WAYPOINT 2050

AN AIR TRANSPORT ACTION GROUP PROJECT

Balancing growth in connectivity with a comprehensive global air transport response to the climate emergency:
a vision of net-zero aviation by mid-century.

ATAG
AIR TRANSPORT ACTION GROUP

SUMMARY

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The air transport industry is the global network of commercial aircraft operators, airports, air navigation service providers and manufacturers of aircraft and their components. It is responsible for connecting the global economy, providing millions of jobs and making the modern, internationally-connected quality of life possible. The Air Transport Action Group (ATAG), based in Geneva, Switzerland, represents the full spectrum of this global business. ATAG brings the industry together to form a strategic perspective on commercial aviation's sustainable development and the role that air transport can play in supporting the sustainability of other sectors of the economy.

www.atag.org

WAYPOINT 2050 IS A COLLABORATION OF EXPERTS FROM ACROSS THE AVIATION SECTOR, LOOKING AT HOW THE INDUSTRY CAN ACCELERATE WORKING TOGETHER TO CONTRIBUTE TO THE WORLD'S CLIMATE ACTION MISSION. COLLABORATION IS NOT A NEW WAY OF DOING BUSINESS IN AVIATION: IT IS CENTRAL TO HOW THE SYSTEM FUNCTIONS. IN 2009, THE AIR TRANSPORT INDUSTRY SET ONE OF THE FIRST GLOBAL, SECTOR-WIDE, CLIMATE PLANS FOR ANY INDUSTRY.

In the decade since, airlines have spent over a trillion dollars on more efficient aircraft; the aerospace sector has spent over $150 billion on efficiency research and development; CO_2 emissions per seat kilometre have improved by 21.5%; ten new (and significantly more efficient) aircraft types have entered service (or are about to); over 365,000 flights have taken off on sustainable aviation fuel (which wasn't even certified until 2011); the world's first CO_2 standard for aircraft and the first carbon pricing mechanism for a single global sector were negotiated and adopted at the International Civil Aviation Organization (ICAO); and collaboration across the sector has driven efficiency improvements in air traffic management. It's been a busy ten years.

But while the industry is accustomed to working together, the race towards 2050 and beyond is going to require a considerable acceleration in efforts by partners working within the aviation sector and with other institutions, particularly governments.

Many countries and industry sectors are putting in place net-zero emissions goals for 2050, there are different speeds of decarbonisation underway in different parts of the world. The lack of readily-available solutions for aviation means that the sector falls into a category of 'hard to abate' parts of the economy.

Waypoint 2050 demonstrates, however, that there are potential options for the almost complete decarbonisation of air transport with the industry at a global level able to meet net-zero emissions by 2050, with offsetting through carbon removal taking account of residual emissions (some companies are working to reach this point sooner). This assumes the right level of support from governments, the finance sector, the energy industry and research institutions. The industry itself will need to redouble efforts as well.

There are a range of measures that can help drive aviation towards the technology, energy system and operational measures that are required to meet these ambitions. Many of these are incredibly challenging, but all are achievable with the right policy environment and the necessary focus of resources.

a) reviewing traffic forecasts

By 2050, it is expected that over 10 billion passengers will be carried by air some 22 trillion kilometres each year and, without any additional improvement in technology, fuels or improvements in operations, this activity would generate close to 2,000 megatonnes (Mt) of CO_2. Demographic shifts and population changes mean that the central forecast used in Waypoint 2050 suggests a slowing of growth when compared with recent years (even without the impact of Covid-19). Taking into account the impact of Covid-19 on longer-term growth trends, we can expect a compound annual growth rate of 3.1% from 2019 until 2050, mainly from Asia-Pacific, the Middle East, Latin America and Africa, although there remains significant growth in North America and Europe. Three factors: environmental concerns from consumers; governments moving to reduce growth; or a shift to other modes of transport (such as rail), are expected to have limited impact on the overall growth picture. Despite this, the sector must innovate and accelerate the energy transition to low (and, ultimately, zero) carbon fuel sources in order to ensure its continued licence to operate.

b) innovating with technology

Evolutionary technology will continue to be developed, bringing with it around a 20% improvement in fuel efficiency to each generation of aircraft. But in the next 30 years, the industry will likely see even more radical shifts. By 2050, it is expected that electric-, hybrid- and hydrogen-powered propulsion will have the potential to serve regional, short-haul and perhaps some medium-haul markets. Traditional liquid fuels are expected to remain necessary for long-haul aircraft and for the remaining short and medium haul aircraft that have not shifted to electric or hydrogen, but with a transition towards 100% sustainable and low carbon sources.

