2023

Sustainable Aviation

“

If aviation were unmitigated, it could be responsible for **22% of global emissions** by 2050.

Decarbonizing Aviation: Cleared for Takeoff

Introduction to Sustainable Aviation

Currently, we will not stay below the 1.5°C Paris Agreement climate warming, and without rapid change and support legally and financially, 2°C may also prove challenging to stay below. Aviation alone is responsible for 3-5% of the world's carbon emissions at almost 1 gigaton of carbon emitted annually. By 2050 the aviation industry could be responsible for 22% of all global emission. As other heavy emitting industries, such as cars and construction, begin to decarbonize and travel increases, aviation's impact will grow.

Unfortunately, aviation is a hard to abate industry because airplanes require energy dense hydrocarbon fuels, solutions are extraordinarily expensive to get to scale, air travel demand is expected to grow, and aviation's globality. However, collaborating with tech startups, financial institutions, energy producers, and plane manufacturers has allowed airlines to begin the process of becoming net-zero. More progress is still needed for aviation to reach net-zero goals and to stay below 2°C.

Increasingly, travelers are asking for transparency around sustainability issues. As company whose business is travel, we, as Expedia Group, have a place in helping our partners reach net-zero. We cannot call ourselves a sustainable company without helping the pieces of our business that are heavy climate impactors. Without action now, air travel will become more dangerous and arduous as weather causes more delays and in-flight turbulence.

The following report contains information regarding sustainable aviation and data regarding who does what and how. Sustainability is a constantly changing landscape, so aspects of this report may not be true in the next year or two, especially the data.

Travelers & Sustainability

Sustainability is becoming increasingly important for travelers. They want information that is clear and authentic.

Expedia Group Sustainable Travel Study

90% Of travelers look for sustainable options when traveling

51% Of travelers would be willing to pay more for sustainable transportation

43% Of travelers choose more environmentally friendly

30% Of travelers want to see more sustainable options from airlines

Ansys Sustainable Aviation Survey

63% Of travelers are concerned about airline emissions

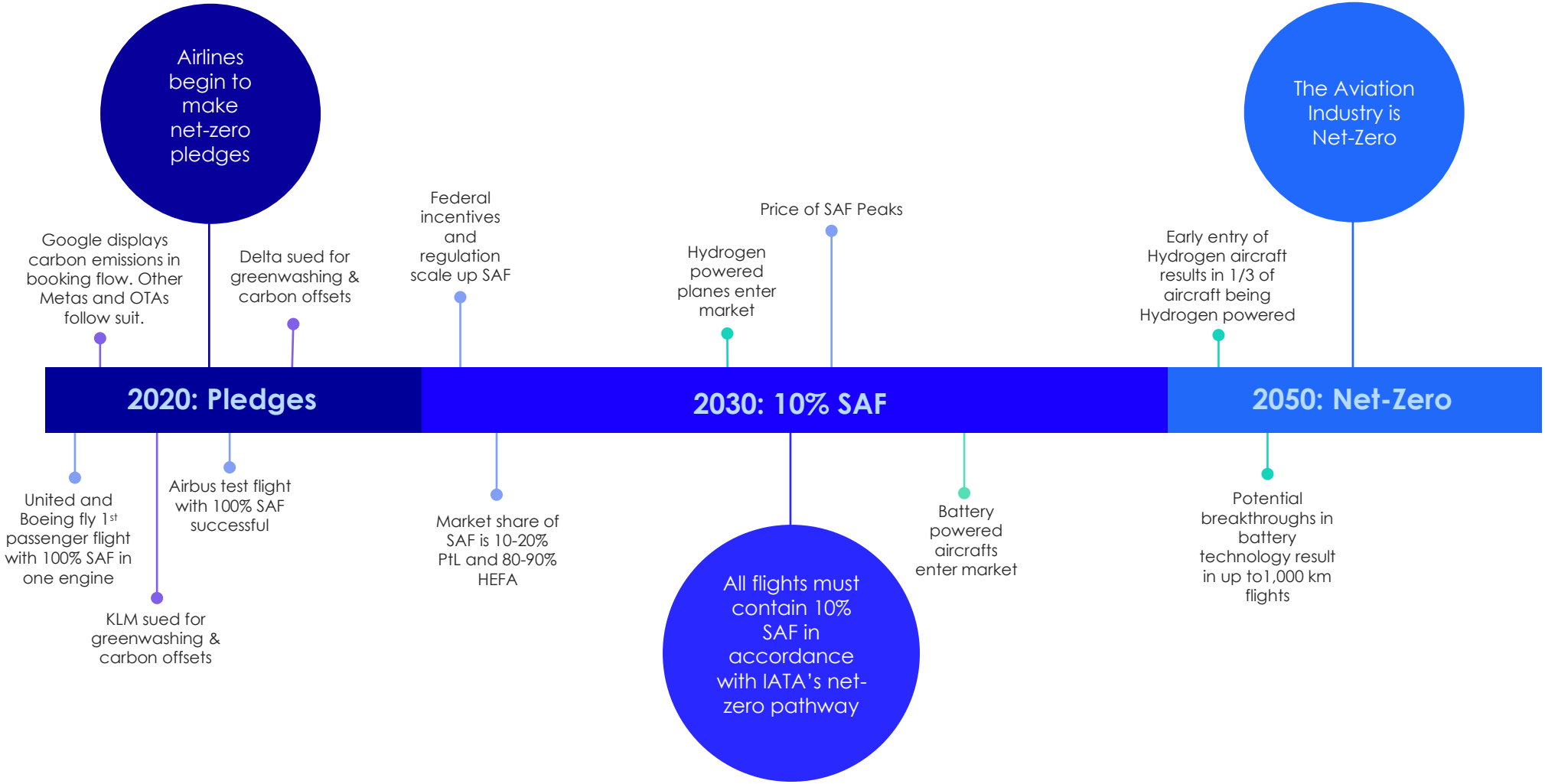
65% Of travelers are willing to pay for greener air travel

32% Of travelers think aviation is not doing enough

32% Of travelers are more likely to fly with airlines committed to sustainability

EG Sustainable Travel Study
Ansys Sustainable Aviation Survey

Sustainable Aviation Timeline



Sustainable Aviation Timeline

Emission Reduction Potential (Provided by ICCT)[i]

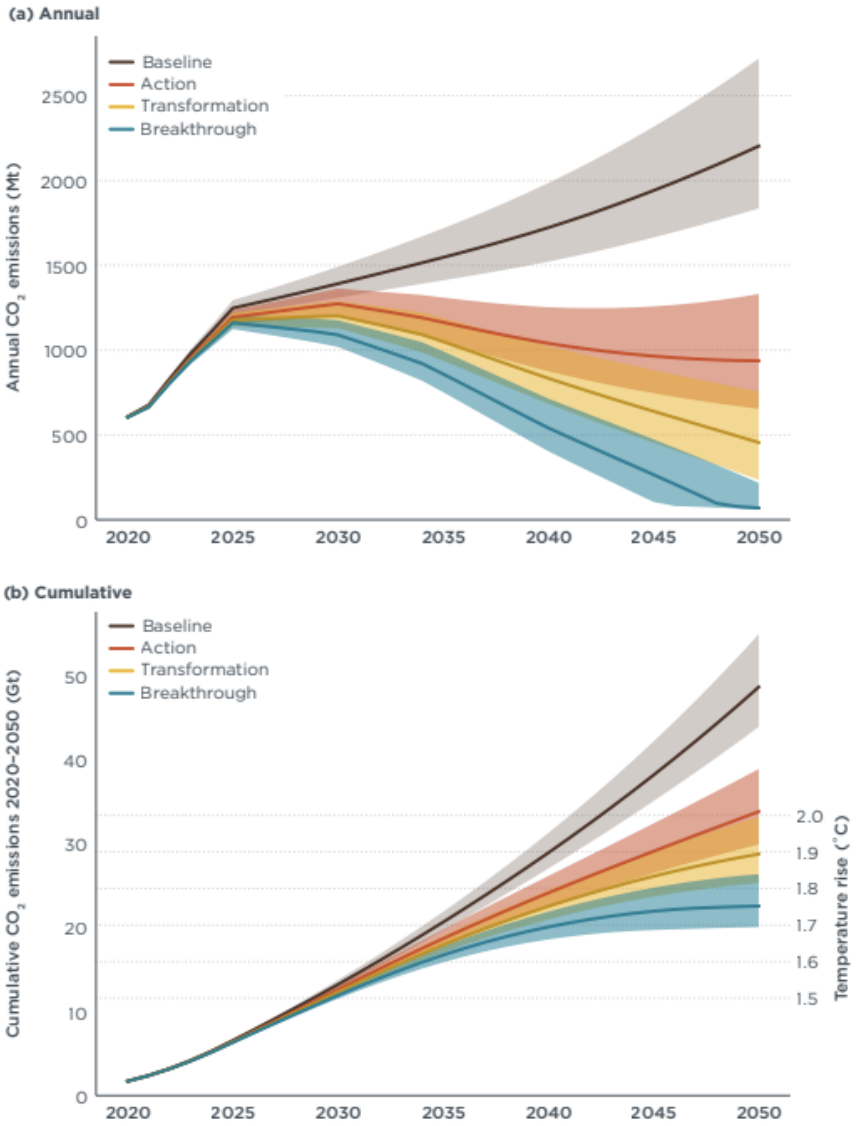


Fig.1 Well-to-wake global aviation CO_2 emissions based on pathway. Solid line is projected forecast. Shaded areas depict the range.

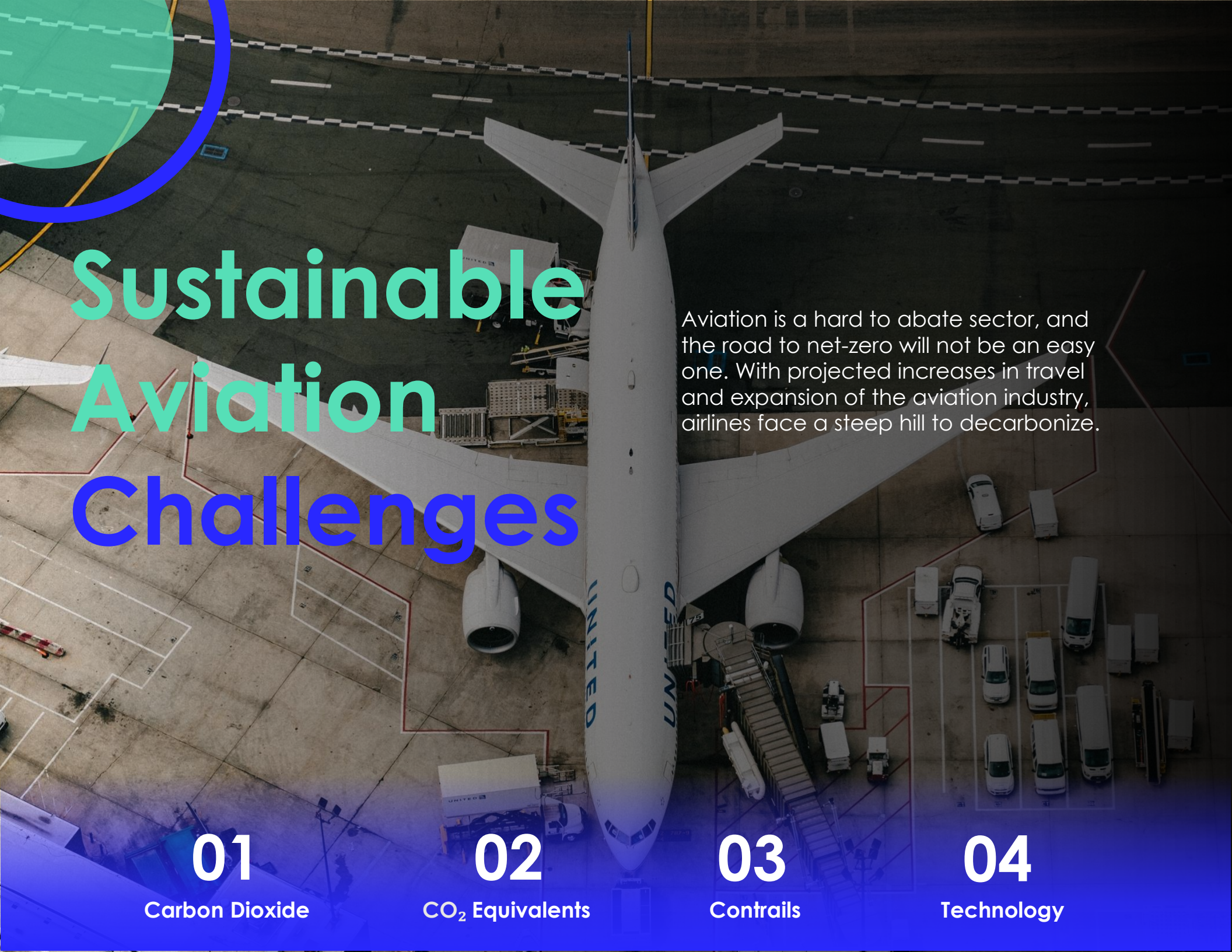
Conditions for Each Pathway

Baseline: Business as normal. Continue to use conventional jet fuel and fleet fuel efficiency continues to increase by less than 1%.

Action: Moderate fuel efficiency and air traffic control technology improvements reduce fuel burn per RPKs to 35% below 2019 levels. In 2025, federal mandates and incentives scale up SAF, making 60% of the market SAF in 2050. Fuel prices rise slightly due to the SAF premium and a carbon tax. Higher ticket prices slightly moderate traffic growth.

Transformation: Concentrated government and industry efforts shift aviation away from fossil fuels in 2035. Hydrogen and electric enter the market in 2030-2035. Aggressive mandates, incentives, and taxes increase SAF demand, resulting in SAF making up 70% of the market. This, however, causes fuel prices to moderately increase by 17% in 2030 and peak in 2040 due to supply and demand. Prices fall in 2050 with increased infrastructure support and global availability of Power to Liquid fuels (PtLs), which uses renewable energy to recycle captured carbon.

Breakthrough: Early and aggressive government action peaks fossil fuel use in 2025 and zeroes out in 2050. Maximum fuel efficiency and air traffic control improvements reduce fuel burn per RPKs by almost half compared to 2019 in 2050. Early market entrance for hydrogen powered aircraft allows for half of regional and narrowbody aircraft sales to be hydrogen-combustion aircraft. SAF follows the same pathway laid out in *Transformation*.



Sustainable Aviation Challenges

Aviation is a hard to abate sector, and the road to net-zero will not be an easy one. With projected increases in travel and expansion of the aviation industry, airlines face a steep hill to decarbonize.

01 Carbon Dioxide

02 CO_2 Equivalents

03 Contrails

04 Technology

01 Carbon Dioxide

When a company reports their carbon emissions, there are three scopes they must look at.

Scope 1: Direct emissions (in-flight fuel use)
Scope 2: Indirect emissions (office electricity)
Scope 3: Supplemental emissions (across the supply chain)

For airlines, Scope 1 carbon emissions are the major concern as over half of their emissions come from in-flight fuel burn. American, Delta, and United, the top 3 grossing airlines for EG, each burned on average over 26,000,000 metric tons of CO_2 and equivalent greenhouse gasses (CO_2e) in 2021. Unfortunately, Scope 1 is the hardest area for airlines to address due to a current lack of technology or alternative fuel types. Therefore, most initiatives and solutions are geared toward increasing fuel efficiency and finding alternative fuel options to reduce emissions.

Flight Equivalencies

Seattle (SEA) to New York (JFK) one way

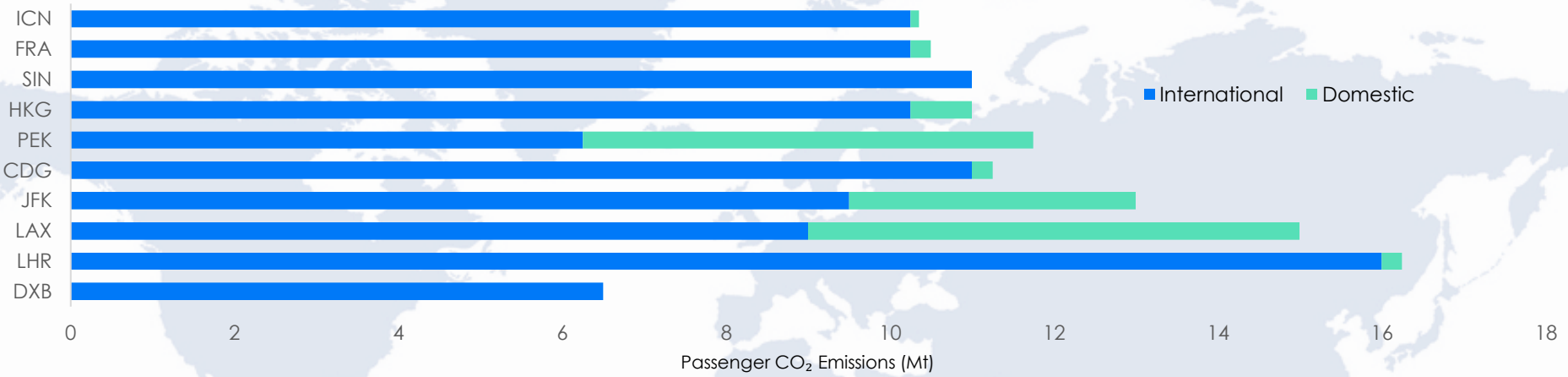
Average CO_2 Emissions:
281kg per passenger

Which is equivalent to…

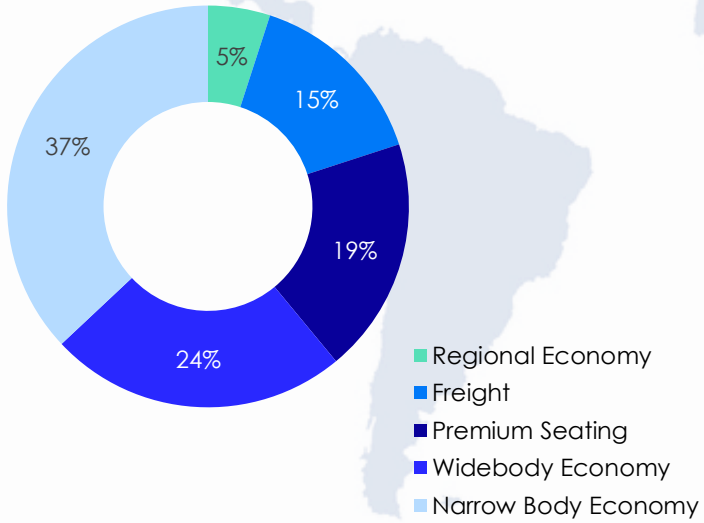
- Only breathing for 281 days
- Driving from Seattle to San Diego by yourself with moderate traffic
- Staying in a hotel for 9 days
- Riding over half the distance of the Trans-Siberian Express (the longest train ride at 5,772 miles)

All data is from 2019 and provided by ICCT.

