Fly Net Zero

Information pack

"The world's airlines have taken a momentous decision to ensure that flying is sustainable. The post-COVID-19 re-connect will be on a clear path towards net zero. That will ensure the freedom of future generations to sustainably explore, learn, trade, build markets, appreciate cultures and connect with people the world over. With the collective efforts of the entire value chain and supportive government policies, aviation will achieve net zero emissions by 2050."

"We have a plan. The scale of the industry in 2050 will require the mitigation of 1.8 gigatons of carbon. A potential scenario is that 65% of this will be abated through sustainable aviation fuels. We would expect new propulsion technology, such as hydrogen, to take care of another 13%. And efficiency improvements will account for a further 3%. The remainder could be dealt with through carbon capture and storage (11%) and offsets (8%). The actual split, and the trajectory to get there, will depend on what solutions are the most cost-effective at any particular time. Whatever the ultimate path to net zero will be, it is true that the only way to get there will be with the value chain and governments playing their role."

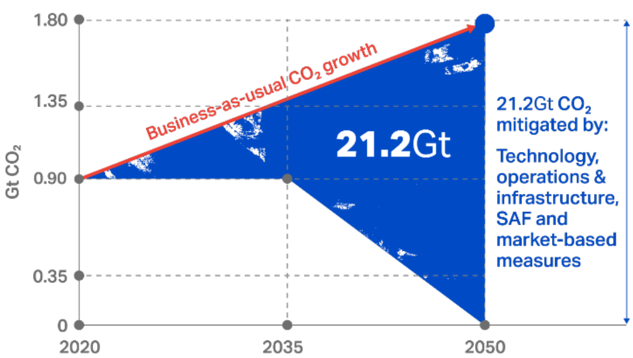
"There will be those who say that we face impossible numbers and technical challenges. Aviation has a history of realizing what was thought to be impossible—and doing so quickly. From the first commercial flight to the first commercial jet was about 35 years. And twenty years on we had the first jumbo jet. Sustainability is the challenge of our generation. And today we are launching a transition that is challenging. But in 30 years it is also within reach of human ingenuity, provided governments and the whole industry work together and hold each other accountable for delivery," said Walsh.

Net zero carbon 2050 resolution

Fact sheet

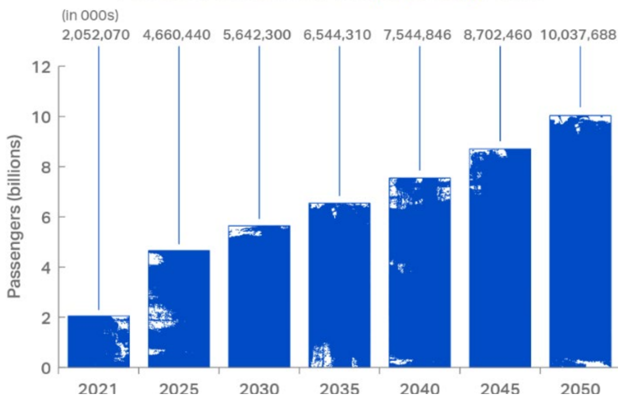
At the 77th IATA Annual General Meeting in Boston, USA, on October 4th 2021, a resolution was passed by IATA member airlines committing them to achieving net-zero carbon emissions from their operations by 2050. This pledge brings air transport into line with the objectives of the Paris agreement to limit global warming to 1.5°C.

Net Zero: Aviation carbon emissions to be abated by 2050



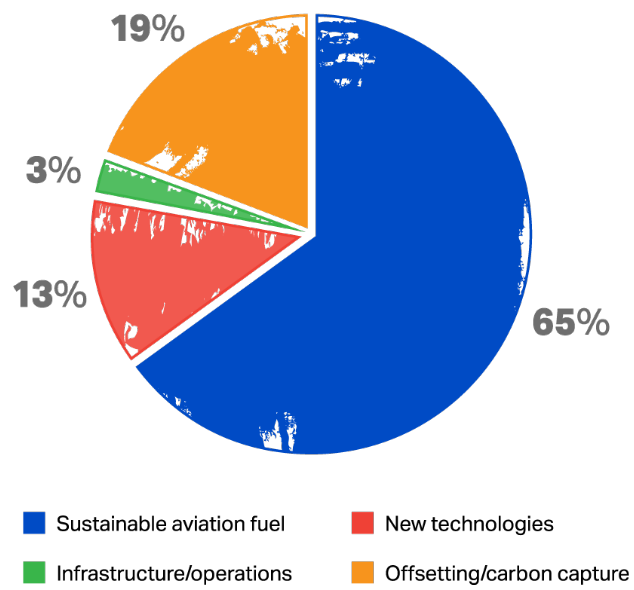
Current projections estimate that demand for individual air passenger journeys in 2050 could exceed 10 billion.

