal, with realistic short term action in the first decade to create a credible pathway beyond 2030.
- In the meantime governments should take action to limit the growth of aviation through domestic, bi- or unilateral actions, including an embargo on the further expansion of the industry.

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