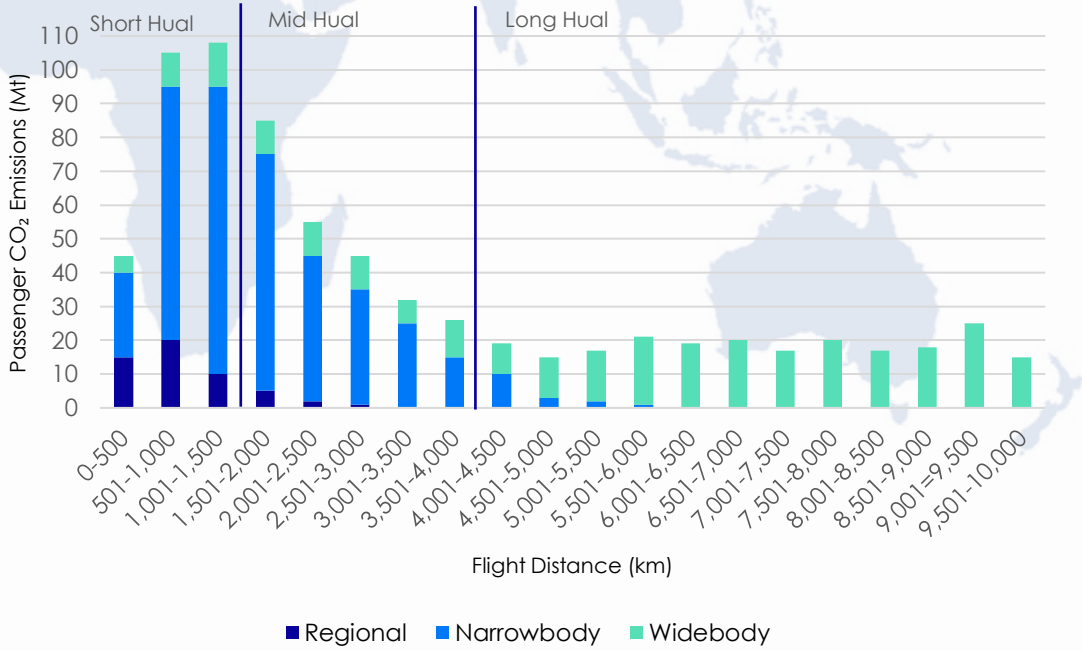
Top 10 Departure Airports & CO_2 Emissions



CO_2 Emissions by Operations and Class



Share of Passenger CO_2 Emissions



02 CO_2 Equivalents (CO_2e)

Besides CO_2, aircrafts emit other jet fuel combustion byproducts which could increase airline's share of global emissions by at least 2%. Nitrous oxides, soot, water vapor, and aerosols are the four main greenhouse gasses (GHG) emitted during fuel combustion. While studies are being done to understand the full effect of these byproducts on the environment, some GHGs have a carbon equivalent, such as Nitrous Oxides.

Ideal Byproducts

$CO_2 + H_2O + N_2 + O_2 + SO_2$

Actual Byproducts

$CO_2 + H_2O + NOx + SOx + SO_2 + CH + CO$

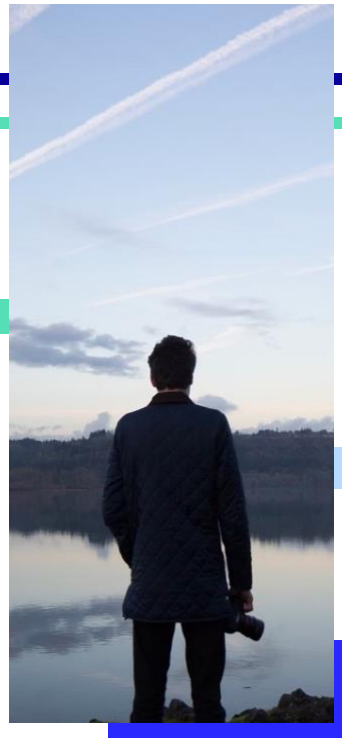
1 Nitrous Oxide per **300** Carbon

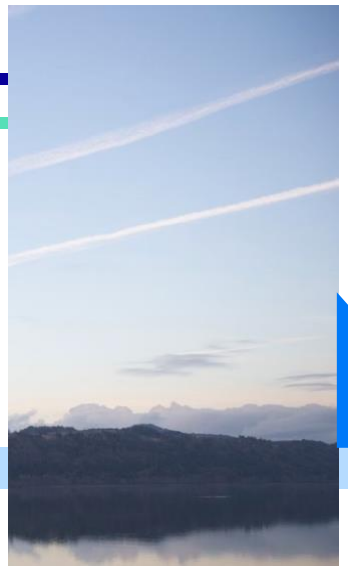
03 Contrails

Early 2023, **Lufthansa, Google, and the EU** partnered up to investigate the impact of contrails and other CO_2e. They plan to use this data to update how passenger emissions are calculated.

Contrails (condensation trails) and cirrus clouds are collectively referred to as aviation-induced cloudiness. Contrails are ice particles that are emitted by aircraft and tend to be visible at cruise altitudes. In high humidity, persistent contrails will form and grow to 200 to 400 meters high and several kilometers in width.[ii] These persistent contrails spread due to turbulence from passing aircraft, wind patterns on a flight track, and possibly solar heating. Contrails then transform into cirrus clouds and can become indistinguishable from naturally forming cloud cover. Many of these cirrus clouds increase cloudiness, especially in air traffic hot spots.

Clouds play a role in managing the Earth's climate, so the increase of aviation-induced cloudiness could increase warming exacerbating the traditional role of clouds; trap outgoing heat, while reflecting incoming solar radiation. Currently, contrails are predicted contribute to almost two-thirds of aviation's climate impact, however their full impact is still being studied.[iii]





04 Technology

For aviation to reach net-zero by 2050, significant technological advances must occur. Batteries must be able to power flights longer than 100km, planes must be retrofitted to combust hydrogen, and renewable sustainable aviation fuels must be refined quickly and easily. Unfortunately, most of this technology will not be available for until mid 2030 at the earliest. Additionally, the technology needed for net-zero may not be widely available for another few years after that.

One major contributor to the lack of technology development is the severe lack of funding, incentives, and mandates. Estimates by Mission Possible Partnership put the average annual investments needed at $175 billion.

Options are few and far between when it comes to decarbonizing aviation. Aircraft require power-dense fuel, and most flights are over 1,500 km. Therefore, fuel alternatives must meet those criteria to be considered a viable alternative. Then, years of development and testing are needed before that option is available. After development and testing, the cost to switch over is high due to a high demand and limited supply. Realistically, aviation may not hit its 2050 goal unless research and development are prioritized and accurately funded.

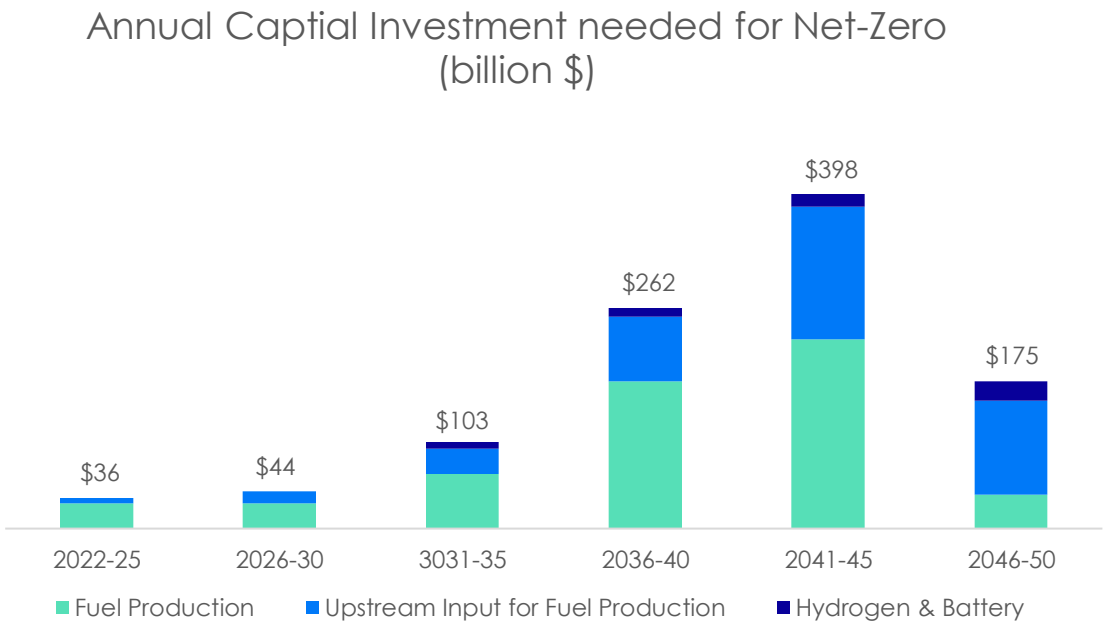
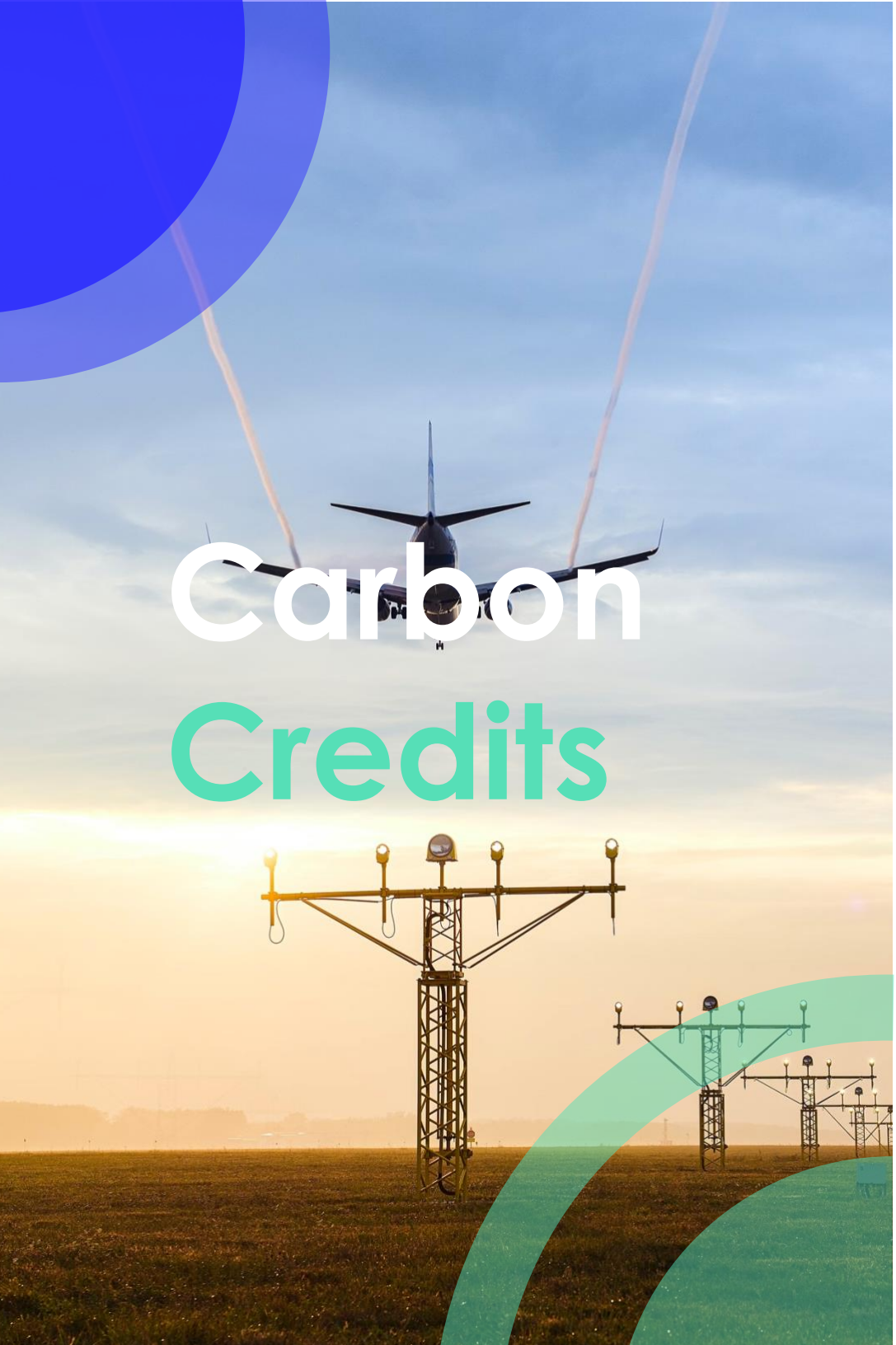


Fig.2 Annual capital investment in billions of dollars needed for aviation to hit net-zero. Fuel production refers refining and manufacturing. Upstream input refers to harvesting of feedstocks. Courtesy of MPP.


Road To
Net-Zero



Carbon Credits

The Carbon Credit Market (CCM) is a growing voluntary market and is projected to be worth upwards of $50 million in 2030 as more and more companies make net-zero pledges. While Carbon Credits are a part of decarbonizing aviation, they should not be considered the only solution or heavily relied upon to reach net-zero. One way to think about it is that using carbon credits in a climate action plan is like taking Advil for a chronic headache instead of going to the doctor. Carbon offsets and removals treat symptoms, but do not cure the underlying issue.

Carbon offset programs should only be used to address emissions that cannot be eliminated by other industry decarbonization methods.

Understanding the Complex Carbon Credit Market (CCM)

The CCM is new and complex. There are multiple kinds of projects that carbon credits support in the voluntary market. The main types are reforestation, deforestation prevention, and various community infrastructure improvements. Carbon capture technology, which permanently removes carbon from the atmosphere and then stores that carbon underground or reuses it, is also offered on the voluntary market. However, carbon capture has a high cost per credit.

Differentiating the Carbon Market

Carbon Offsets

Easily becomes a catch-all term but should not be confused with removal or insets. Carbon Offsets are what most Carbon Credits translate to. Offsets allow a company to reduce their carbon footprint by paying the equivalent of what they emitted. Nature-based projects, including deforestation preventions and reforestation may be referred to as carbon removals, however their impact is not nearly enough when compared to permanent removals.

Permanent Carbon Removal/Sequestration:

Used interchangeably, Permanent Carbon Removals and Sequestrations reduce a company's footprint by directly removing their emissions using carbon removal technology. This technology will take carbon and store it in unground wells or create solid carbon. Most of this technology is still in development.

Carbon Insets

A company directly removes all emissions directly from the supply chain. A company emits zero emissions as opposed to net-zero.

CORSIA[iv]

CORSIA, or the Carbon Offsetting and Reduction Scheme for International Aviation was adopted by ICAO in 2016. The first global sector agreement of its kind, CORSIA has 193 member states, with non-ICAO member states planning to join in 2027 at the latest. CORSIA provides airline members a unified framework and requirements for reporting, verifying, and offsetting/reducing CO_2e. 2019 emissions are used as a baseline for airline offsetting requirement calculations. In 2024 until 2035, the baseline will be switched to 85% of 2019 emissions. Under CORSIA, airlines will be required to purchase offsets and removals within the scope of CORSIA. CORSIA only applies to international flights and does not include domestic connecting flights that may be a part of a ticket. Therefore, for a LAX-JFK-LHR flight, only the JFK-LHR flight is included in the scope of reporting. Currently, CORSIA is in stage one and only requires flights between member countries to offset.

CORSIA is not meant to replace direct decarbonizing efforts, but rather provides a framework for achieving short- and medium-term goals. Since aviation cannot be fully zero, carbon offsets play a small role in offsetting the remaining emissions until permanent reduction technology is widely available.

A framework for emission reduction calculations and claims from using nonconventional jet fuels is also included in CORSIA. To be considered a CORSIA "eligible fuel," the fuel must emit at least 10% less CO_2e from well-to-wake compared to conventional jet fuel. These fuels include sustainable aviation fuels (renewable or waste-derived) and lower carbon aviation fuels (fossil fuel)

“

If you buy an airplane ticket, along with enough carbon offsets to counterbalance your flight, the emissions from that jet are still entering the atmosphere. The damage is still being done since you’re **not actually removing CO_2** from the air.

Grist, Climate Media Organization

The Issue with Carbon Credits

01 Unregulated

Today's CCM is fragmented and heavily unregulated. Finding information on carbon pricing data and a program's impact is limited or virtually impossible. Each carbon offset provider has different standards for their projects. As a result, the CCM is susceptible to fraudulent offset programs and carbon credit companies. By aligning with one of these fraudulent programs, even without knowing, places a huge risk on Expedia if the offsets are found to be ineffective or fraudulent. Currently companies such as Delta, Disney, and Shell have been sued due to their partnership with Verra whose rainforest offset were found to be worthless.[v] Because the carbon offset market can be consumer facing (especially in Airlines), consumer voluntarily donate money on behalf of the company they offset for. As more carbon offset are found useless or not providing the expected impact, customer trust in carbon offsets and companies using them decreases. Furthermore, the cost per carbon varies from project to project. Therefore, projects that have a cheaper cost per carbon could be favored regardless of impact and viability. Lastly, carbon credit accounting standards are undefined. Issues with double-counting and additionality can cause severe negative impacts on net-zero progress by inflating emission reductions.

Carbon Credits in the News

May of 2023, Delta Airlines was sued $1bn for greenwashing and offering bogus carbon offsets to travelers.

KLM was the first airline to face court due to greenwashing and carbon offsetting scheme in 2022.

Novel Carbon Offset litigation is being developed due to uncertainty and skepticism of the carbon market.

EU approved a ban that limits carbon-neutral claims backed by offsetting in May.

Read more about Delta's Lawsuit, KLM's Lawsuit, Carbon Offset Litigation, skepticism surrounding the CCM, and the EU Ban

02 Get out of Jail Card

Another issue with carbon credits is that high polluting industries can continue to pollute without making any systematic changes. Carbon offsetting becomes a get out jail free card if it is the only solution airlines use to "reduce" their emissions. For example, Airline A emits 1,000Mt of CO_2 in a month. Instead of making progress to reduce their emissions for the next month, Airline A spends or asks their customers to donate a total of $3,000 to "reduce" their emissions by buying trees, rainforest protection credits, etc. The next month Airline A does the same thing, and this cycle continues as long as they can call their business net-zero. Heavy reliance of carbon offsets for net zero goals is in the past, as regulating bodies, like the EU, are cracking down on greenwashing.

03 Limited Technology, Limited Impact

Lastly, large scale carbon capture technology is still in the research and development phase, so most carbon offsets are small ecological programs that have varying impacts. Carbon reductions are currently done by protecting old growth forests and planting more trees, which does have benefits, but requires more resources for a large-scale impact.

"You've probably heard of carbon offsets. While they may offer customers some peace of mind, traditional carbon offsets ...simply don't meet the scale of this global challenge… It's just not realistic to think we can plant enough trees to start bending that curve today. I believe the world and the airline industry has to be bolder.

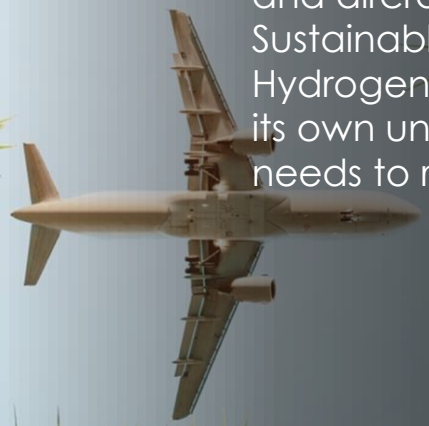
Scott Kirby, United

"This plan fails to get to grips with the real challenges of carbon credits – it's a trader's charter, written by and for the companies that want to buy and sell pollution, not cut it. It ignores what leading scientists have made clear, that offsetting can't be used instead of action to directly cut carbon emissions."

Charlie Kronick, Greenpeace

Powering Net-Zero Flights

To power net-zero flights, multi-industry collaboration is needed to innovate and mass produce aviation technology of the future. Three proposed powering methods are making headway in fuel production and aircraft engine technology: Sustainable Aviation Fuels (SAF), Hydrogen, and Electric. Each comes with its own unique set of challenges and needs to reach net-zero by 2050.