Forecasted evolution of air transport passenger traffic



The expected carbon emissions on a 'business as usual' trajectory over the 2021-2050 period is approximately 21.2 gigatons of CO_2. Mitigating that amount of carbon will be an enormous technological challenge.

Contribution to achieving Net Zero Carbon in 2050



Success will require the coordinated combined efforts of the entire industry (airlines, airports, air navigation service providers, manufacturers) and significant government support.

The net-zero objective will be met through a combination of maximum elimination of emissions at source and the use of approved offsetting and carbon capture technologies. The key elements of the emissions reduction strategy are:

- The use of Sustainable Aviation Fuel (SAF), sourced from feedstocks that do not degrade the environment or compete with food or water
- Investment in new aircraft technology, including radical new aerodynamic and alternative propulsion (electric or hydrogen) solutions
- Continued improvement in infrastructure and operational efficiency, with a particular focus on improved air traffic management
- The use of approved offsets including carbon capture and storage technology

Milestones towards net zero

The below table illustrates a potential set of estimated milestones towards net-zero, including the mix of abatement measures ('pathways') and some noteworthy actions envisaged.

DATE	AMOUNT OF CO_2 ABATEMENT	PATHWAY	ACTION
2025	**381 megatonnes (Mt)** (2021-2025)	97% offsets, 2% SAF, 1% improvements above business as usual (BAU)	ICAO agree long-term goal for international aviation (2022); energy sector commits to at least 6 million tonnes SAF production; agreement of full implementation of Article of Paris Agreement
2030	**979 Mt** (2026-2030)	93% offsets; 5% SAF, 2% Improvements above BAU	Use of 100% SAF on aircraft, ANSPs fully implement ICAO Aviation System Block upgrades to deliver fuel efficiency improvements of 0.3% by 2030
2035	**1,703 Mt** (2031–2035)	77.5% offsets, 17.5% SAF, 3% improvements above BAU, 2% Carbon Capture Utilization and Storage (CCUS)	Evolutionary technology achieving 30% reduction in fuel burn, electric/hydrogen aircraft for regional markets (50-100 seats, 30-90 min flights) become available
2040	**3,824 Mt** (2036-2040)	44.5% offsets, 40% SAF, 7.5% non drop-in fuel (new propulsion technologies), 5% CCUS, 3% improvements above BAU	Feasibility of new aircraft such as blended-wing bodies demonstrated with full-scale working prototypes, electric/hydrogen for short-haul markets (100-150 seats, 45-120 min flights) become available.
2045	**6,153 Mt** (2041-2045)	55% SAF, 24% offsets, 10% non drop-in fuel, 8% CCUS, 3% improvements above BAU	Necessary infrastructure for new energy requirements (low carbon electricity/hydrogen) becomes available
2050	**8,164 Mt** (2046-2050)	65% SAF, 13% non drop-in fuel, 11% CCUS, 8% offsets, 3% improvements above BAU	Commercially viable annual SAF production of 449 billion litres available

Links

Text of net-zero resolution
Factsheets on SAF, Offsetting/Carbon Capture, New Technology, Operational/Infrastructure improvements
ATAG Waypoint 2050 report