c) improvements in operations and infrastructure

These areas present a vital area of early action to help the pathway to 2050. A wide range of measures can be implemented by airlines, airports and air traffic management to reduce CO_2 from the operation, with collaboration playing a vital role. Importantly, continual improvements are needed to maintain (or enhance) existing operational efficiency and to ensure that increasing congestion does not degrade airspace efficiency.

d) deploying sustainable aviation fuel (SAF)

Perhaps the single largest opportunity to meet and go beyond the industry's 2050 goal is the rapid and worldwide scaling up of sustainable aviation fuel and new energy sources. It is likely that aviation will need between 330-445 million tonnes of SAF per annum by 2050. Analysis shows that this is achievable, with rigorous sustainability criteria ensuring a transition that does not impact food or water use. Rather than relying on a single option, there are a range of feedstocks available, from non-food

crops to waste sources and eventually a shift to power-to-liquid fuels made from recycled or directly-captured CO_2 and low-carbon electricity. The scale-up will be a significant challenge: up to $1.45 trillion worth of investment over the next 30 years will be required to develop this new energy system, although with the right support from government and the energy sector, it is far from insurmountable (annualised, it is the equivalent around 6% of typical oil and gas capital expenditure). Policy will play a core role in this shift – government support to channel feedstocks towards aviation and not to other transport sectors (where alternative energy sources are already available). It is estimated up to 14 million jobs could be created or sustained by this shift, creating new energy industries around the world: where 90% of fossil fuel oil comes from just 22 countries today, this new SAF path could open up opportunities in almost every country.

e) investing in out-of-sector carbon reduction market-based measures

Aviation will need to turn to carbon offsets in the near-term to stabilise CO_2 emissions as it works on long-term, permanent, in-sector reductions through the ramp-up in alternative energy and new technology. It is not envisioned that investing in out-of-sector carbon reduction should be the primary means of meeting long-term goals. Due to the long time horizons of fleet turnover and the global nature of the industry, it is expected that there could be a need to remove residual CO_2 emissions, even if aviation manages to meet almost all of its energy requirements from SAF, and progresses radical new technologies. But the types of 'offsets' available in 2050 will likely be different to those available today as demand from other sectors also grows. Forestry, natural carbon sinks and carbon removal opportunities may play a role in 2050 and beyond.

Waypoint 2050 explores three consolidated scenarios for how air transport can meet its goal. Which of these scenarios plays out over time will be determined by a number of decisions in the course of the coming decades, induding:

- How do we prioritise investment in both sustainable aviation fuel deployment and radical new technologies?
- Can energy providers massively scale up SAF and hydrogen production at the same time?
- Will governments, finance institutions and consumers play the role they need to accelerate the energy transitions?

Whilst the solution will likely be some combination of all the scenarios, the important lesson learnt from the work in this report is that it can be done. Aviation can achieve net zero emissions at a global level, by 2050. There is enough feedstock to produce the necessary SAF and hydrogen is a possibility for some aircraft. Efficiency will continue to improve and modern air transport will remain a key driver of connectivity, business and social connections across the world well after the middle of this century.

- *Due to the nature of technology developments, the energy transition and political realities constantly changing, it is envisioned that this report may also be subject to change as the outlook evolves.*

There is not just one pathway

In order to reduce the complexity of forecasting across a wide range of variables, this report has identified three specific scenarios. These are built on a range of sub-scenarios which are explored in the full Waypoint 2050 report and include:

a) Traffic growth forecasts.
b) Technology developments.
c) Operations and infrastructure improvements.
d) Sustainable aviation fuel.
e) The role of out-of-sector market-based mechanisms to fill any remaining gaps.

The central traffic growth projection used shows that, by 2050, over 10 billion passengers will fly each year a distance of 22 trillion revenue passenger kilometres. Without any intervention (keeping the current fleet and current level of operational efficiency), this activity would generate close to 2,000 megatonnes of CO_2 and require over 620 Mt of fuel.

The scenarios on the next pages outline how the industry would use technology, operations, infrastructure and sustainable aviation fuels to bring this down to net-zero CO_2 in 2050, and towards decarbonisation in the years afterwards.

Compatible with the Paris Agreement

Although the Paris Agreement does not establish sector-specific goals for addressing potential temperature rise, analysis shows that the aviation sector's 2050 goal to halve net CO_2 emissions on a 2005 baseline was in line with the Paris Agreement goal to limit global temperature rise to "well below 2°C above pre-industrial levels". A net-zero 2050 pathway will bring aviation in line with the 1.5°C stretch goal.