01
Sustainable Aviation Fuel

02
Hydrogen

03
Electric

In Comparison

Provided by Mission Possible Partnership

	Flight Type Feasibility	*Technology Readiness Level (TRL)[vi]	Current Market Availability	Challenges	Benefits
Sustainable Aviation Fuel	Long Haul International	**HEFA: 9 PtL: 5-6 Other: 6-8	HEFA is high and makes up .1% of the fuel market. PtL and others are lower.	Currently 2-5 times more expensive than jet fuel Feedstock availability and constraints Available only to airports near a SAF factory	Potential reduction of 80% of carbon emissions Utilizes renewable resources that are easily available around the world Drop-in fuel Reduction of contrails
Hydrogen	Regional Flights *(with potential for Long Haul International)*	1-5	Still in R&D Expected to enter in late 2030	Hydrogen technology is relatively new and requires planes to be modified Liquid hydrogen requires cryotanks and more storage space than jet fuel Apprehension to hydrogen powered aircraft	Can be completely carbon zero Good way to use excess energy produced by wind turbines and solar panels Reduction of noise and contrails
Electric	Short Haul Regional *(can increase with use of hybrid)*	1-5	Still in R&D	Current battery technology cannot power flights longer than 100km *(pot. 1,000km in next gen.)* Batteries become dead weight in flight	No emissions Smoother, quieter, and produces no contrails Help push for battery advancement

*Technology Readiness Level (TRL) is a method used to estimate a technology's maturity during development

1-2: Basic Research
2-4: Feasibility Research
3-6: Technology Development
5-7: Technology Demonstration
6-9: System Development
8-9: System Test and Entry to Market

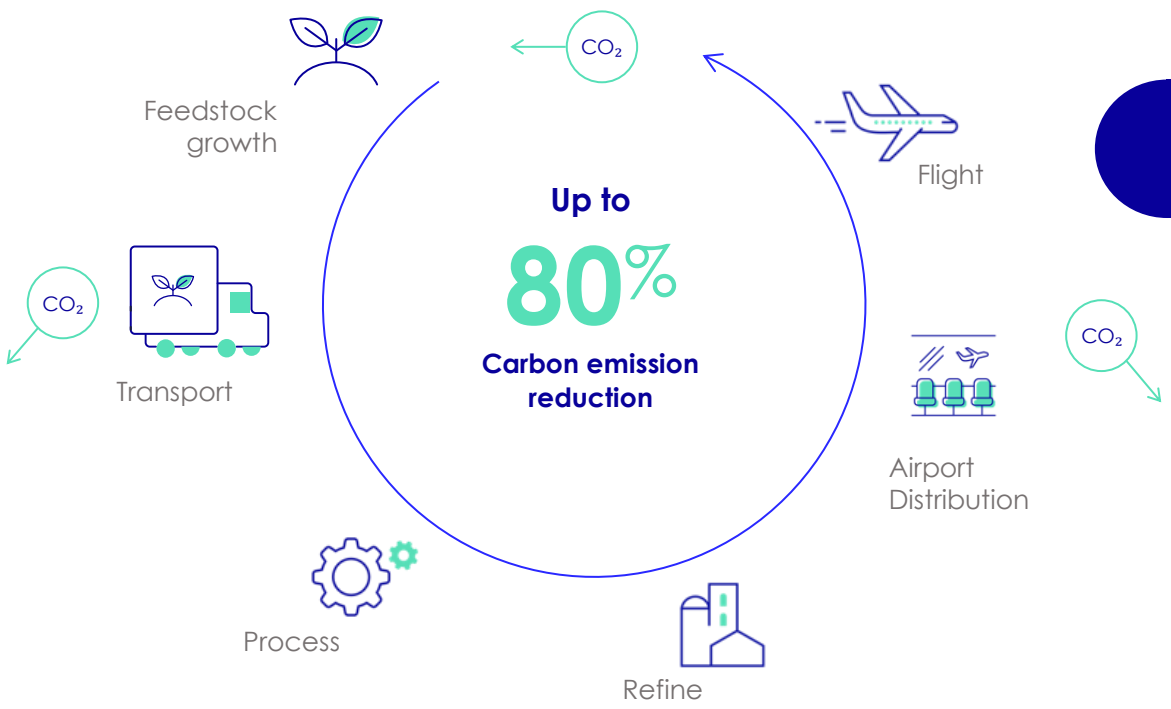
**HEFAs are SAFs made from biological feedstocks, PtL stands for Power to Liquid which are SAFs made using excess renewable energy.

Sustainable Aviation Fuel (SAF)

SAF is 2 to 5 times more expensive per MWh than conventional jet fuels.

A "catch-all" term to describe various types of aviation fuels that are made from feedstocks, Sustainable Aviation Fuel (SAF) is a drop-in solution to decarbonizing aviation fuel. SAF currently has the potential to reduce fuel-based emissions by 80% in 2050. While SAF does emit greenhouse gases (GHGs), the process of making and burning SAF is relatively net-zero. Carbon is still emitted during combustion but is absorbed and/or recycled during the cultivation and production of feedstocks. Furthermore, SAF has a lower density but higher energy content per kilogram compared to conventional jet fuel. Therefore, aircrafts would burn less fuel and carry less fuel mass, thus increasing fuel efficiency and offsetting current SAF costs over time.[vii]

Due to a very similar molecular structure as conventional fossil fuels, SAF is combined with jet fuels today to create as little as 10% to up to 50% blends in modern aircraft with no engine modification. However, less than .1% of aviation fuel use is SAF. Currently, SAF is not widely accessible, and only airports with regional SAF production can drop-in SAF during refilling, such as LAX and SFO. For the aviation sector to reach the mandated 2050 net-zero goal, production of SAF must increase from .24Mt in 2022 to around 330 to 445Mt, an over 1,000% scale up.[viii] Due to limited supply, high demand, and low technology readiness levels (TRLs), SAF is 2 to 5 times more expensive per megawatt hour than conventional jet fuel.



Sustainable Aviation Fuel

Conventional Jet Fuel

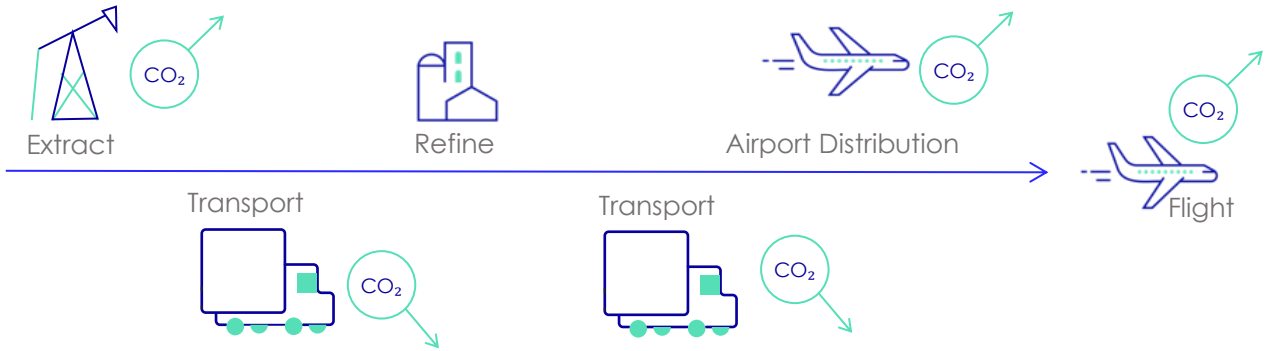


Fig.3 Simplified SAF production versus conventional fossil fuels

Types of SAF

The 130 potential feedstock sources for SAF can be categorized as either biological or non-biological.

Biological Feedstocks

Biological feedstocks are currently the most accessible form of SAF. Typically refined through a process called HEFA which is used to produce renewable diesel, biological feedstocks range from **cooking & animal oils, woody biomass, cooking & agriculture waste, and non-food crops.** Unfortunately, biological feedstocks require large amounts of land and water to produce and thus availability is limited. In order to scale up SAF, heavy reliance of biological feedstocks is not completely feasible. Due to this constraint biological feedstock SAF will be cheaper than non-biological feedstock SAF early on, but prices will increase with demand if other options are not available.

Non-Biological Feedstocks

Non-Biological feedstocks use **renewable energy and industrial waste gas (captured carbon)** to recycle existing carbons to create hydrocarbon fuels, thus creating a use and emit loop. Non-biological also refers to e-fuels, or Power to Liquids (PtL). Currently PtL is the most expensive SAF option on the market due to the substantial amounts of renewable energy needed to make energy dense jet fuels. However, as production of renewable energy increases, these prices could be comparable to convention jet fuel. PtL has the potential to reduce carbon emissions by 100%.

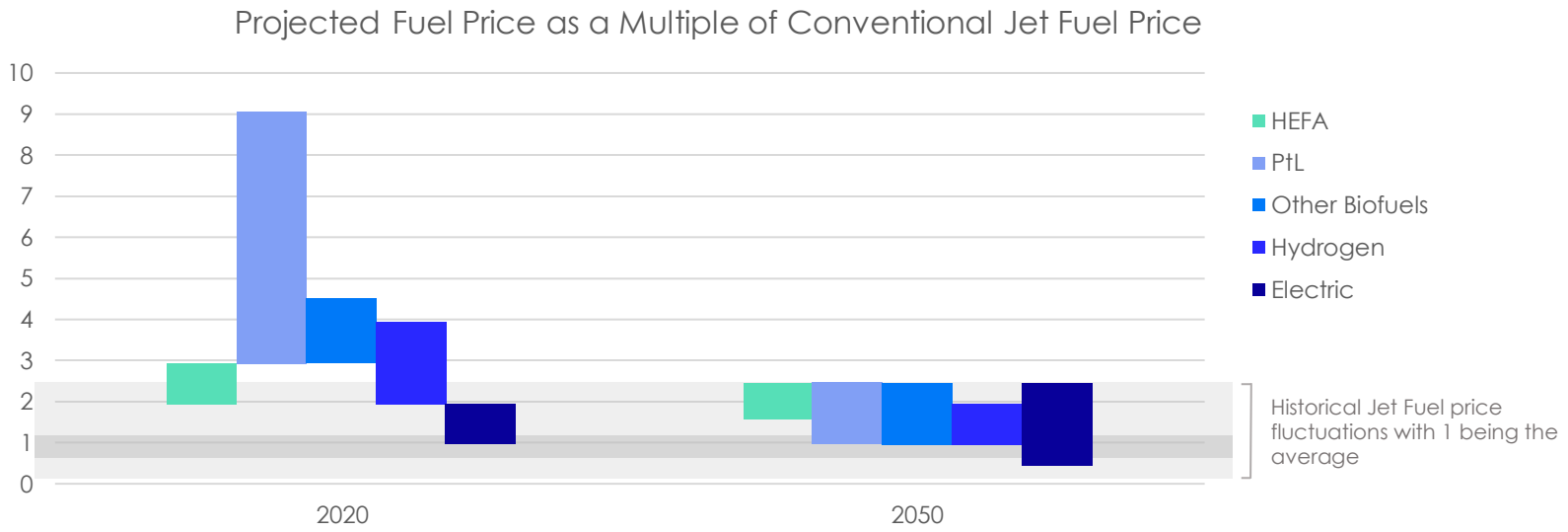


Fig.4 Projected fuel/energy price as a multiple of convention jet fuel prices. This multiple is based upon $/MWh.

SAF Opportunities

Outside of the clear environmental benefit of SAF, it has economic and social advantages.

Economically

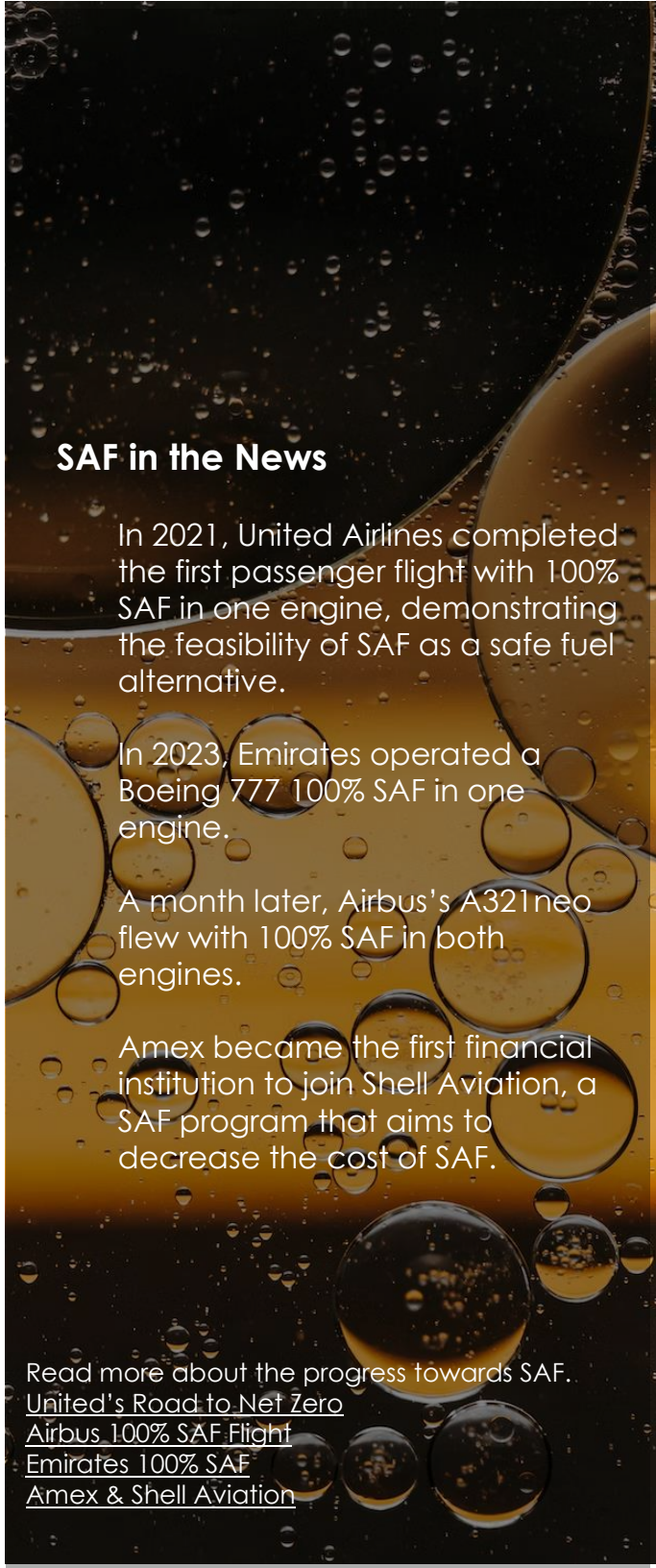
In theory, SAF production can be available around the world, thus reducing global reliance on specific reserves and geo-political influences on prices. Countries and cities that have difficulties with waste management could turn that waste into SAF. Islands can use seaweed overgrowth. Developed countries with strong renewable energy infrastructure can make PtL. Therefore, SAF can generate jobs globally and strengthen economies.

Socially

Slightly less significant in impact, countries and airlines that proactively build their SAF infrastructure gain a competitive advantage by demonstrating their commitment to sustainability.

SKYNRG

"Currently, SAF is two to five times more expensive than fossil kerosene, making it difficult to generate the demand and supply needed to scale up this industry. Breaking through this "chicken-and-egg" situation is essential for accelerating SAF production and playing part in solving aviation's biggest challenge: decarbonizing."



SAF in the News

In 2021, United Airlines completed the first passenger flight with 100% SAF in one engine, demonstrating the feasibility of SAF as a safe fuel alternative.

In 2023, Emirates operated a Boeing 777 100% SAF in one engine.

A month later, Airbus's A321neo flew with 100% SAF in both engines.

Amex became the first financial institution to join Shell Aviation, a SAF program that aims to decrease the cost of SAF.

Read more about the progress towards SAF.
United's Road to Net Zero
Airbus 100% SAF Flight
Emirates 100% SAF
Amex & Shell Aviation

Regulations and Incentives to Scale SAF

Provided by MPP[ix]

	Demand		Supply	
	Direct demand for SAF	**Increase fossil fuel cost**	**Subsidies for SAF production**	**Low-cost loans / green bonds**
Description	A certain minimum share of sustainable jet fuels is prescribed. Minimum penalty for non-compliance with blending requirements	Price discovery via predetermined maximum of allowances Additional taxation of fossil jet fuel	Tax credits for SAF that reduce GHG (by at least 50%)	Grants or low-cost loans (or possibly loan guarantees) to support sustainable infrastructure, innovation, research and development
SAF Incentive	Achieving large scale SAF production and supply at competitive cost, thereby lowering production cost	"Zero-emissions rating" for SAF portion of jet fuel usage Taxation of fossil jet fuel results in reduced price differential between SAF and fossil jet fuel	Tax exemption/credit for SAF portion of jet fuel usage results in reduced price differential between SAF and fossil jet fuel	Promotion of SAF uptake and production by reducing the investment risk, increasing investment returns and demonstrating government support to help secure third-party investment
Program Examples EMEA EU NAMER	ReFuelEU Aviation Initiative Blend mandate GHG reduction mandate	EU ETS Energy Taxation Directive	Low Carbon Fuel Standard Sustainable Skies Act Sustainable Aviation Fuels Act	Horizon Europe, InvestEU, etc. Green Fuels, Green Skies Blender's Tax Credit Sustainable Aviation Fuel Grand Challenge

SAF Programs: A Multi-Industry Effort

Airlines operating in EU airports will be required to have a minimum of 2% SAF in 2025, increasing to 10% in 2030 and reaching 63% in 2050.[x] Other mandates and incentives around the world are expected to follow in the coming years. Therefore, a multi-industry effort to make SAF cheaper, accessible, and diverse is currently underway and gaining serious traction as airlines get closer to the 2030 midpoint. There is a vast amount of SAF funding programs that tend to focus on one of two goals: (a) Make SAF cheaper by stimulating the market or (b) Develop SAF infrastructure through research and development.

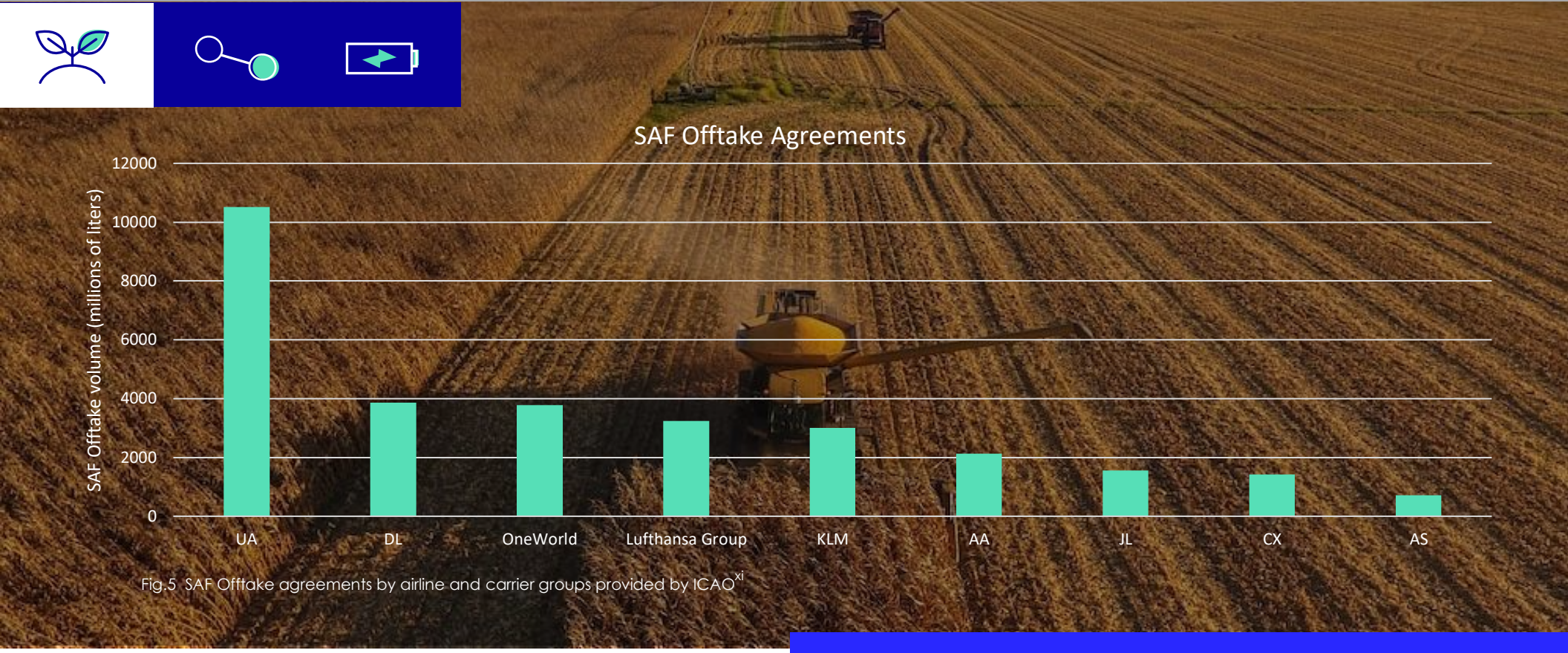


Fig.5 SAF Offtake agreements by airline and carrier groups provided by ICAO[xi]

Market Stimulation: Reducing the SAF Premium

Since SAF is currently 2 to 5 times more expensive than Jet Fuel, and prices are expected to increase as demand grows, market stimulation programs and investments either: (A) Connect airlines with businesses that will help cover the SAF premium or (B) Set an agreement between the SAF provider and airline in the form of an investment.