Net zero 2050: sustainable aviation fuels

Fact sheet

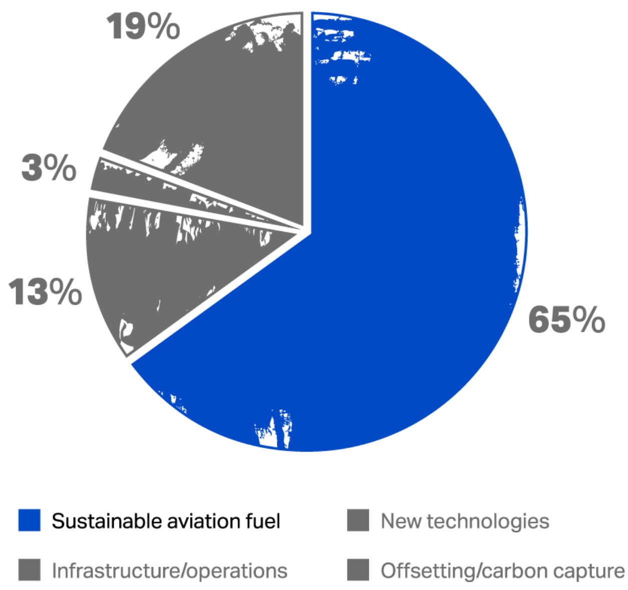
The aviation industry's net-zero carbon emissions target is focused on delivering maximum reduction in emissions at source, through the use of sustainable aviation fuels (SAF), innovative new propulsion technologies, and other efficiency improvements (such as improvements to air traffic navigation).

This factsheet looks at the potential for SAF to provide the bulk of the emissions reductions the industry will need to make by 2050.

What is SAF

SAF is a liquid fuel currently used in commercial aviation which reduces CO_2 emissions by up to 80%. It can be produced from a number of sources (feedstock) including waste oil and fats, green and municipal waste and non-food crops. It can also be produced synthetically via a process that captures carbon directly from the air. It is 'sustainable' because the raw feedstock does not compete with food crops or water supplies, or is responsible for forest degradation. Whereas fossil fuels add to the overall level of CO_2 by emitting carbon that had been previously locked away, SAF recycles the CO_2 which has been absorbed by the biomass used in the feedstock during the course of its life.

Contribution to achieving Net Zero Carbon in 2050



We estimate that SAF could contribute around 65% of the reduction in emissions needed by aviation to reach net-zero in 2050. This will require a massive increase in production (see chart below) in order to meet demand. The largest acceleration is expected in the 2030s as policy support becomes global, SAF becomes competitive with fossil kerosene, and credible offsets become scarcer.

The state of sustainable aviation fuel (SAF) in 2021

360,000 flights
2016: 500 flights
2025: 1 million flights

100 million litres per annum
2016: 8 million litres
2025: ~5 billion litres

36 countries with SAF policies
2016: 2 countries
2025: global agreement?

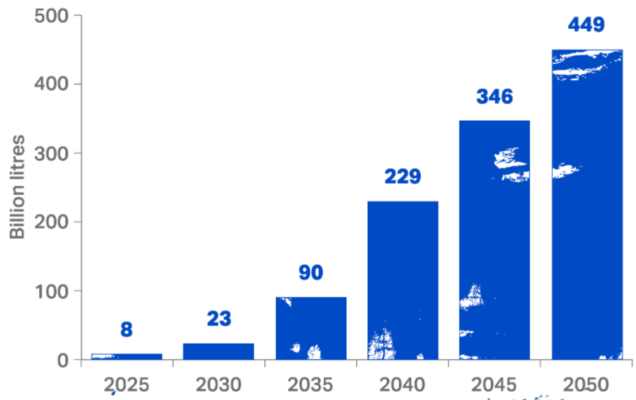
7 technical pathways
2016: 4 pathways
2025: 11 pathways

70% average CO_2 reduction
2016: ~60% reduction
2025: ~80% reduction

$13 billion in forward purchase
2016: $2.5 billion
2025: >$30 billion

Source: IATA 2025 estimates

Expected SAF required for Net Zero 2050



Sustainable Aviation Fuels in Practice

Main milestones so far:

- **2008:** The first test flight with biojet fuel was performed by Virgin Atlantic.
- **2011–2015:** 22 airlines performed over 2,500 commercial passenger flights with blends of up to 50% biojet fuel from feedstock including used cooking oil, jatropha, camelina, and algae.
- **January 2016:** Regular sustainable fuel supply through the common hydrant system started at Oslo Airport. Alternative fuel producer Neste and supplier SkyNRG as well as Air BP involved.
- **March 2016:** United became the first airline to introduce SAF into normal business operations by commencing daily flights from Los Angeles Airport (LAX), supplied by AltAir.
- **June 2017:** At the 73rd IATA AGM in Cancun, IATA members unanimously agreed a resolution on the deployment of SAF, including calling for constructive government policies, and committing to only use fuels which conserve ecological balance and avoid depletion of natural resources.
- **November 2019:** Commercial SAF flights exceed 250,000 and more than 45 airlines gain experience using SAF.
- **June 2020:** Two new technical SAF certifications are approved by ASTM increasing the approved technical pathways for SAF production to seven.

IATA's Strategic Action Plan

Industry actions

- The Air Transport Action Group (ATAG) Waypoint 2050 study examines the potential of different decarbonisation options, including some of the possible achievement trajectories for SAF out to the year 2050. It is feasible to replace almost all fossil jet fuel with SAF over the coming decades.
- Provide industry leadership and publicly available guidance material on best practice concerning sustainability standards, accounting procedures, logistics, communication, effective policy and business case development
- Influence policy negotiations to ensure aviation can opt into existing ground transport policies, and in some cases, have aviation preferentially incentivized to use SAF

Role of governments

- To develop policies that efficiently accelerate the commercial production and deployment of SAF. Positive incentives are the most effective policy tool and involve the allocation of public funds (from an array of support incentives). Positive policies reduce project risk, making a business case more competitive and allowing organic supply and demand to develop into a sustainable market.
- A mandate policy (forcing airlines to use a certain quantity of SAF) is not IATA's preferred option for advancing the deployment of SAF, especially when a mandate is not accompanied by positive measures. A mandate rarely delivers the optimal economic outcome, typically resulting in higher prices, and thus diverting resources which could be deployed for other environmental investment.
- The US and the EU are pursuing different approaches to SAF policy development explained (see factsheet).

Other avenues for government support include:

- Adopt globally recognized sustainability standards and work to harmonize standards.
- Ensure existing policy incentive frameworks designed for ground transport, also include aviation and apply higher incentives for aviation over ground transport, which has other energy alternatives.
- Encourage user-friendly SAF accounting methods, including developing an industry designed functioning book and claim framework and seek to harmonize global standards.
- Support sustainable aviation fuel R&D and demonstration plants.
- Implement policies that de-risk investments into SAF production plants and engage in public-private partnerships for SAF production and supply.
- Commit to policy certainty or at a minimum policy timeframe that match investment timeframes.

Net zero 2050: new aircraft technology

Fact sheet

The aviation industry's net-zero carbon emissions target is focused on delivering maximum reduction in emissions at source, through the use of sustainable aviation fuels (SAF), innovative new propulsion technologies, and other efficiency improvements (such as improvements to air traffic navigation).

This factsheet looks at the timelines for introducing new aircraft and propulsion technologies that will bring us to zero-emissions flight. For further information, please consult IATA's Technology Roadmap and the Waypoint 2050 report from the Air Transport Action Group which outlines these technology pathways in more detail.

Historic trends

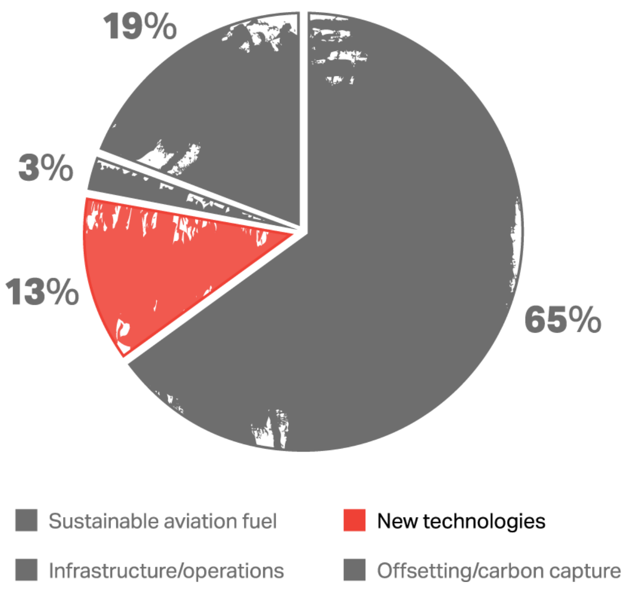
The fuel-efficiency of aircraft has been consistently improving since the first passenger jets were introduced in the 1950s. Each new generation of plane has reduced emissions by around 15-20%. The overall fuel efficiency of the fleet is around 80% better than 50 years ago.