For example, Shell Aviation and Qantas's SAF Fund create airline and business relations that allow airlines to reduce the cost of SAF with the help of companies' wanting to offset business travel or business investments. Other airline investments into SAF, such as IAG's $400 million investment and 20-year partnership with Phillips 66, allow airlines to buy mass amounts of SAF at current prices by promising to source most of their SAF from their energy provider partner. This is also called an offtake. Typically, other companies are not a part of this transaction. The hope is that by stimulating the market early on, SAF will be cheaper to purchase in 10 years or less.

Research & Development: Building a SAF Infrastructure

Research and development programs are working toward building local SAF infrastructures, discovering new potential feedstocks, and creating better refining processes that reduce emissions further. United's Sustainable Future Fund (UA SFF) is an example of this model. UA SFF and its corporate partners invest into Sustainable Aviation startups. They use a Kickstarter model to support and scale up SAF production and infrastructure and other sustainable aviation technology companies, such as Boom and Heart Aerospace. Other airlines, such as Qantas and Japan Airlines, have made investments in supporting their local SAF infrastructure.

Explore Some Sustainable Aviation Startups

Heart Aerospace

BOOM

Universal Hydrogen

CEMVITA

Hydrogen

Hydrogen is the most abundant element in the world; however, it is often attached to other molecules. Therefore, hydrogen must be extracted from other compounds using electrolysis. For hydrogen fuel to work in aircraft, current aircraft must be retrofitted with hydrogen combustion engines and liquid hydrogen tanks. To store gaseous H_2 large tanks would be needed that would reduce passenger capacity significantly, therefore H_2 will be stored as a liquid in circular cryotanks (cryogenic tanks) at -423.17 °F. Currently, hydrogen combustion is currently not market ready but is being investigated and tested as an option for zero emission flights. Hydrogen aircraft could enter the market in large scale by end of 2030. [ii]

There are various types of hydrogen, however the most important for aviation is Green.

Green

Green, or "clean", hydrogen is produced by splitting water using electrolysis. Electrolysis is powered using surplus renewable energy. For example, on a particularly windy day, the extra energy a wind turbine generated that is not used could be used to create Green hydrogen instead of being lost.

$$H_2O \rightarrow H_2 + O_2$$

As of 2023, Green Hydrogen makes up .1% of all hydrogen production, but production is expected to increase as renewable energy costs decrease. By the time hydrogen makes its market entry in aviation, green hydrogen will be the dominate method of extracting hydrogen. Airlines are expected to follow the coattails of the maritime shipping sector, who see hydrogen as the dominate fuel solution to achieving their net-zero goals. Additionally, in order to achieve net-zero, green hydrogen is the only option available.

Current Challenges to Hydrogen

Hydrogen powered aircraft has a TRL of 1-5, which compared to SAF's, is significantly lower. Hydrogen powered planes have a maximum range of 2,500 km and are not yet fit for high altitudes. If introduced today, they would not be able to complete a flight from DFW to SEA. However, with innovations in hydrogen power and aircraft design, the maximum range could increase drastically in a few decades with the help of multi-industry investments.

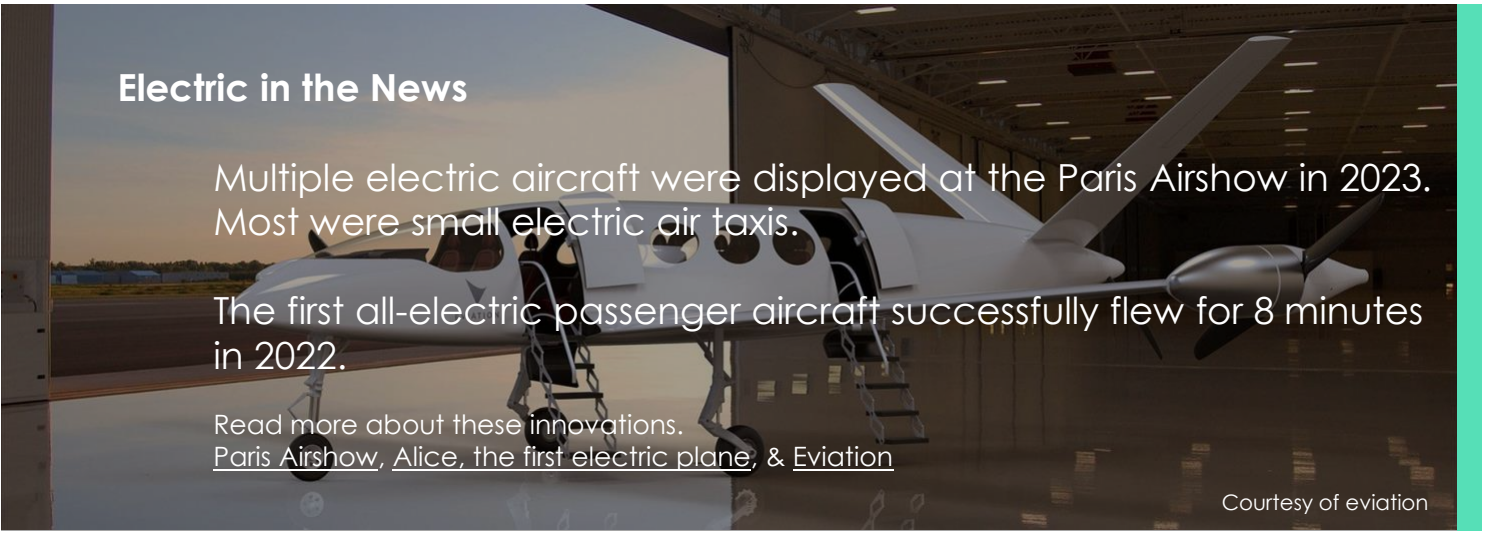
Electric

Of all the options, electric is the least feasible. Current battery technology can only power around 100km of travel, and potentially 1,000km with next-gen batteries. Another downside is that as e-planes fly, they do not lose weight. Once a battery is fully used, it becomes dead weight as opposed to SAF and hydrogen which is released as it burns. Therefore, e-planes do not become more fuel efficient over time. Electric will most likely only power short-haul flights and small aircraft, such as private/recreational planes and helicopters. Until electric can make a full market entrance, hybrid aircraft may serve as a bridging technology.

Electric

Hybrid & Hydrogen

SAF

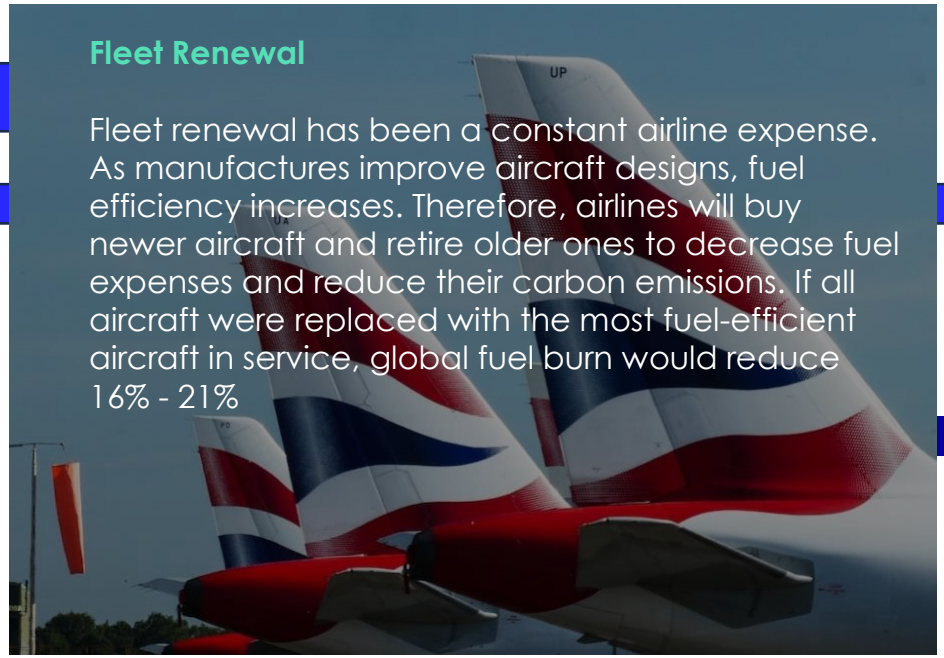


Other Initiatives

Outside of working towards net-zero, airlines have other initiatives that work toward more sustainable supply chains, operations, and community impact.

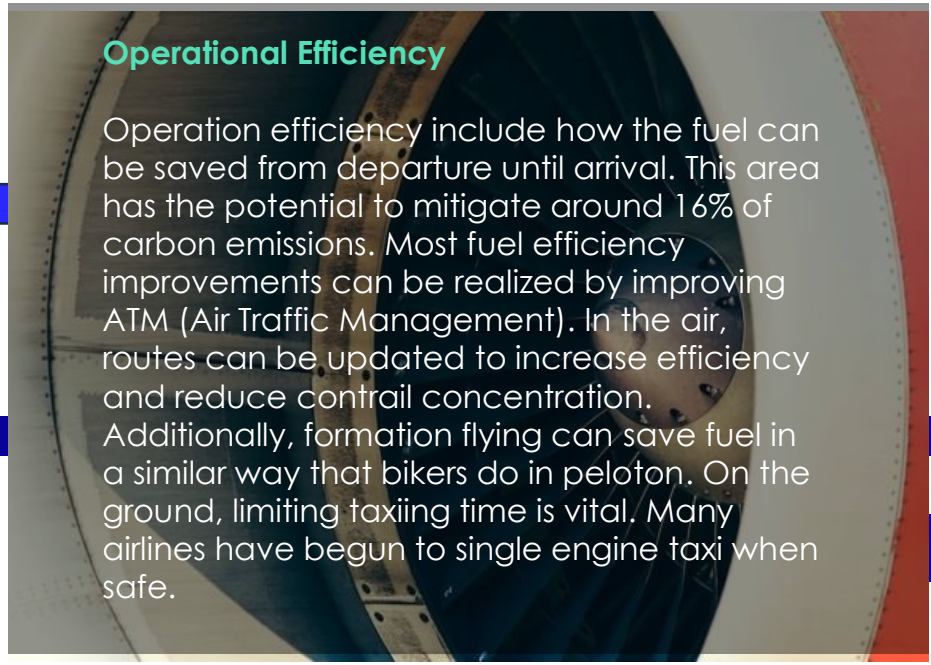
01 Fuel Efficiency

Airlines spend around 20% - 30% of their budget on fuel, therefore increasing fuel efficiency has always been pertinent to reducing costs. Fuel efficiency can be accomplished by fleet renewal and retrofitting and operational efficiencies. If fleet renewal and aircraft improvements follow historical trends, fuel efficiency will increase by 1% a year. However, a 2% increase per year by 2030 is needed to reach 2050 targets, making aircraft 40% more efficient in 2050 compared to 2019.



Fleet Renewal

Fleet renewal has been a constant airline expense. As manufactures improve aircraft designs, fuel efficiency increases. Therefore, airlines will buy newer aircraft and retire older ones to decrease fuel expenses and reduce their carbon emissions. If all aircraft were replaced with the most fuel-efficient aircraft in service, global fuel burn would reduce 16% - 21%

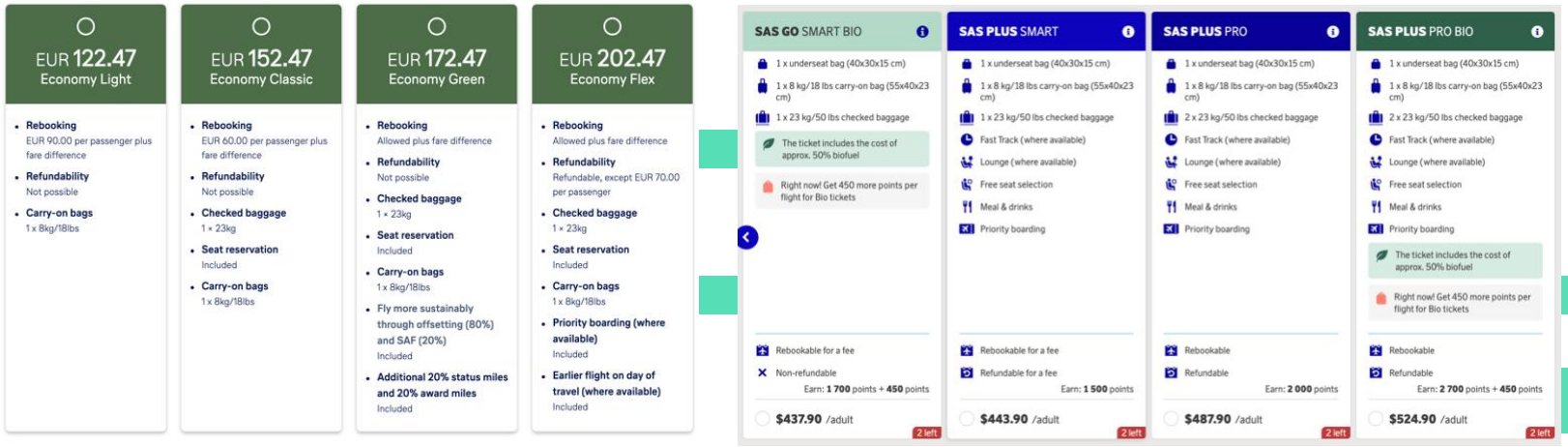


Operational Efficiency

Operation efficiency include how the fuel can be saved from departure until arrival. This area has the potential to mitigate around 16% of carbon emissions. Most fuel efficiency improvements can be realized by improving ATM (Air Traffic Management). In the air, routes can be updated to increase efficiency and reduce contrail concentration. Additionally, formation flying can save fuel in a similar way that bikers do in peloton. On the ground, limiting taxiing time is vital. Many airlines have begun to single engine taxi when safe.

02 Green Fares

Green fares are another way airlines are trying to encourage travelers to reduce their climate impact when flying. These fares are not unlike traditional voluntary carbon offset and SAF programs. The only major change is where travelers are being prompted to reduce their emissions. Instead of reducing emission either on an external site, during package selections, or post booking, travelers are presented with a green fare, either business or economy, that includes carbon offsetting in the ticket price. Currently only SAS and Lufthansa group offer green fares for flights traveling within the EU.



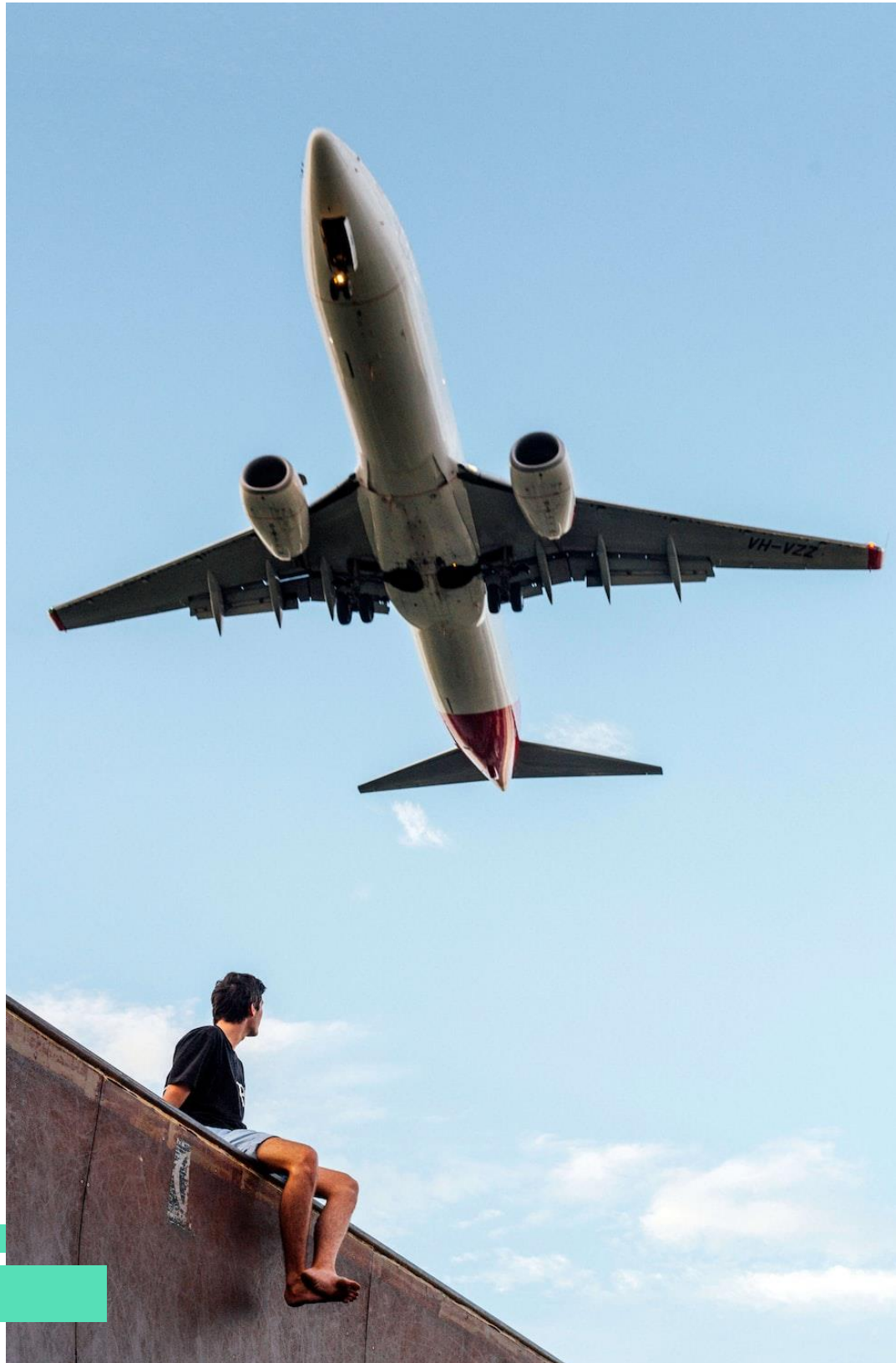
However, green fares are currently under scrutiny due to potential greenwashing through a misleading name. Activists and customer groups in the EU argue that using the word “green” can imply that the ticket the traveler bought has little to no carbon footprint. Other airlines are also in trouble for greenwashing when prompting travelers to offset.