The incremental improvements brought over time have principally come from more efficient engines, better aerodynamics, and reduced weight. The use of composites instead of aluminium in the latest generation of planes has brought weight down, allowing engines to operate more efficiently.

The next quantum leap

The aircraft industry is expected to continue with incremental improvements to existing technology. Geared turbofan engines and further advances in design will drive a further 15-25% fuel efficiency improvements over the next two decades. From the mid-2030s, however, radical new propulsion technologies and advanced designs may become viable that offer the chance to move away from traditional jet engine and tube-and-wing flight.

Contribution to achieving Net Zero Carbon in 2050



Hybrid-electric

Hybrid-electric concepts combine the advantages of both combustion and electric engines. The combustion and electric propulsion systems can be used in combination during take-off to provide maximum thrust, and the combustion engine can be throttled back when the aircraft is in cruise flight or descending. Combustion engines could also be smaller and reduce on-board weight. Hybridisation is a necessary intermediate step for larger airplanes towards a pure electric propulsion system. Hybrid-electric aircraft on a new airframe body such as the Blended Wing Body can contribute to achieving CO_2 reductions of up to 40%.

Potential entry into service: Small aircraft (15 – 20 seats) with hybrid-electric propulsion are expected during this decade, regional aircraft in the 2030s and possibly larger ones from 2040.

Fully electric

Instead of combustion engines, electric motors drive conventional propellers or sets of multiple small fans. Electric energy is stored in batteries (which however have a penalising weight) or potentially in fuel cells. CO_2 emissions during operations are zero for full electric aircraft. Lifecycle emissions strongly depend on the primary energy mix for electricity generation. If fully renewable sources are used, they could be close to zero as well. An additional benefit would be the eradication of non-CO_2 effects (such as contrails and NOx emissions).

Potential entry into service: Small electric test aircraft up to 9 seats are already flying. Electric aircraft up to 19 seats are planned for the later 2020s, and regional aircraft in the 2030s. Norway has the goal of operating all domestic and short-haul flights electrically by 2040.

Hydrogen

Hydrogen is a carbon-free fuel that can be used as a propulsion fuel for combustion in conventional engines, replacing jet fuel (including in large aircraft), and also in fuel cells for electrical power. The weight of hydrogen is three times lower than that of an amount of jet fuel with the same energy content, but its volume even in liquid (cryogenic) form is four times larger. Much larger tanks as well as fundamental changes in the aircraft fuel system are therefore needed.

Potential entry into service: One of the biggest challenges for hydrogen use in aviation is its availability at large scale, the need to produce 'green' hydrogen and the existence of appropriate supply infrastructure. Interest is growing however, and technology programmes now envisage entry into service around 2035.

Advanced aircraft configurations

The development of radical new aerodynamic designs for commercial airplanes could create significant efficiency improvements and make it easier for alternative propulsion systems to succeed. Here are three potential examples:

Canard wing: Already used in military airplanes, canard-wing planes create low-dra through the main wing being set further back behind small forewings. As with other radical designs, canard-wing planes could be in production from 2035-40.

Blended wing: Wide airfoil-shaped bodies and efficient high-lift wings enable significant lift-to-drag ratio improvements compared with conventional aircraft. High fuel savings are generated as the entire plane is designed to generate lift.

Strut or truss-braced wing: Utilises a structural wing support to allow for larger wing spans without increases in weight. By increasing the span the induced drag is reduced and therefore the engine performance requirements can be reduced. The high wings allow for larger engine sizes, e.g. open rotors.