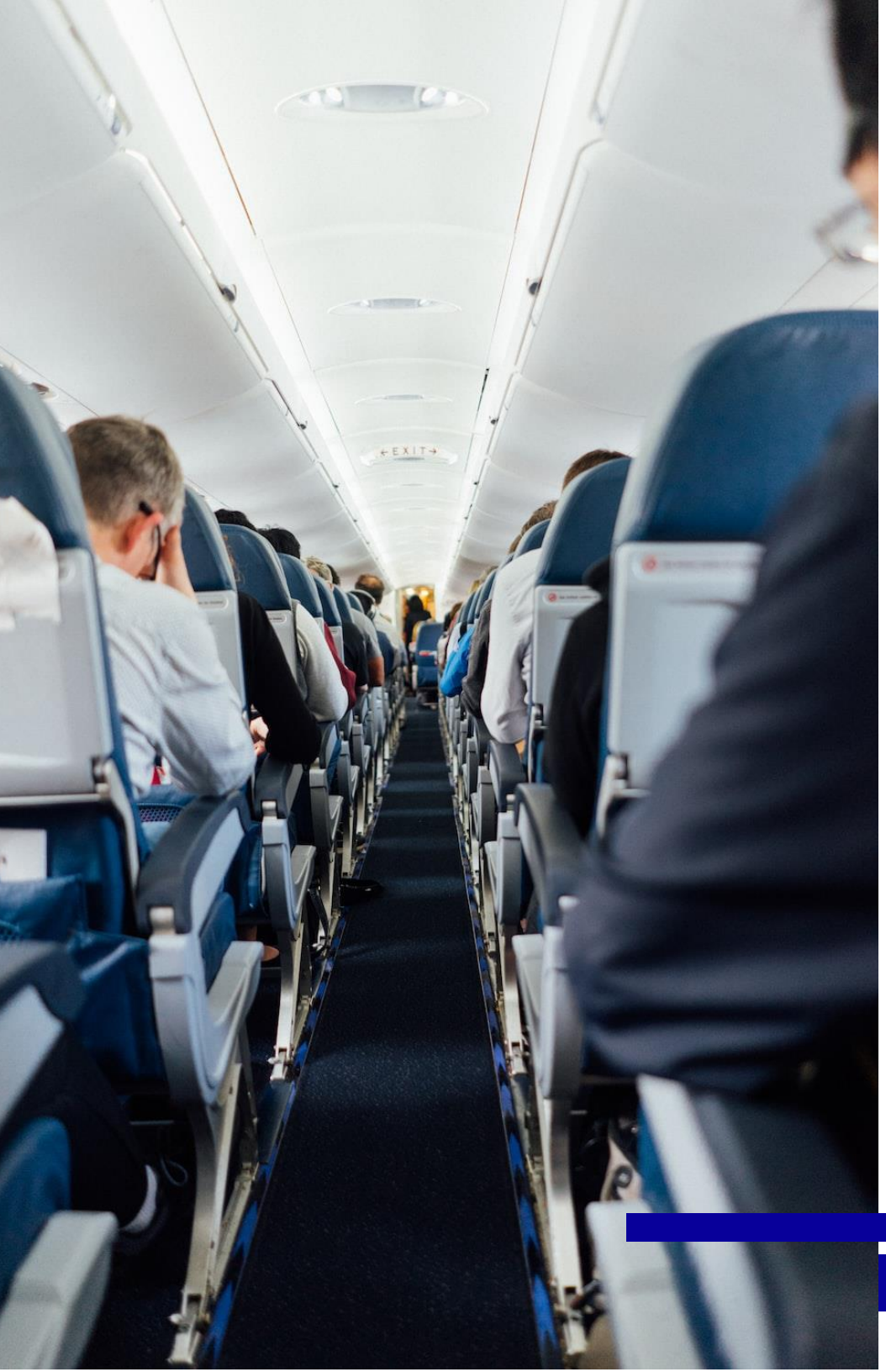
03 Noise Reduction

Today, the FAA already has noise standards for aircraft departing or landing in the US. Noise pollution from airports decrease the standard of living in nearby neighborhoods and apartment complexes. To increase airport traffic, while respecting the communities around airports, airlines and aircraft manufactures are working towards decreasing aviation noise.

03 Wastewater & Water Use

Airlines use a lot of water and chemical to maintain their airplanes. A major source of water consumption is through aircraft cleaning. One-way airlines are combating this is switching to semi-dry and dry methods of cleaning, such as a foam engine wash developed by GE. Emirates saved over 11 million liters of water by making that switch. In water scarce or stressed regions, airlines are looking for ways to respect their local water source and reduce their consumption. Alaska collaborates with nonprofits to clean up West Coast water supplies especially during intense periods of drought.





04 Digitalization

Airlines have been switching to completely digital boarding passes and checked bag tags to reduce their paper consumption. This also has the added benefit of reducing wait times at the check in counter by allowing guests to check in online.

04 Wildlife Protection

Many airlines are committed to preventing wildlife trafficking and work with nonprofits to protect wildlife areas. Uniquely, Air Canada will ship bees into Canada during the summer to promote wildflower growth and stabilize bee populations.

06 Renewable & Compostable In-Flight Service

Airlines are trying to make all aspects of their supply chain sustainable. Airlines have begun using artisan and renewable items in their overnight bags and replaced in-flight service meal containers and cups with recyclable options.

Unique Initiatives

Every airline has a unique approach to achieving net-zero. While there are some obvious trends, no one airline is the same. Airlines have different capacities and resources to reach net-zero, so some have come up with unique ways to educate and engage travelers.

01 Trees & Seats

Etihad plants a tree for every preferred seat purchase. Other airlines use seat purchases for carbon offsetting.

02 Traveler Education

Air New Zealand has created an extensive sustainability marketing campaign with the goal of educating and engaging travelers.

03 Train Partnerships

KLM and ITA are partnered with their local train providers and will direct travelers to trains for regional short flights.

04 Reducing Emissions Outside of the Airport

ITA offers points to travelers that use a digital boarding pass, public transportation to the airport, and offsetting. Travelers that do two or more receive additional points.

Airlines & Sustainability

Executive Summary

All data is based upon the top 75 grossing airlines with EG in June 2023. Airline sustainability initiatives data is from June 2023. The Sustainability world is constantly changing, so this data may be very different in a few months. Therefore, this is only a snapshot in time.

01 **Almost all airlines have a sustainability plan available to read, and all airlines are required to follow IATAs path to Net-Zero at a minimum.** Sustainability is pertinent for airlines and will continue to grow in importance as 2050 grows closer.

02 **Over half of Airlines have some form of sustainability customer activation in their booking flow.** Airlines differ on whether they offer a voluntary carbon offset, SAF program donation, or a combination of the two. However, most will offer carbon offset in some capacity. These programs tend to attract around 10% of travelers, potentially more when there are incentives.

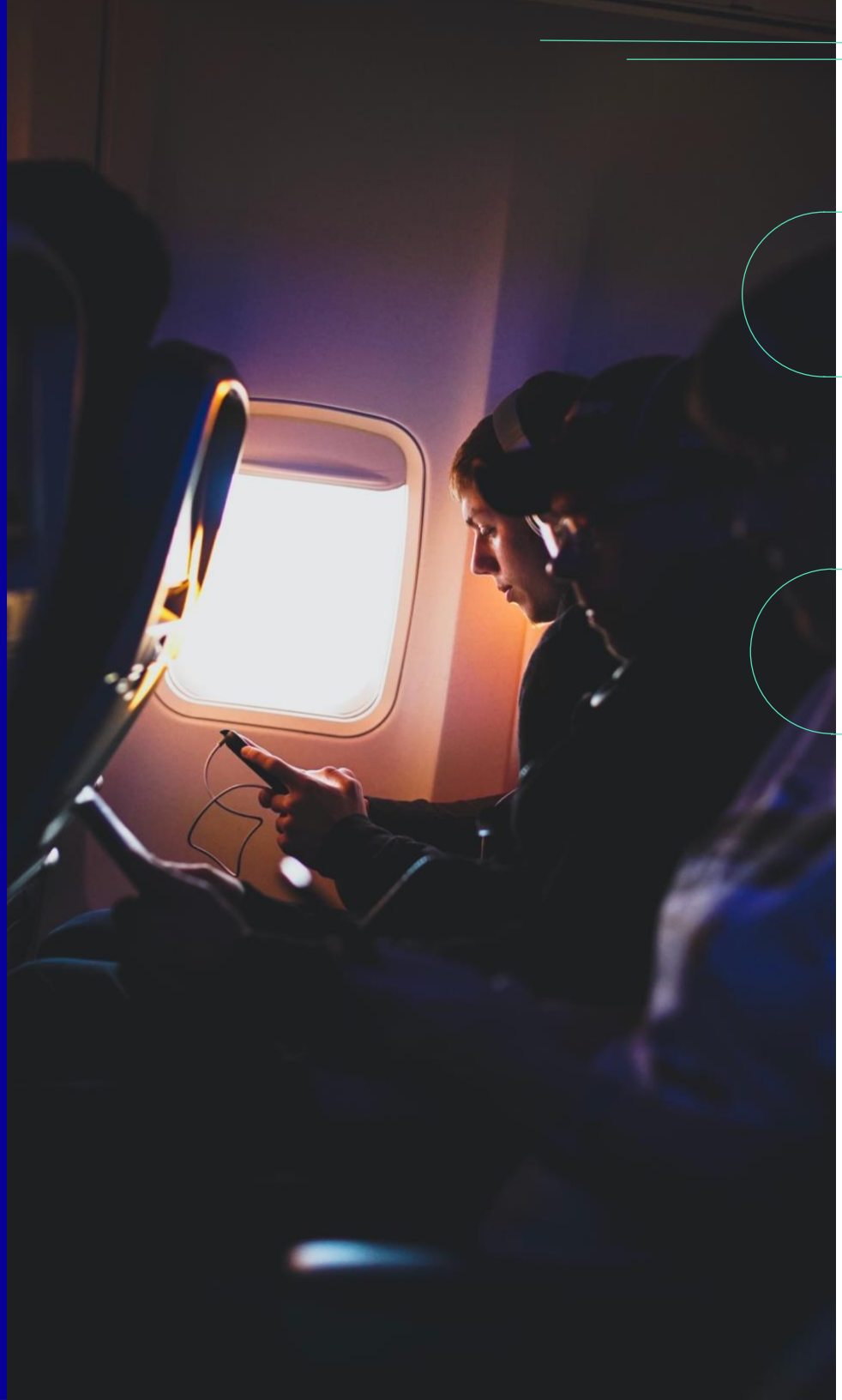
03 **Airlines use the book-and-claim method when SAF donation is offered.** Travelers help airlines pay the higher SAF cost by paying for their equivalent portion of SAF despite it not being on their specific flight. Airlines promise to use traveler donations to buy SAF within a year on another flight.

04 **Voluntary carbon offset options and SAF donations tend to be offered to travelers during "package & extras" selection or in a link-off.** Travelers are more likely to find more information about sustainable aviation or the carbon offset program in the link-off.

05 **Over half of airlines display emissions, and almost all OTAs display some information about flight emissions.** Displaying emissions is becoming an industry standard for OTAs. For airlines, emissions tend to only be shown when offsetting.

06 **A multi-industry effort is occurring to reduce the price of SAF and build a SAF infrastructure.** Big airlines and carrier groups such as IAG, Lufthansa Group, and United are leading the charge. International airlines are also focusing a developing local SAF production.

07 **Airlines are using creative ways to reduce emissions and educate travelers.** Partnerships with train operators, planting mangroves for every seat purchased, and extensive marketing to educate travelers on sustainable aviation are a few of the numerous unique way airlines are trying to achieve net-zero by 2050.



60%

Of airlines prompt travelers to offset their emissions

Of airlines prompt travelers to offset their emissions

52%

36%

Of OTAs display emissions

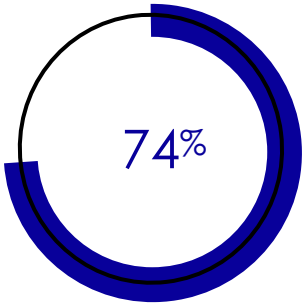
Of Metas Display Emissions

75%

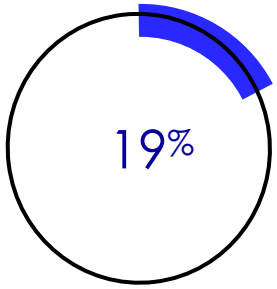
Customer Activation

For a more detailed look of who has customer activation and displays emissions, please download the Sustainability & Booking Flow Competitive Analysis.

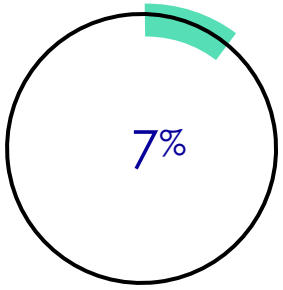
Activation Type



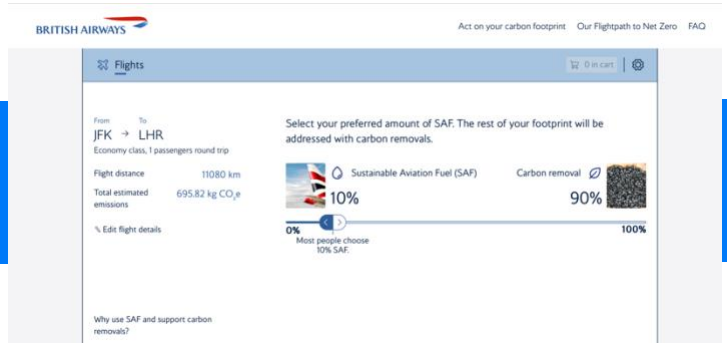
Carbon Offset



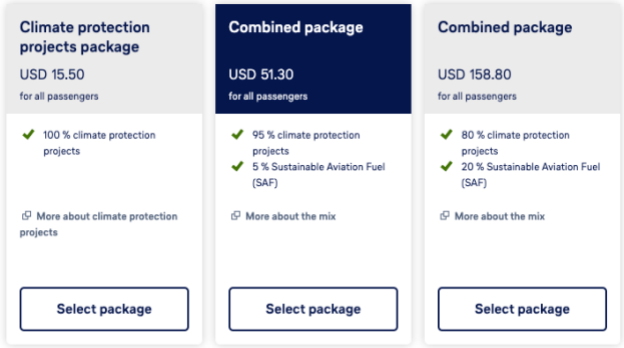
Combination



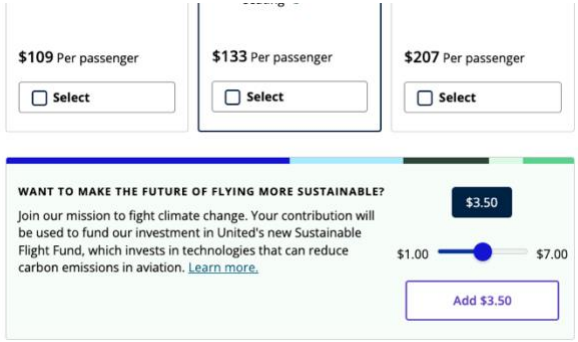
SAF Donation



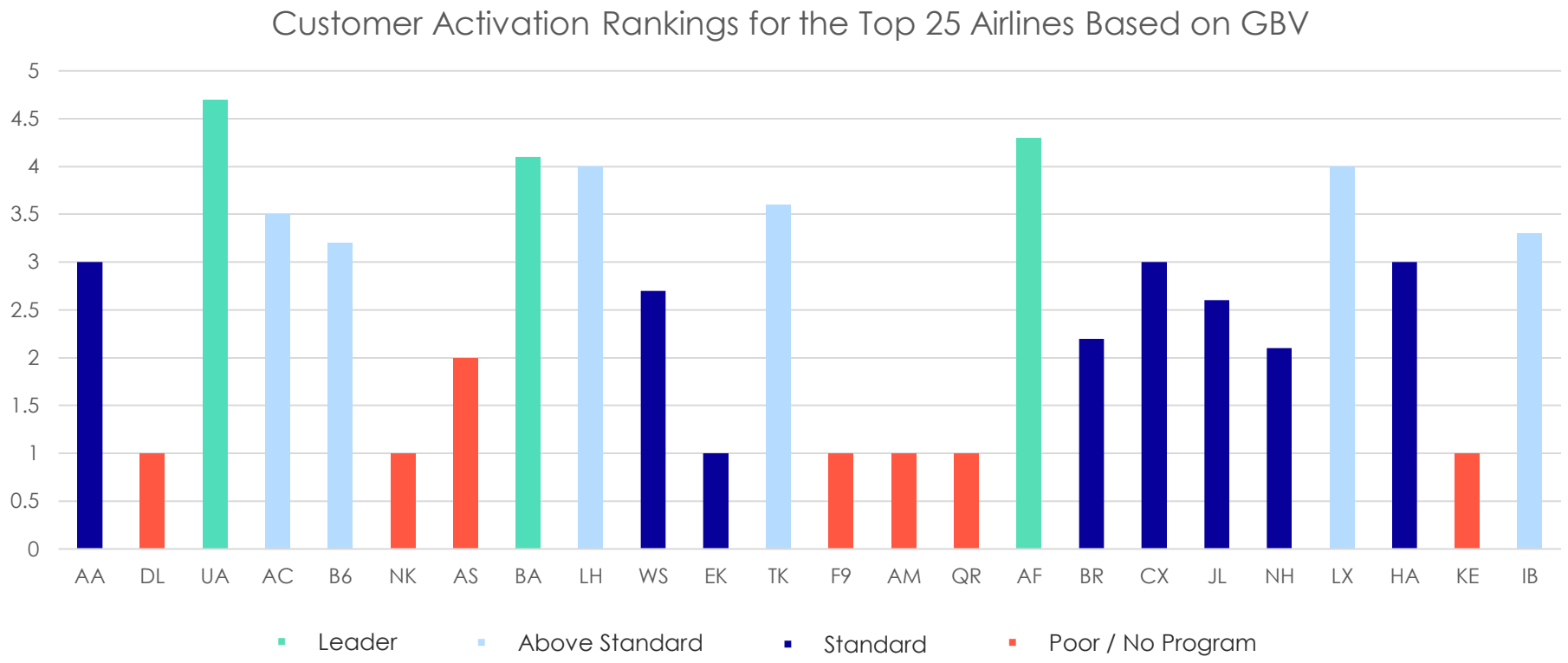
British Airways
Slider & Link Off Template



Lufthansa Group
Package Selection Template



United Airlines
Quick Add



UA has explicitly stated that carbon offsetting will not be a part of their strategy, therefore their voluntary program on allows small contributions ($1.50 - $7.50) to their SAF fund.

DL is facing a lawsuit over their program and have since removed it prior to this report.

NK does not have an updated Net-Zero plan since 2019, nor do they offer carbon offsets. *This is typical with budget airlines.*

Airline groups, such as Air France-KLM and Lufthansa, have the same program across all airlines within the group.

B6 & AF are the only other two airlines in the top 25 based on GBV to offer SAF book-and-claim options.

NAMER and **EMEA** airlines are more likely to have offset programs due to growing regulations in their markets.

EK & BA both have a carbon offsetting program and a donation fund for their individual charity organizations. The donations tend to be smaller amounts than the voluntary offsets.

BA, LH, DL, NK, and **F9** are under scrutiny for greenwashing. Those with offset programs are also being investigated for fraudulent offset credits.

Scoring is based on the average of the following metrics:

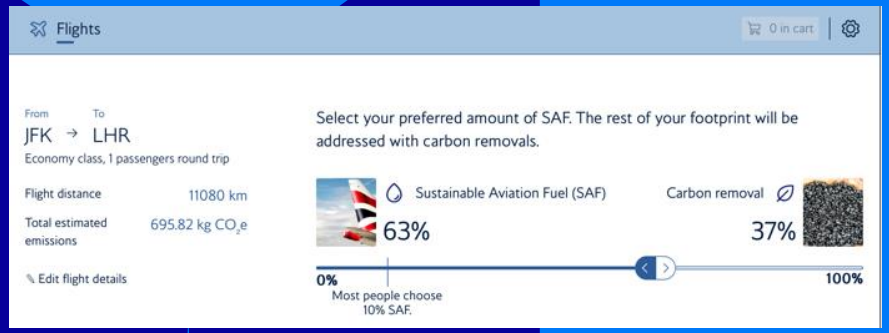
- Program diversity
  - What and how many projects are available? Do travelers choose what they support?
- Ease of use
  - How easy is it to find and use?
- Traveler education
  - Is there information about why to offset?
- Transparency
  - Is there information about where the money is going?
- Legitimacy of program
  - Is there any scrutiny or issues?
- Look and Feel

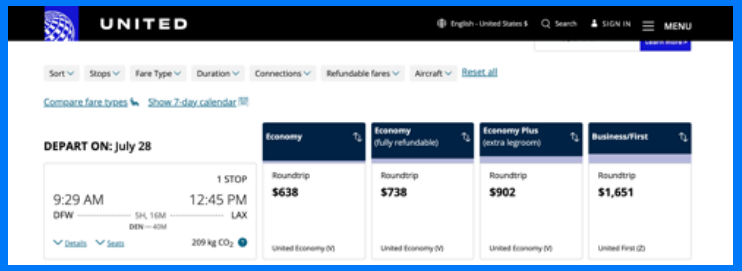
Emission Displays

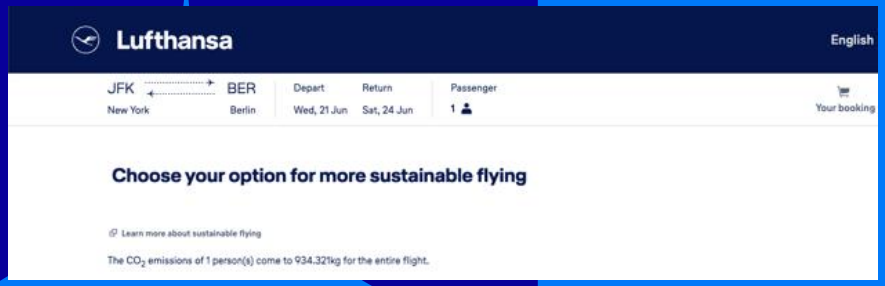
Carbon emissions estimates are calculated by considering the aircraft make & model, flight distance, origin & destination airports, number of passengers, fare type, and typical speed & altitude. Currently, most estimates do not include SAF usage, CO_2e, and flight direction.