Net zero 2050: offsetting and carbon capture

Fact sheet

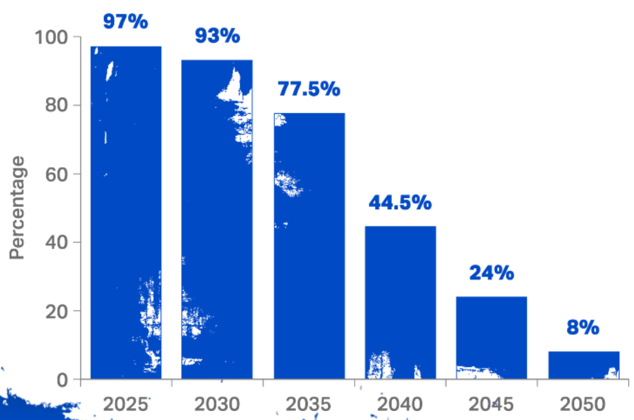
The aviation industry's net-zero carbon emissions target is focused on delivering maximum reduction in emissions at source, through the use of sustainable aviation fuels (SAF), innovative new propulsion technologies, and other efficiency improvements (such as improvements to air traffic navigation).

The industry plan for net-zero foresees a rapid decline in the use of offsets as in-sector solutions take over (see chart below). If it proves impossible to completely eliminate emissions at source, however, the industry is committed to mitigating the remaining emissions using offsetting mechanisms, including carbon capture technologies. This fact sheet explains more about these options. (For more on the existing Carbon Offsetting and Reduction Scheme for International Aviation program, see the dedicated CORSIA factsheet.)

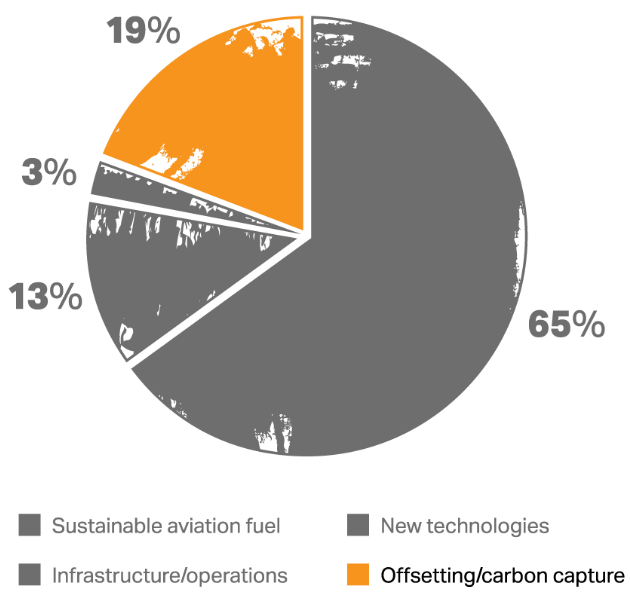
Offsetting has been criticized as poorly-regulated, with the quality of some schemes called into question. The aviation industry therefore subscribes to some key criteria to ensure that offsetting is robust:

- CO_2 reduction or removal used as an offset be 'additional' to business-as-usual activity.

Estimated percentage reliance on offsets for industry CO_2 reduction



Contribution to achieving Net Zero Carbon in 2050



Offsets must also represent a permanent reduction of emissions that cannot be reversed.
- To quantify the greenhouse gas reduction benefits from an offsetting project, a baseline must be determined to represent what would have happened if the project had not been implemented. Emissions reductions will need to be quantified using accurate measurements, valid protocols, and be audited.
- Procedures must be in place to track units and to avoid that an emissions reduction is counted more than once towards attaining climate change mitigation.
- Carbon offsetting projects must comply with local, national and international laws, and must have safeguards in place to manage environmental and social risks.

Offsets: forestry and natural climate solutions

Some 15-20% of the world's greenhouse gas emissions come from deforestation. The move to use forestry as a source of carbon credits has been investigated for many years and is under discussions at the UN as part of the Paris Agreement. But there are challenges: ensuring that the forestry protection is permanent and looking after indigenous communities are just two areas that must be considered. The accounting framework for the international transfer of credits must also be decided on.

Moreover, there is increasing pursuit of other climate solutions which could not only prevent CO_2 emissions, but actually remove CO_2 from the atmosphere. Reforestation, though, must come with safeguards to ensure that trees planted grow to maturity. Rehabilitation of peatlands which cover 3% of the earth, could also provide significant carbon sinks.

At this stage, the scale of the 2050 potential from these natural climate solutions is unknown, although estimates suggest up to 11.3 billion tonnes of carbon could be reduced annually through such measures.