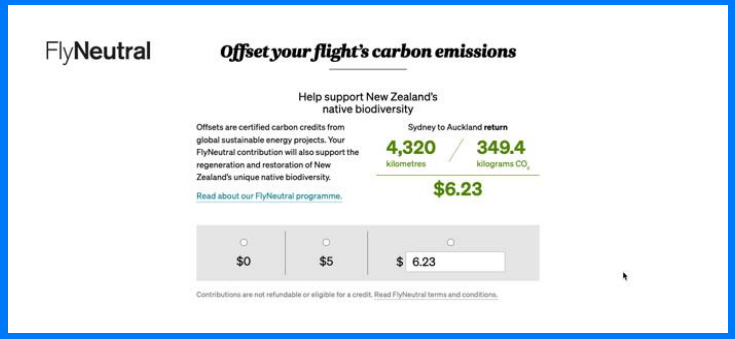
If an airline offers a carbon offset and/or SAF donation, they will most likely display emissions to travelers. Emission displays are used more to demonstrate how carbon offset prices are calculated for each traveler as opposed to influencing traveler decisions. The only airline that displays emissions during flight selection in the booking flow is United Airlines. United also includes a percentage difference compared to an average flight.

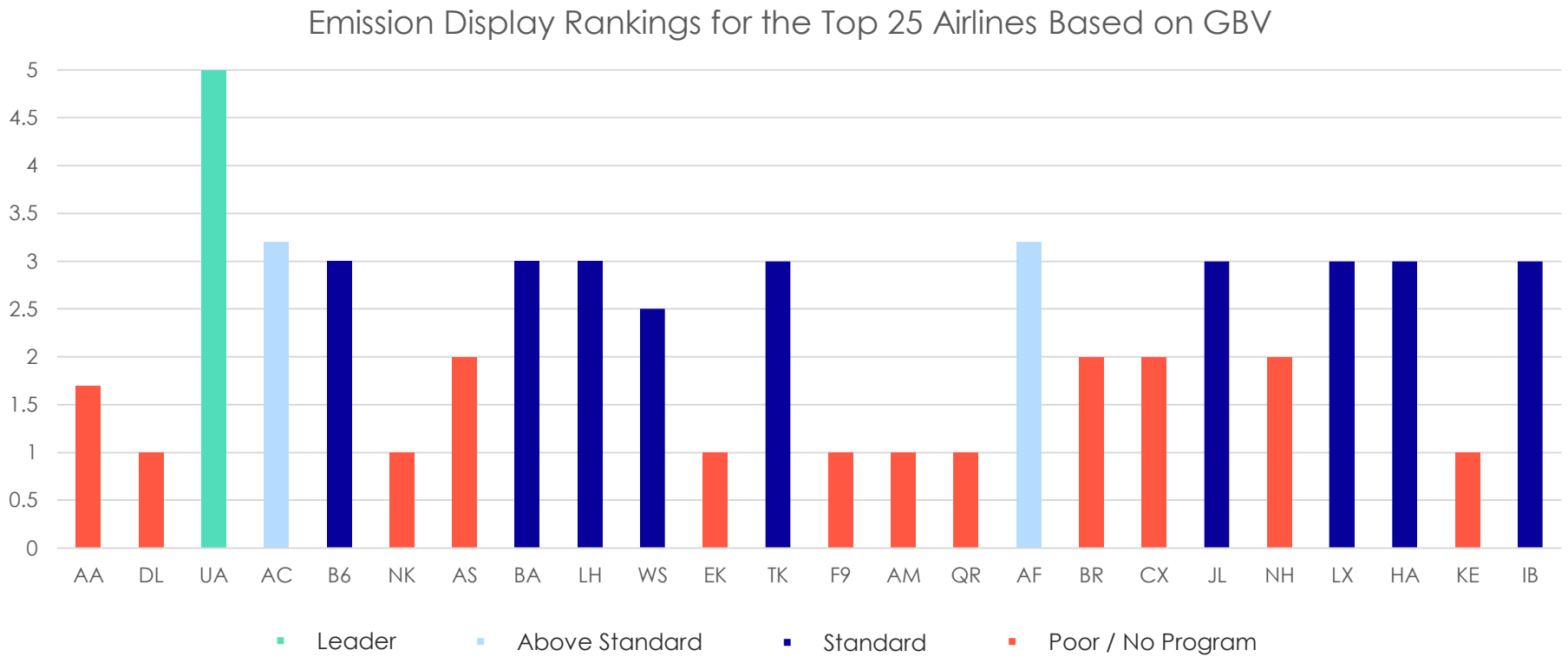
Emission displays are always per passenger, not total flight emissions.











BA, JL, & IB are partners with Chooose.com, a carbon offset company, and display their emissions exactly the same.	**UA** is the only airline that displays emsissions during flight selection. Therefore, they are the only airline that could potentially change traveler decisions during flight selctions.	Emission displays are typically where a traveler would offset. Airlines tend to use emission displays to influence travelers to offset. Emissions are used to justify the cost of the offset.
AA calculates their emissions by travel lengths as opposed to flight specific data, Therefore, their calculations have a higher chance for error and may cause travelers to offset more than their actual footprint.		

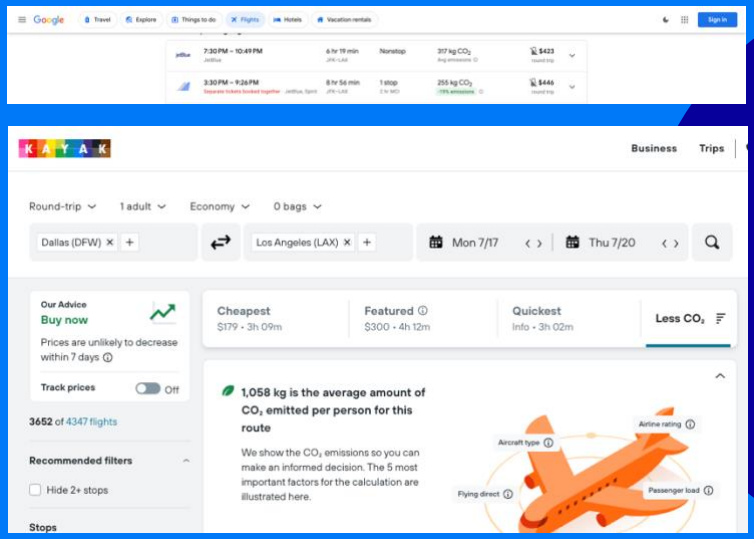
Scoring is based on the average of the following metrics:

- Emissions Displayed
  - Is it numerical and comparable?
- Display
  - How easy is it to find? How is it influencing travelers?
- Traveler education
  - Is there information about why to offset?
- Look and Feel

Emission Displays

Includes 16 OTAs & 4 Metas at different POS.

EG Product & Technology has found that carbon emission badges increased traveler trust and showed a gross profit increase of +1.84%. They project an annualized gross profit impact of +$1,145,598.

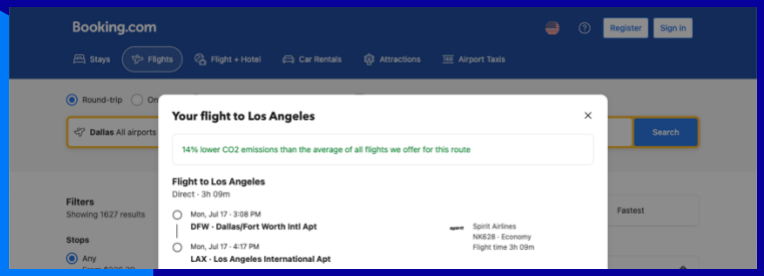


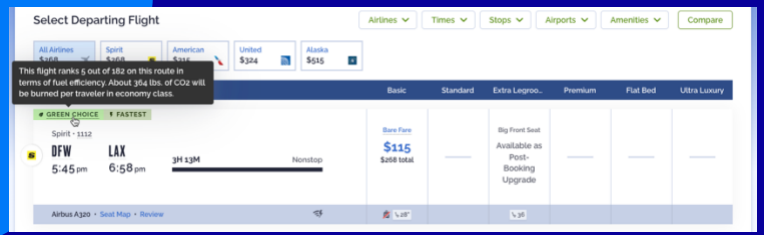
Meta

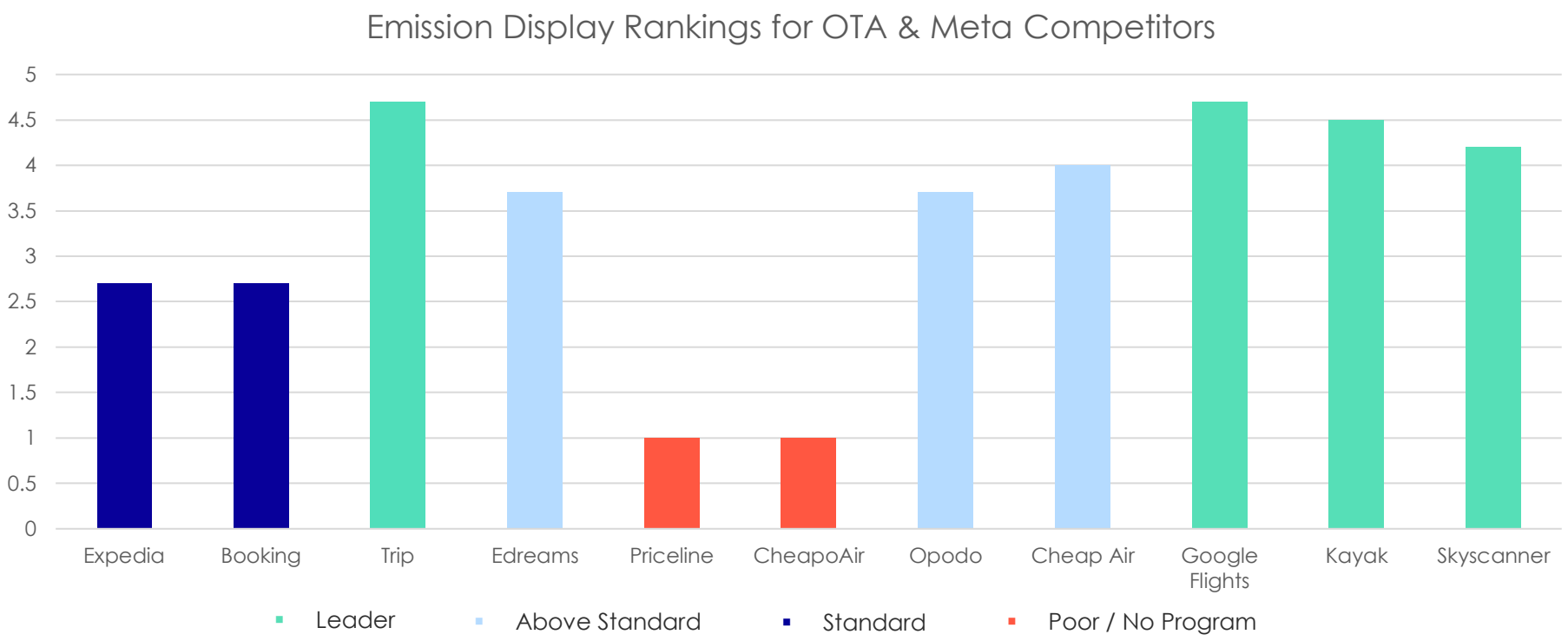
Almost all Metas display carbon emissions to travelers. Most notably is Google Flights and Kayak. When displaying emissions, displaying a number and then a percentage difference compared to average is the standard.

OTA

Competitors, Booking and Trip, display carbon emissions. When compared to Expedia, OTAs that do display emissions go a step further by displaying a percentage difference as opposed to just a badge. Most OTAs that display emissions also have a “Low Emission Flights” filter, which Expedia and Booking currently do not have.







Expedia is the only OTA with a program that does not display emissions numerically. Product stated that they did not see a difference in traveler behavior when emission amounts and percentages were displayed.	**Other Expedia** products, such as Orbitz do not display emissions.
Google Flights received criticism when they removed contrails and CO_2e from their emissions display. They are currently investigating impact with Lufthansa to display emissions more accurately.	
Priceline is the only Booking Holdings product to not display emissions.	**All 3 Metas, Trip, Opodo, Edreams, and Cheap Air** have a "low emissions" filter compared to OTAs. **Expedia** currently does not have a "low emission filter."

Scoring is based on the average of the following metrics:

- Emissions Displayed
  - Is it numerical and comparable?
- Display
  - How easy is it to find? How is it influencing travelers?
- Filterable
- Traveler education
  - Is there information about why to offset?
- Look and Feel

Greenwashing

Greenwashing occurs when a company's products, practices, or policies are marketed as being sustainable when they are in fact not. To the right are a few airlines currently under scrutiny for greenwashing.

As of July 2023, 17 European airlines have been accused of greenwashing by European Consumer group, BEUC. Those accused include Lufthansa Group, Air France/KLM, SAS, and TAP. This is the largest greenwashing accusation for the aviation industry so far. BEUC has identified the following greenwashing tactics.[xii]

01 Claims that paying extra credits can "offset", "neutralize", or "compensate" the CO2 emissions of a flight are factually incorrect as the climate benefits of offsetting activities are highly uncertain, while the harm caused by the CO2 emissions from air travel is certain.

02 Airlines are misleading consumers when charging them more to contribute to the development of 'Sustainable Aviation Fuels' (SAFs): Such fuels are not market-ready and recently adopted EU legislation sets very low targets for how much they should represent in aircrafts' fuel mix.

03 Implying that air travel can be "sustainable", "responsible" and "green" is deceptive. None of the strategies deployed by the aviation sector are currently able to prevent Greenhouse Gas emissions.

Lawsuits

In addition to intense scrutiny, Delta and Air France/KLM were sued earlier this year for greenwashing.

Delta

June 2023, a class action lawsuit against Delta was filed in California for claiming carbon neutrality in marketing items. Delta claimed they were "carbon neutral" since 2020 because they offset their emissions. However, there is speculation on how credible those offset credits are and their role in getting Delta to Net-Zero. Furthermore, one of Delta's offsetting partners was found to sell bogus credits with little to no impact in carbo reduction. The case is still pending in courts.

Air France/KLM

Air France/KLM is battling a lawsuit in the Dutch courts for their sustainability marketing scheme "Fly Responsibly" which is also connected to their voluntary carbon offsetting program, "CO_2Zero." The plaintiffs argue that the program is not reducing aviation climate damage and promoting flying under the guise of supporting sustainable aviation.

When externally communicating sustainability goals, it is important that at EG we are not providing lip service. Due to a lack of legislation, we must be careful in how we market sustainability initiatives. Sustainability is a growing landscape that will continue to develop legally.

Airline Profiles

01 American Airlines (AA)

Profile Highlights

- AA is the first airline to have their sustainability targets approved by the Science Based Targets Initiative (SBTi) as science based.
- They have partnered with FAA and NASA to test new air traffic control systems that were successful and implemented nationwide in 2021.
- AA is initiating a corporate business offset program to help companies reduce their scope 2 emissions by investing in SAF.

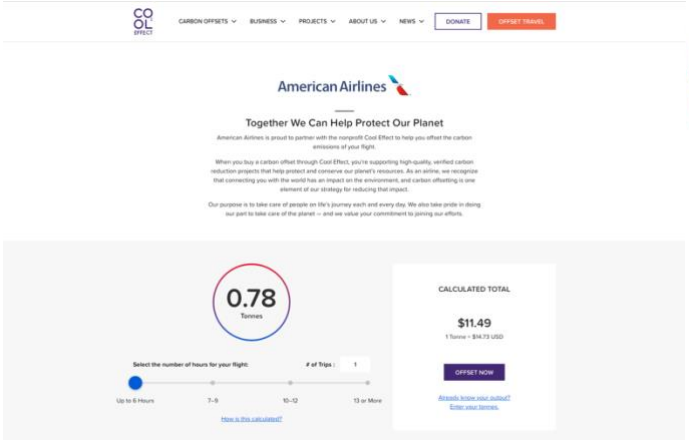
Other Initiatives

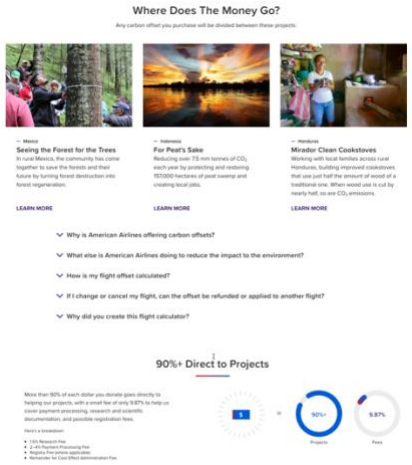
- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Switching to more sustainable in-flight service materials (plastic to biodegradable)
- Looking into methods to reduce contrails

Major Goals (SBTi approved)

2030	10% SAF
2035	Reduce GHG emissions intensity by 40%
2050	Net-Zero

Carbon Offset Program





Sustainable Aviation Fuel

- $100 million market stimulation investment
- Oneworld Alliance has purchased 550 million gallons of blended SAF

02 Delta (DL)

Profile Highlights

- *Delta is battling a lawsuit for greenwashing and bogus carbon offsets as of May 2023.*
- Delta is collaborating with MIT to research contrail impacts.
- Delta has a corporate SAF program with Deloitte as one of its main partners.

Delta Air Lines faces proposed U.S. class action over carbon neutral claims

By **Allison Lampert** and **Clark Mindock**

May 30, 2023 4:08 PM CDT · Updated a month ago

Other Initiatives

- Eliminated pre-packaging for most food items and has switched to biodegradable where possible
- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Complete electrification of all ground support equipment at key hubs
- Ensuring more sustainable supply chains

Major Goals

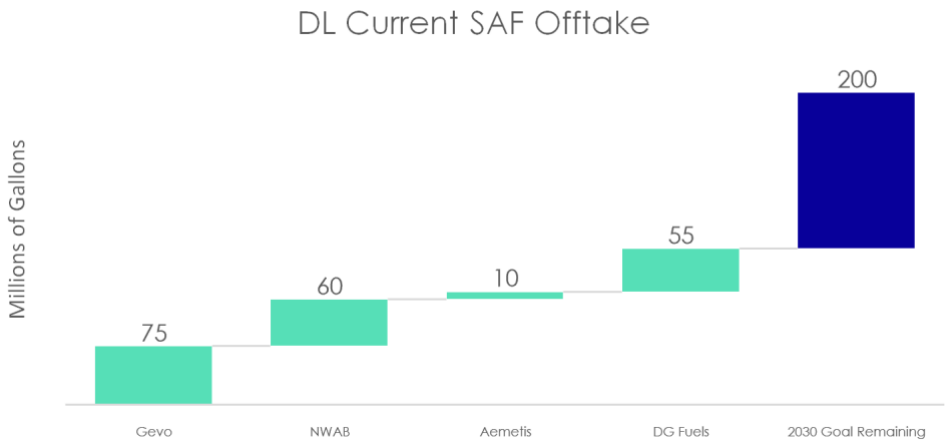
2030	10% SAF
2035	100% electric ground support equipment
2050	Net-Zero

Carbon Offset Program

- *Does not have an active voluntary offset program for travelers*

Sustainable Aviation Fuel

- $1 billion investment through 2030
- Use primarily at LAX, SFO, CDG, LHR, AMS



03 United Airlines (UA)

United Eco-Skies Alliance℠

Profile Highlights

- UAV Sustainable Flight Fund launched in 2023, which is a investment vehicle designed to accelerate research and development sustainable aviation
- Customers are shown flight emissions during flight selection. United is the only airline to do this.
- United Eco-Skies Alliance is United's corporate travel offset program focused solely in SAF.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Switching to more sustainable in-flight service materials (plastic to biodegradable) including upcycled lifejackets
- As of May 2023, 34% of United's ground control is electric

Major Goals (SBTi approved)

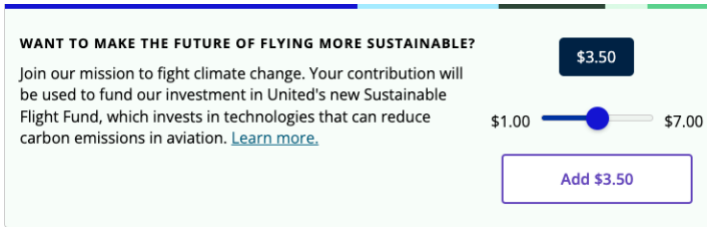
2030	10% SAF
2035	Reduce GHG emissions intensity by 50%
2035	Net-Zero

Carbon Offset Program

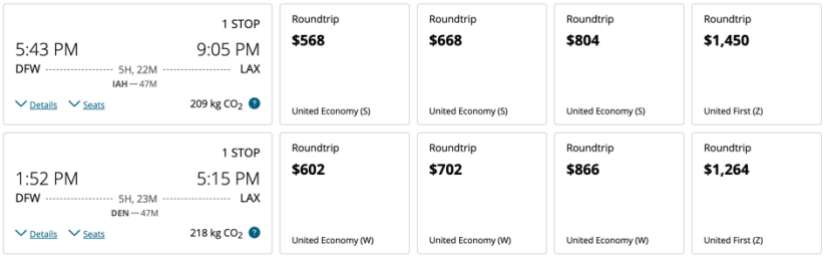
- *United is **strictly against** using carbon offsets as part of their sustainability strategy*

Sustainable Aviation Fuel

- UAV Sustainable Flight Fund (SFF)
- Only US POS, customers are prompted to donate to the SFF



4,200 Travelers
Donated to SFF in the first 10 days



04 Air Canada (AC)

AIR CANADA
LEAVE LESS

Profile Highlights

- Air Canada's progress to Net-Zero has been certified by IATA Environmental Assessment (IEnvA) as a Stage 2 compliant airline, the highest level.
- In 2021, they launched the Leave Less Travel Program which allows corporate customers to offset business travel emissions with SAF and traditional carbon offsets.

Other Initiatives

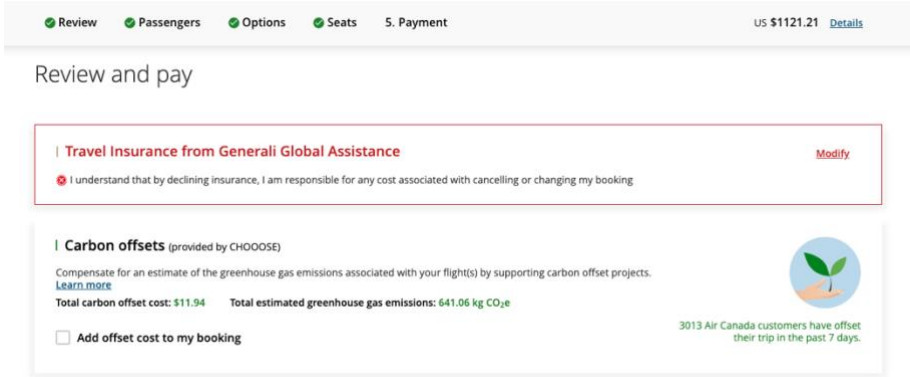
- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Retrofitting older aircraft to reduce noise levels to below standards
- Creation of waste segregation programs at airports and in-flight

Major Goals (SBTi approved)

2030	10% SAF, 20% GHG net reduction
2035	Reduce GHG emissions intensity by 40%
2050	Net-Zero

Carbon Offset Program

- Partnered with Chooose
- Travelers are prompted during the booking flow



Sustainable Aviation Fuel

- 1% for all flights by 2025
- Purchased 2.5 million gallons from Neste

05 JetBlue Airways (B6)

Profile Highlights

- In 2021, JetBlue offset over 5.3 million metric tons of carbon in an effort to offset emissions that cannot be avoided.
- JetBlue Ventures has nine public sustainability related-investments ranging from weather predicting to electric aviation development.
- JetBlue Sustainable Travel Partners' launch year allowed JetBlue partners to help source ~325,000 gallons of SAF and reduce 2,370 metric tons of CO_2.

Other Initiatives

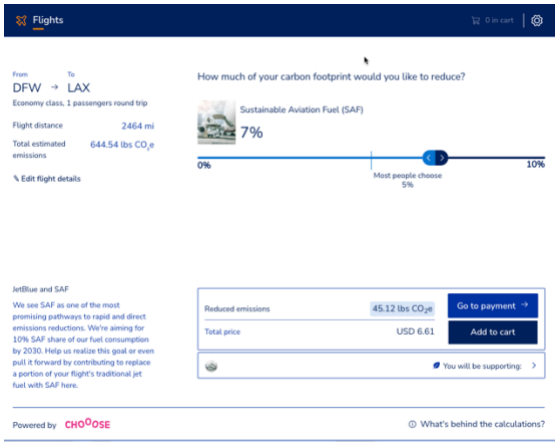
- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Reducing onboard waste by discontinuing use of "peel & reveal" meals with reusable dishes
- Several multi-industry partnerships that are focused on decarbonizing aviation

Major Goals (SBTi approved)

2030	10% SAF
2040	Net-Zero

Carbon Offset Program

- Partnered with Chooose
- Link-off is prompted after a completed purchase
- Only allows travelers to offset with book-and-claim SAF



Sustainable Aviation Fuel

- Consumed over 1.2 million gallons of SAF in 2021

06 Spirit (NK)

Spirit Airlines has not updated their goals or disclosed sustainability information since 2020, so information is limited or outdated.

Major Goals (assumed due to IATA membership)

Carbon Offset Program

- Does not currently have an offset program, internally or for travelers

Sustainable Aviation Fuel

- No current information regarding SAF commitment

Other Initiatives

- Working towards higher fuel efficiency
- Reducing in-flight waste
- Noise reduction

07 Alaska Airlines (AS)

Profile Highlights

- Alaska is collaborating with Microsoft and Twelve to advance production and use of PtL SAF fuels. They are planning to begin test flights.
- Fueling the Future is Alaska's SAF fund for business travel offsetting that is focused in Market Stimulation .
- Alaska is partnered with Shell to increase SAF availability in the Pacific Northwest.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Requiring guests to pre-order inflight service to reduce waste
- Reducing bag tag waste with E-bag tags
- Cleaning and protecting West Coast water supplies to balance out water footprint

Major Goals

Carbon Offset Program

- Offset program uses miles
- Planning to focus on nature-based projects in area of service until carbon removal technology is more mature

Sustainable Aviation Fuel

- Using SAF in regular operations at SFO

08 British Airways (BA)

Profile Highlights

- BA's partnership with Phillips 66 has allowed all BA flights out of Heathrow to contain a small percentage of SAF. They are using existing pipeline infrastructure.
- In 2025, BA flights out of San Francisco will contain a small percentage of SAF. Thus, BA will be one of the few airlines fueling with SAF globally and locally.
- Project Speedbird, an initiative by BA and partners to build up SAF infrastructure in the UK, was accelerated in 2022.

Other Initiatives

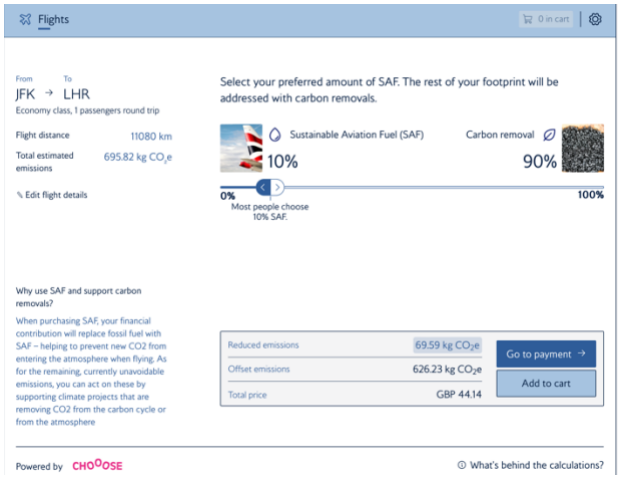
- Working towards higher fuel efficiency through fleet renewal and fuel efficiency dashboards
- Accelerating ground support electrification
- Looking into ways to reduce in-flight food waste that are compliant with current regulations

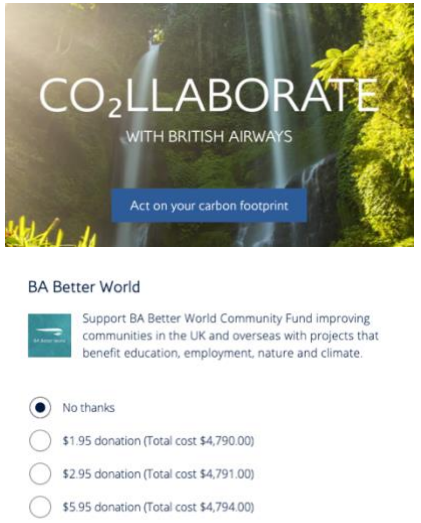
Major Goals

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- Partnered with Chooose.com
- Offers traditional carbon offsets and SAF book-and-claim
- BA Better World is a voluntary donation that is in booking flow (not a carbon offset)





Sustainable Aviation Fuel

- Parent company IAG has committed $865 million to SAF investments and purchases

09 Lufthansa Group (LH & LX)

#MakeChangeFly

Profile Highlights

- Currently Lufthansa Group is under scrutiny for their Carbon Offset program and potential greenwashing.
- Lufthansa Group is working with Google Flights and the EU to study contrail impacts on climate change and create an updated calculation for the Traveler Impact Model (TIM).
- Lufthansa offers green fares to travelers. These fares allow travelers the option to pay for the SAF premium or offset their flight when choosing flights.

Other Initiatives

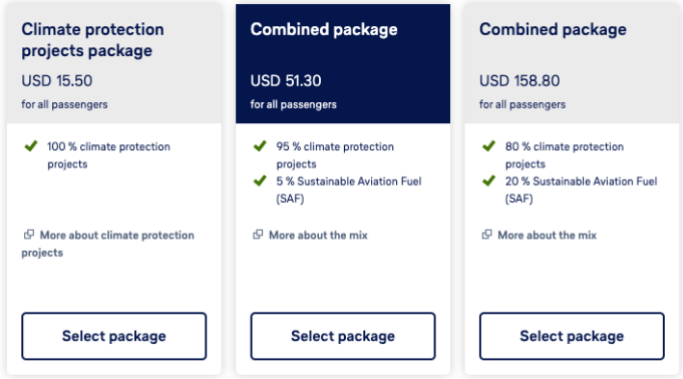
- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Expanding train and bus services to reduce the number of short-flights
- Replacing 100% of all single use plastics by 2025

Major Goals

2030	10% SAF
2030	Reduce GHG emissions by 50%
2050	Net-Zero

Carbon Offset Program

- Partnered with Compensaid
- Offers SAF and traditional offsets
- Green fares for flights within EU
  - Business and Economy only



Sustainable Aviation Fuel

- Swiss Air will be one of the first airlines to use PtL fuels
- Lufthansa Group has made a $250 million investment in SAF

10 WestJet (WS)

Profile Highlights

- All WestJet flights departing Calgary and San with SAF from November 2022 to January 2023.
- WestJet has one of the youngest fleets in North America, with aircraft no older than 10 years.

Other Initiatives

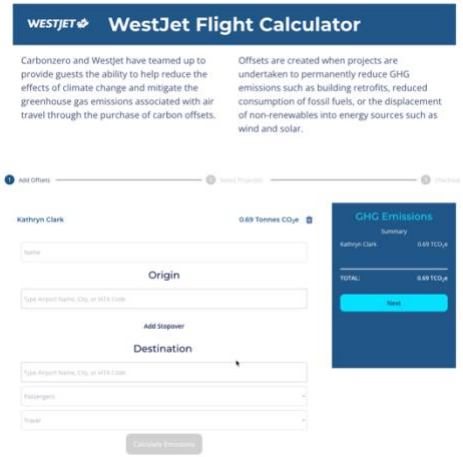
- Working towards higher fuel efficiency through fleet renewal and winglet technology
- Building headquarter offices with maximized natural light, geothermal heating, and rainwater capture
- Electrifying ground support equipment and vehicles

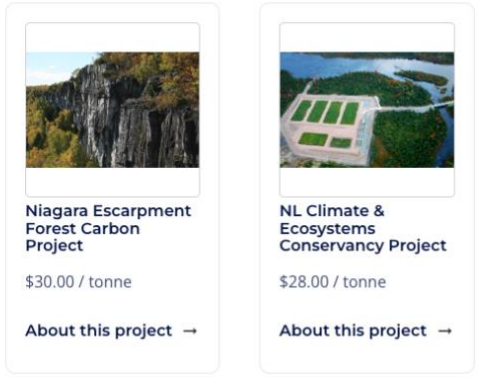
Major Goals

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- Partnered with Carbonzero
- Link-off is prompted at the end of the booking flow





Sustainable Aviation Fuel

- Committed to helping build Canada's SAF infrastructure

11 Emirates (EK)

Profile Highlights

- Emirates flew a demonstration flight that contained 100% SAF in one engine in January, 2023. This was the first SAF powered flight in the Middle East and Africa. The flight lasted 42 minutes.
- Emirates One&Only Wolgan Valley is Australia's first luxury conservation resort that is located in the Greater Blue Mountains, a World Heritage site. Emirates has invested over $125 million in the resort and conservation projects nearby.
- Emirates is focusing on building the PtL infrastructure in the UAE. They have also helped create the *UAE's National Sustainable Aviation Fuel Roadmap*.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and pilot training
- Preserving wildlife and habitats
- Reducing waste in supply chain

Major Goals

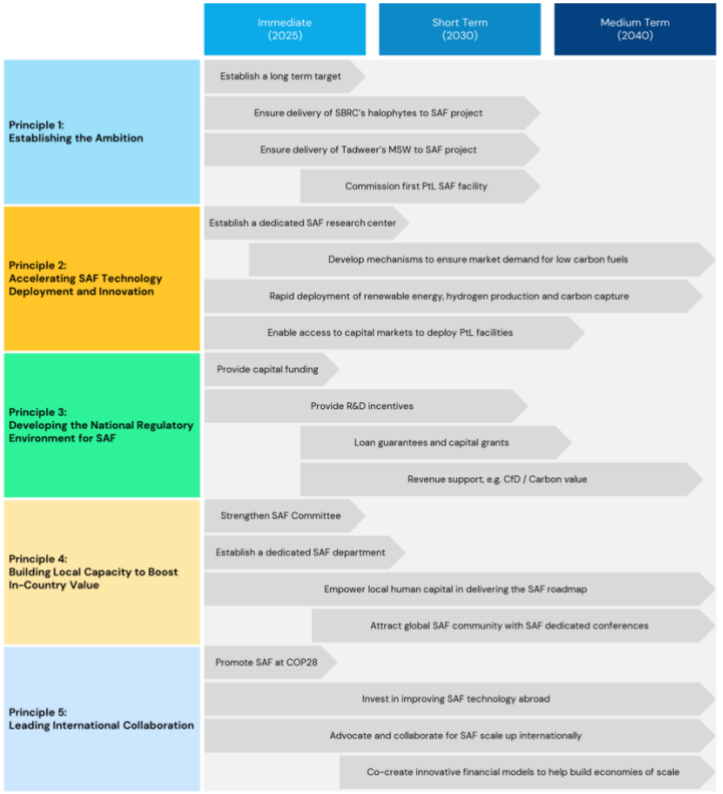
2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- Offsets internally

Sustainable Aviation Fuel

- $200 million investment for SAF R&D only
- SAF purchases and carbon offsets are considered "business as normal" and therefore are not prompted to travelers



UAE SAF Roadmap

12 Turkish Airlines (TK)

Profile Highlights

- In 2008, Turkish and IATA Green Team collaborated to study and implement a Fuel Efficiency Program that uses the following tactics: Optimizing Operations, New Technology, Air Traffic Management. Turkish has taken on more than 100 operation optimization projects since then.
- For the second year in a row Turkish was name the "Most Sustainable Flag Carrier Airline" by World Finance magazine.
- 9 buildings at Turkish's hub, Istanbul Airport, have been certified as a LEED (Leadership in Energy and Environmental Design) building

Other Initiatives

- Training all employees on aviation's impact on climate change
- Reducing water consumption, chemical use, and paper use in operations
- Using sustainable in-flight service material

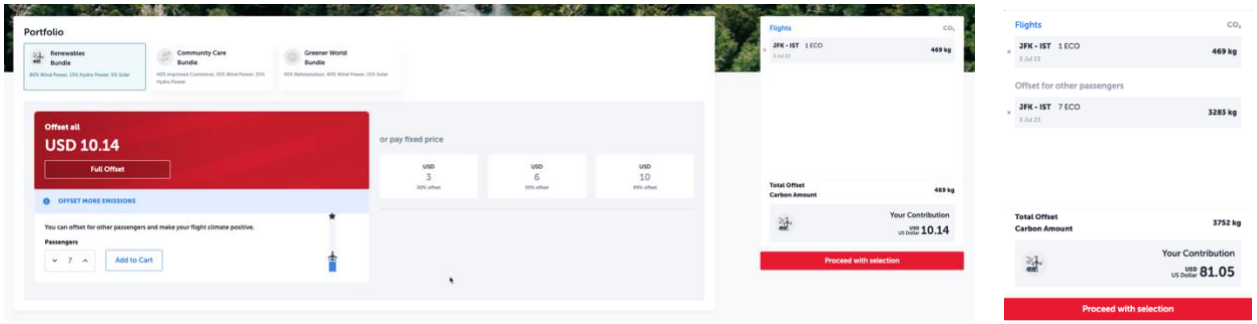
Major Goals

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- Partnered with CO2mission for a Link-off
- Travelers can offset for others

$21,141.64
Donated since launch



Sustainable Aviation Fuel

- Uses SAF on flights from Istanbul to Paris, Oslo, Gothenburg, Copenhagen, London and Stockholm

13 Frontier Airlines (F9)

Profile Highlights

- Frontier showcases endangered animals on their aircraft. They provide more information and ways to help on their website.
- By increasing prices per carry on and checked bag, Frontier hopes to increase fuel efficiency through traveler incentives.

Other Initiatives

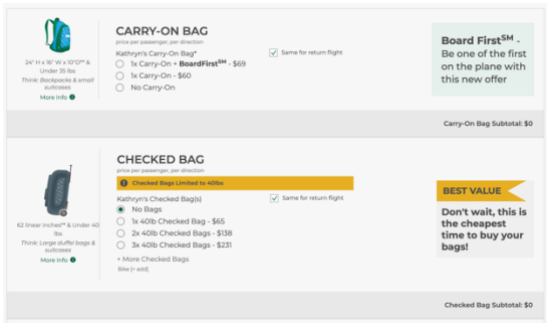
- Working towards higher fuel efficiency through fleet renewal and decreasing aircraft weight
- Promoting sustainable tourism

Major Goals (assumed due to IATA membership)

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- Does not currently offer carbon offsets
- Asks in booking flow for travelers to pack less in order to increase fuel efficiency



PACK LIGHT

More baggage means more weight and more weight means more fuel and a larger carbon footprint.

Sustainable Aviation Fuel

- No current SAF contribution

14 Aeromexico (AM)

Profile Highlights

- In 2021, Aeromexico saved more than 4.7 M liters of fuel saving them $2.5 M compared to 2020.
- Aeromexico follows the EU Emission Trading Scheme (ETS) and Mexico's CORSIA regulation body when reporting carbon offsets.
- Aeromexico is highly focused on reducing water usage and waste to reduce stress on Mexico City's water infrastructure.