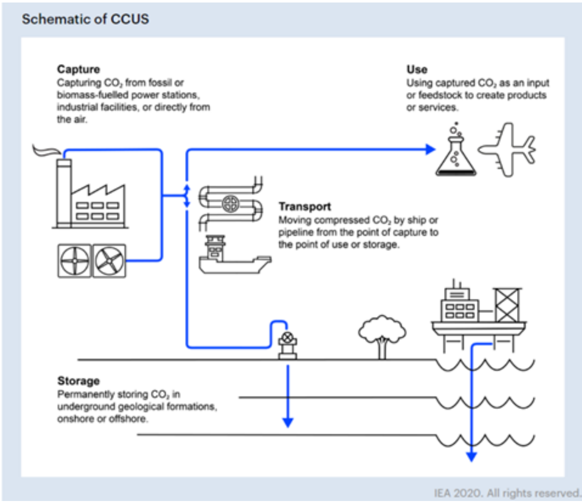
Direct air carbon capture and sequestration

Direct air capture (DAC) is a nascent technique in which CO_2 (and potentially other greenhouse gases) are removed directly from the atmosphere. The current technique uses large fans that move ambient air through a filter, using a chemical adsorbent to produce a pure CO_2 stream that could be stored or re-used. Significantly, unlike traditional carbon capture technologies, it removes CO_2 from the atmosphere, rather than being attached to a power station or other source of emissions.

To have any significant effect on global CO2 concentrations, DAC would need to be rolled out on a vast scale – perhaps up to 30,000 large DACs facilities would capture some 30Gt of CO_2 per year (or up to 30 million small scale plants by the end of the century).

Carbon capture utilization and storage

Carbon Capture Utilization and Storage (CCUS) is a technology that can capture up to 90% of the CO_2 emissions produced from the use of fossil fuels in electricity generation and industrial processes. Furthermore, the use of CCUS with renewable biomass is one of the few carbon abatement technologies that can be used in a 'carbon-negative' mode – actually taking carbon dioxide out of the atmosphere. It can even then be used to create SAF.



The CCUS chain works by capturing and transporting the carbon dioxide, recycling the CO_2 for other industrial purposes, and securely storing it underground. Despite being a technology available for many years, there has not so far been widespread use of the method and there is some skepticism as to its ability to be a major part of the world's climate response. One of the key arguments against the use of CCUS technology is that it could facilitate a prolonged use of fossil energy, rather than pushing investment towards low carbon and renewable energy. However, the Intergovernmental Panel on Climate Change (IPCC) states that CCUS will be absolutely critical to limit global warming to 1.5° C and that without the use of these technologies the target cannot be met*. And the International Energy Agency has indicated that CCUS could reduce global carbon dioxide emissions by 19%.

*IPCC_AR6_WGI_Full_Report.pdf page 308

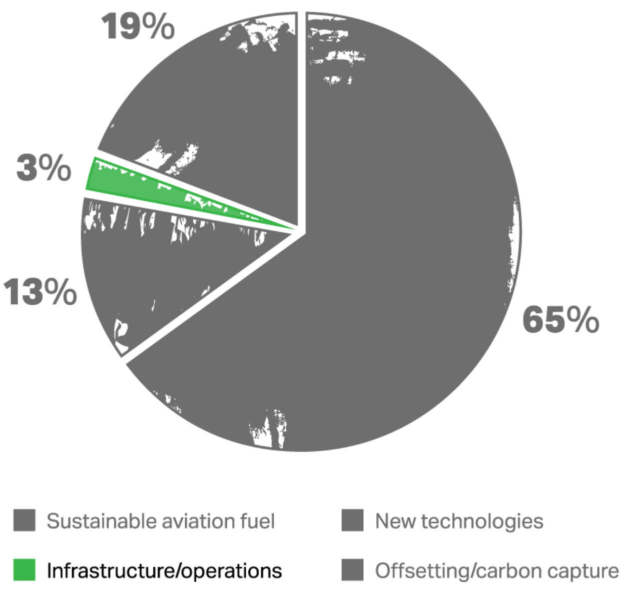
Net zero 2050: operational and infrastructure improvements

Fact sheet

The aviation industry's net-zero carbon emissions target is focused on delivering maximum reduction in emissions at source, through the use of sustainable aviation fuels (SAF), innovative new propulsion technologies, and other efficiency improvements (such as improvements to air traffic navigation).