Other Initiatives

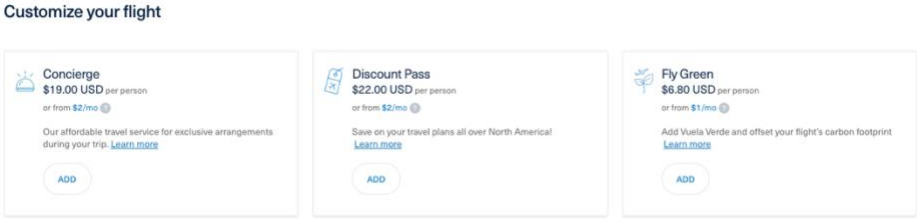
- Combatting human and animal trafficking
- Reducing noise pollution
- Reducing paper consumption through digitalization initiatives

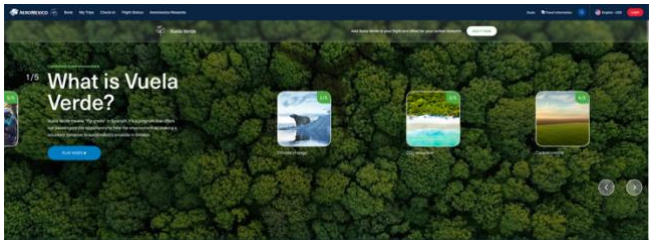
Major Goals

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- In house offset program called Vuela Verde (Fly Green)





Sustainable Aviation Fuel

- On International Day for Combating Climate Change in 2021, Aeromexico flew with SAF from San Francisco to Mexico City and Guadalajara

15 Qatar Airways (QR)

Profile Highlights

- Qatar Airways is the first carrier in the Middle East certified to the highest level of IATA's Environmental Assessment programme (IEnvA)
- They were the first airline to use GE's '360 Foam Wash' which replaces water wash methods.
- WeQare is Qatar's cargo sustianabilty program focused on transporting wildlife to their natural habitat free of charge.
- Qatar has codeshares with French and German train networks.

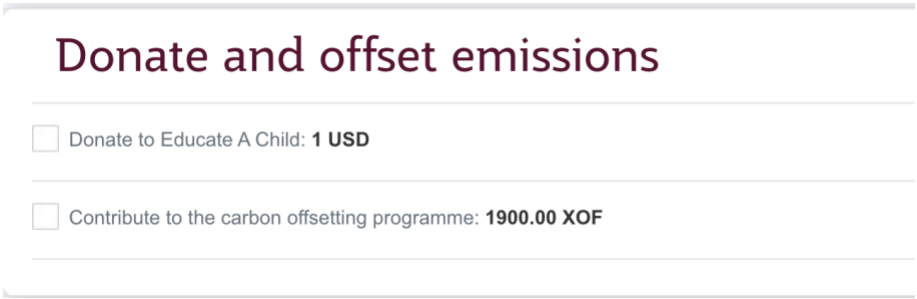
Other Initiatives

- Donating surplus food to reduce food waste
- Reducing the noise footprint in air and on ground
- Making in-flight supply chain sustainable

Major Goals

Carbon Offset Program

- In-house offset program
- Planning to focus on nature-based projects in area of service until carbon removal technology is more mature



Sustainable Aviation Fuel

- Will purchased 28 million gallons over 5 years to use starting in 2028

16 Air France-KLM Group (AF & KL)

Profile Highlights

- KLM group is moving travelers over to train for short regional trips to reduce emissions.
- Currently KLM is battling a lawsuit for greenwashing. They are one of the first airlines to face this.
- They are one of the first European airline groups to have decarbonization goals validated by SBTi.

Other Initiatives

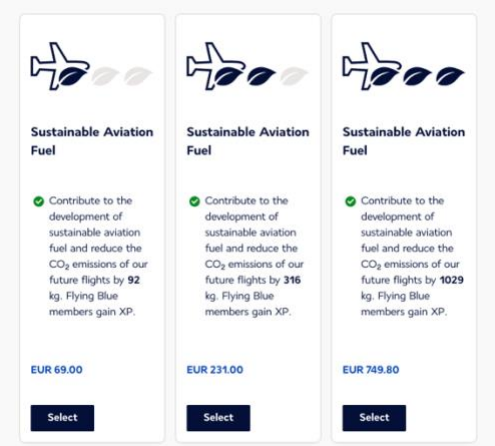
- Training pilots to reduce fuel use through energy efficient procedures
- Reducing noise footprint and paying the Airport Noise Tax (French policy)
- Utilizing a circular supply chain
- Electrifying operations where able

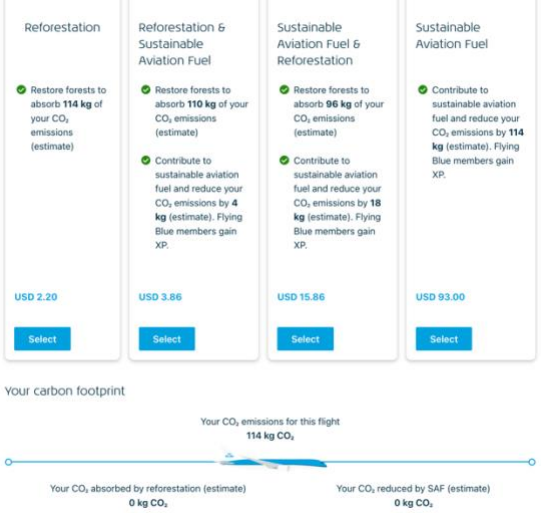
Major Goals (SBTi approved)

2028	64% of fleet is new generation aircraft
2030	10% SAF
2040	Net-Zero

Carbon Offset Program

- In-house program available during booking flow
- Air France only offers SAF offsets





Sustainable Aviation Fuel

- Amsterdam flights flying with .5% SAF since 2022
- All France flights flying with up to 1% SAF since 2022

17 EVA Airways (BR)

Profile Highlights

- EVA finalized an order for 5 more 787-9 Dreamliners, one of Boeings most efficient planes. This brings them to a total of nine 787-9 and seven 787-10.
- EVA is the first Taiwan-based airlines ot commit to the the Green Travel Carbon Offset Program in 2017.
- All in-flight manuals are fully digitalized, reducing paper and weight.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and weight reduction
- Reducing noise pollution and CO_2e emissions

Major Goals

2020	Achieve carbon-neutral growth
2030	10% SAF
2040	Net-Zero

Carbon Offset Program

- Partnered with ClimateCare
- External site
- Working towards setting up a cargo transport carbon offset program

Sustainable Aviation Fuel

- Made their first flight with SAF in May 2023
- Looking to build and establish SAF infrastructure in Taiwan

18 Cathay Pacific (CX)

Profile Highlights

- Cathay Pacific launched the first major corporate Sustainable Aviation Fuel program in Asia in 2022.
- Cathay sends food waste that cannot be donated to be converted into energy or fuel.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and in-flight operational efficiency
- Evaluating scope 3 emissions with hope of reducing all supply chain emissions
- Reducing in-flight waste

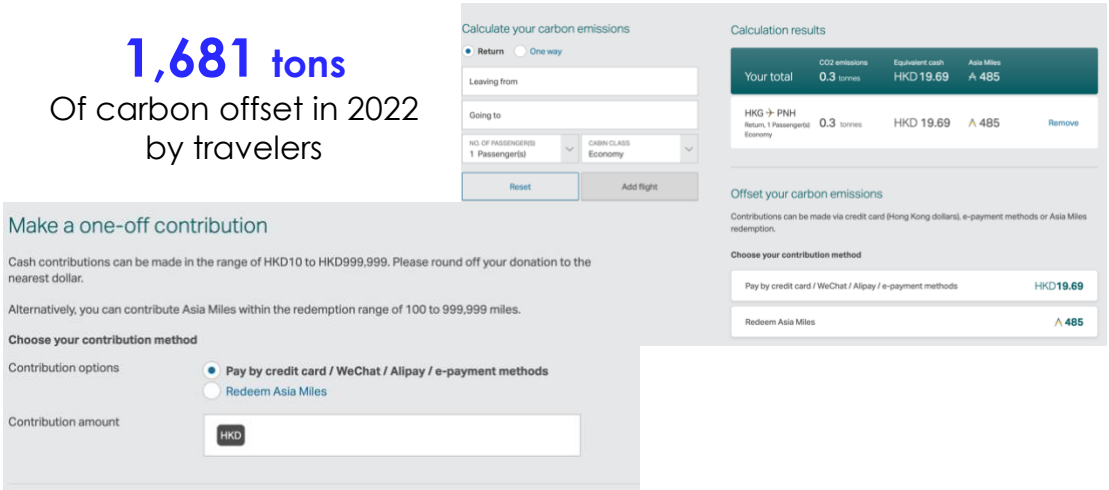
Major Goals

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- Program has been available since 2007 outside of booking flow
- Extended to cargo this year

1,681 tons
Of carbon offset in 2022
by travelers



Sustainable Aviation Fuel

- Introduced SAF to the Hong Kong International Airport in 2022
- Receiving 38 mil. gallons of blended SAF over the next 7 years

19 Japan Airlines (JL)

Profile Highlights

- JAL receive a certificate of appreciation for cooperation with the Carbon Offset Program for the Tokyo 2020 Olympic games. They donated 6% more carbon credits than required by the program.
- JAL Group is participating in the Plastic Circular Challenge 2025 (only available in Japan).
- JAL offers a meal cancellation program to reduce food waste from travelers who prefer to not eat on overnight flights.

Other Initiatives

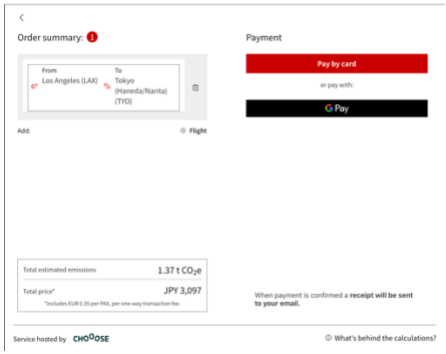
- Reducing paper consumption by switching over to iPads
- Reducing food waste
- Reducing emissions across all supply chains

Major Goals

2030	Reduce emissions by 10% compared to 2019
2030	10% SAF
2040	Net-Zero

Carbon Offset Program

- Partnered with Chooose for offsite offsetting



Sustainable Aviation Fuel

- Working with partners to build infrastructure for SAF in Japan

20 All Nippon Airways (NH)

Profile Highlights

- Future Promise is ANA's hub for all sustainability initiatives.
- ANA launched the "Green Jet" in 2022 which has leaf motifs, sharkskin technology which reduces emissions and vegan headrest covers.

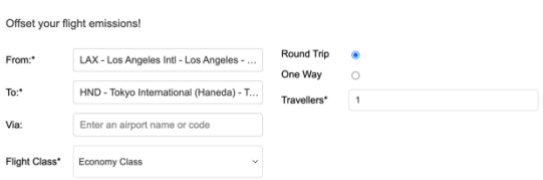
Other Initiatives

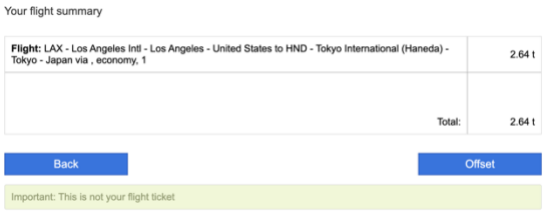
- Working towards higher fuel efficiency through operational efficiencies and weight reduction
- Looking for more sustainable supply chains
- Using carbon capture for 1% of emission by 2030 and 10% by 2050

Major Goals

Carbon Offset Program

- Partnered with blue dot green





Sustainable Aviation Fuel

- SAF Flight Initiative: For the Next Generation is ANA's corporate SAF program

21 Hawaiian Airlines (HA)

Profile Highlights

- Par Hawaii, the largest local refiner, partnered with Hawaiian Airlines to begin exploring the potential of converting local factories into SAF production.
- In 2022, Travel Pono was debuted which informs travelers how to visit the Hawaiian Islands sustainably.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and single engine taxiing
- Supporting local food systems by sourcing most in-flight food from Hawaii
- Reducing in-flight waste with aluminum alternatives
- Committed to hydrogen and electric when available for all short-haul flights

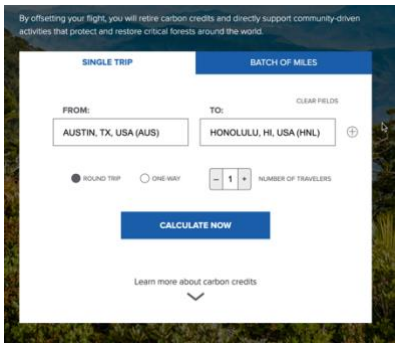
Major Goals

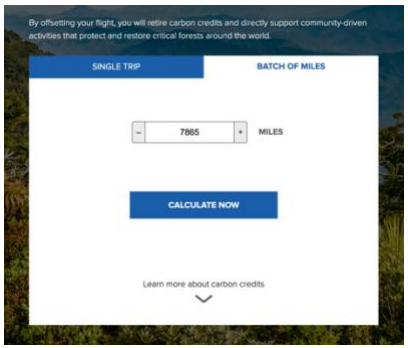
2030	10% SAF
2035	Reduce emission intensity by 45%
2040	Net-Zero

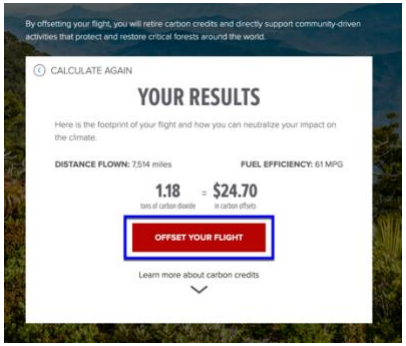
Carbon Offset Program

- Partnered with Conservation International
- Can receive miles from offsetting

2,400 acres
Protected trough offsets







Sustainable Aviation Fuel

- Sourcing all SAF from California
- Committed to buying 10 mil. gallons of SAF over the next 5 years
- Partnered with the largest Hawaiian refinery to build Hawaii's SAF infrastructure

22 Korean Air (KE)

Profile Highlights

- Late June 2023, Korean Air announced their partnership with GS Caltex, a Korean SAF producer, to begin testing SAF. The Korean government will base their SAF use and quality standards based on findings from these flights.
- Korean Air is working toward developing eco-friendly aviation technology and space travel technology.
- In one year, Korean Air achieved their voluntary carbon offset goal which provided an urban green space around South Korean cities. Donations were made through miles.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and operational efficiencies
- Up-cycling outdated in-flight lifejackets and other in-flight service items
- Fighting against wildlife trafficking

Major Goals

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- Korean Air had an offset program, however they reached their goal and have not added a new program since
- They have been offsetting internally to stay compliant with CORSIA once international flight increase to pre pandemic levels

Sustainable Aviation Fuel

- Using SAF only on Paris to Incheon flights
- Helping develop South Korea's SAF infrastructure

23 Iberia (IB)

Profile Highlights

- In 2022, Iberia flew the first flight with waste SAF manufactured in Spain.
- In 2021, Iberia launched its own energy plant in La Muñoza, which now generates 80 million kWh of solar energy.

Other Initiatives

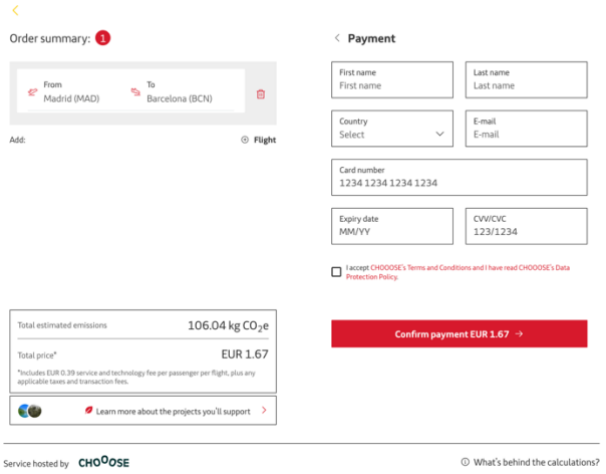
- Working towards higher fuel efficiency through fleet renewal and operational efficiencies
- Digitalizing operations to reduce paper use
- Electrifying and upgrading ground support
- Reduce in-flight waste

Major Goals

2025	-10% emission per passenger
2030	10% SAF
2040	Net-Zero

Carbon Offset Program

- Partnered with Choose for in house program called CO_2llaborate



Sustainable Aviation Fuel

- Purchasing 6 mil. gallons over the next five years

24 Asiana Airlines (OZ)

ASIANA AIRLINES

Profile Highlights

- Asiana Airlines provide mandatory training courses on environmental management for new recruits. The course introduces the company's environmental policies, key strategies, and climate change actions.
- Asiana's crews have switched to using tablets in-flight to reduce paper waste and reduce plane weight.
- Asiana became the first Korean airline to introduce the A350 and A321Neo to ther fleet. These planes reduce feul consumption by 25% and 15%, respectively, compare to counterparts.

Other Initiatives

- Working towards higher fuel efficiency through fleet renewal and operation efficiencies
- Reducing noise pollution below compliance levels
- Protecting biodiversity and preventing animal trafficking

Major Goals

Carbon Offset Program

- Offset internally

Sustainable Aviation Fuel

- Has struck a deal with Shell however details are not fully known
- Fuel would come from APAC network

25 TAP Portugal (TP)

Profile Highlights

- TAP operated the first Portugal flight (LIS-PDL) with 39% SAF (HEFA) in its engine. Emissions were reduced by 35%.
- TAP became the first ailing to launch a carbon offset program in partnership with IATA.

Other Initiatives

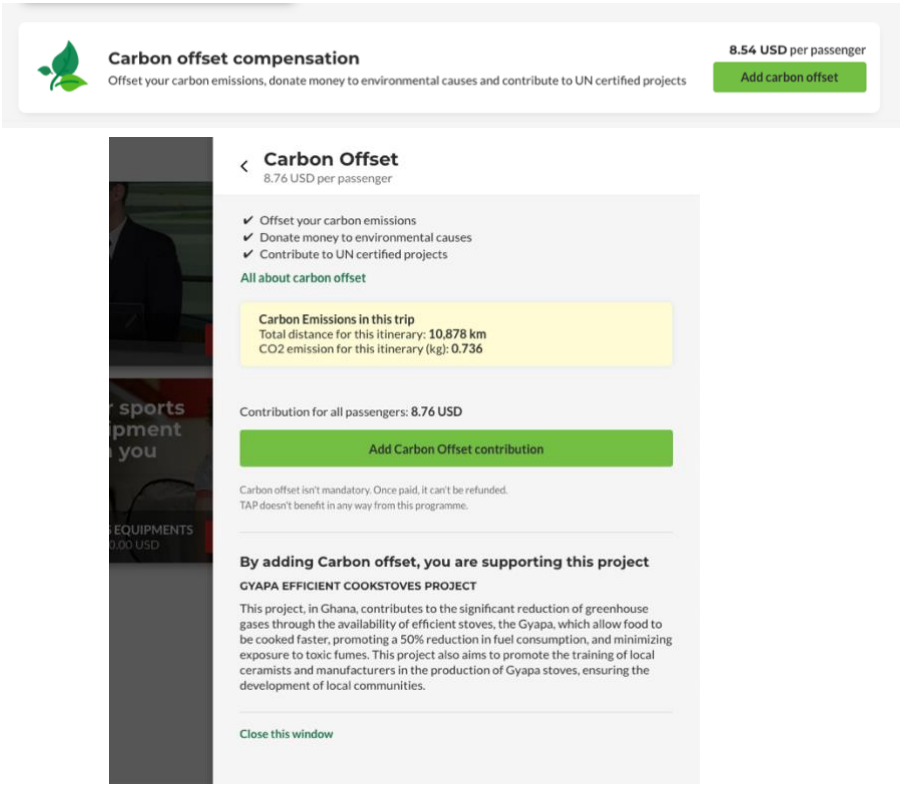
TAP Portugal has not published their environmental and net-zero strategy. Information is found from news sources.

Major Goals

2030	10% SAF
2050	Net-Zero

Carbon Offset Program

- In-house program available during package selection



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