This factsheet looks at the potential for operations and infrastructure efficiency improvements to contribute to reducing CO_2 emissions and help meet the 2050 carbon goal. While the overall emissions reductions from operations and infrastructure efficiency improvements are not by themselves sufficient to meet net-zero, these measures can often be implemented at scale faster than aircraft-level technologies (that are constrained by the rate of entry of aircraft into the fleet) and therefore the impacts from operations and infrastructure efficiency improvements can be significant in the near term.

Contribution to achieving Net Zero Carbon in 2050



Historic trend

The aviation industry has a history of continuous improvement in efficiency. Until the pandemic, there was a steady improvement in the passenger load factor to a record average of over 82% in 2019. Operational efficiencies have resulted in a 55% improvement in fuel burn per passenger km since 1990. It remains the case, however, that some long-sought infrastructure improvements have not progressed as rapidly as originally envisaged.

Aircraft operations (airline and aircraft operator focus) include measures such as:

- weight reduction,
- improvements in aerodynamics of in-service aircraft, and
- use of systems to improve efficiency during the operation of aircraft.

Infrastructure improvements (air traffic management and to a lesser extent airport operations) include measures such as:

- structural changes in air traffic management (ATM) operations, and
- energy savings at the airport such as limitations on the use of auxiliary power units, single engine taxi, and reduced taxi times.

(For more in-depth information into potential operations and infrastructure improvements, see the ATAG *Waypoint 2050* report.)

Operational improvement examples

- Retrofitting winglets - These aerodynamic modifications enable airlines to save more than 4% in fuel, and reduce aircraft noise and NOx emissions. Over 9,000 aircraft have been retrofitted, saving over 100 million tonnes of CO_2 since 2000.
- Light-weight aircraft cabin equipment (including electronic flight bag), seating and cargo containers.
- Electric or assisted taxiing - Reduced engine taxiing, where pilots taxi on a reduced number of engines and then start the rest nearer the runway, has saved one airline 4,100 tonnes of fuel per year at its hub airport.
- Exterior paint – thinner, more aerodynamically efficient, and better maintained paint schemes can improve aerodynamic efficiency.

Infrastructure improvement examples

Airport improvements:

- fixed electrical ground power at gate,
- airport collaborative decision making, and
- surface congestion management (reducing taxiing delays).

ATM improvements:

- performance-based navigation,
- required navigation performance (RNP),
- space-based navigation,
- continuous descent / climb,
- expansion of 'perfect flight' partnerships,
- 4D Trajectory-based Operations (TBO),
- flexible tracks / free-route airspace, and
- flexible use of military airspace.

3 vital ATM programs

Single European Sky: It is estimated that some 6-10% of wasted emissions in Europe could be recovered through more efficient air traffic management. The Single European Sky initiative aims to reduce the fragmentation of European airspace and to modernise Europe's airspace structure and air traffic management technologies. The delivery of seamless air traffic services is built on optimised airspace organisation, supported by progressively higher levels of automation, common ATM data services and an improved role of the Eurocontrol Network Manager to optimise the ATM network. Regrettably, progress towards SES has been very slow, hobbled by institutional resistance and a lack of political leadership.

NextGen: NextGen is a wide-ranging transformation of the entire US air traffic management system. It will replace ground-based technologies with new and more dynamic satellite-based technology. It is a collaborative effort between the Federal Aviation Administration and partners from the airports, airlines, manufacturers, government agencies, state, local and foreign governments, universities and associations. US airspace faces less political complexity than in Europe. Nevertheless, a more rapid roll-out of NextGen will enable more rapid emissions cuts.

ICAO Aviation System Block Upgrades: The ICAO Global Air Navigation Plan (GANP) sets out a series of Aviation System Block Upgrades or technology modernisation projects focused on four performance improvement areas: airport operations; global interoperable systems and data; optimum capacity and flexible flights; and efficient flight paths. The initiatives reflect consensus around the series of technologies, procedures, and operational concepts needed to meet future capacity and ATM challenges. An analysis by ICAO found that if implemented Block 0 and 1 elements would deliver global fuel and CO_2 savings of between 1.6 – 3.0% in 2025. Governments must carry through implementation plans for this vital project.