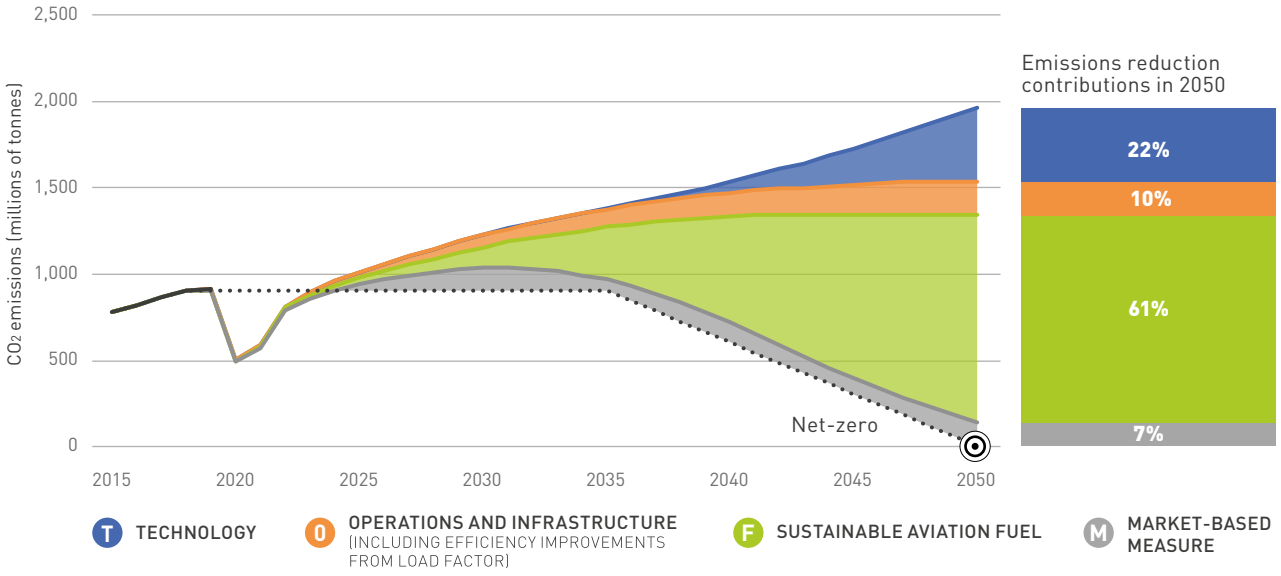
For hard-to-decarbonise sectors such as air transport, meeting the 1.5°C goal and keeping a small percentage of overall human emissions will be a major challenge. For aviation to play a role in helping to achieve the 1.5°C pathway, it is likely that global aviation would need to reach net-zero emissions in the middle years of the century. This is in line with the projected 2050 situation outlined in this report, finding that aviation could reach net-zero emissions by mid-century (with the right support from Governments and the energy sector, and removing residual CO_2 through offset options), but assumes all other sectors also make aggressive cuts in CO_2 emissions in line with their technical ability to do so.

The full report contains detailed forecasts across the range of scenarios explored by Waypoint 2050:
www.aviationbenefits.org/W2050

Scenario 1: pushing technology and operations

Under this scenario, technology improvements are prioritised and ambitious with the expectation of the emergence of unconventional airframes and a transition of the fleet towards hybrid/electric aircraft from 2035/40. Significant investments in operations and infrastructure improvements result in substantial improvements and CO_2 reductions. The gap between CO_2 emissions after technology and operations and infrastructure improvements and the 2050 carbon goal is fulfilled with the use of sustainable aviation fuels. This will require significant quantities of SAF with high emissions reduction factor over their lifecycle. Under this scenario, offsets will be needed to clear up any residual emissions in 2050 but may be required during 2035-2050 as a transition mechanism.

Traffic growth	C	Central scenario: 3.1% compound annual growth rate (CAGR) 2019-2050
Technology developments	T_4	Prioritised development of electric and hybrid electric aircraft in the short-range and <100 seat category with entry into service from 2035/2040 and further enhancements for larger aircraft.
Operations and infrastructure improvements	O_3	High-range improvements and airline load factor improvements
Sustainable aviation fuel	F_2	Backcast of what is required (around 1,200 Mt CO_2 reduction) to replace 90% of conventional jet fuel: 380 Mt (480 billion litres) of SAF with a 100% emissions reduction factor by 2050
Offsets (or other carbon mitigation options)	M_1	Around 135 million tonnes worth of offsets may be required to close the emissions gap to net-zero



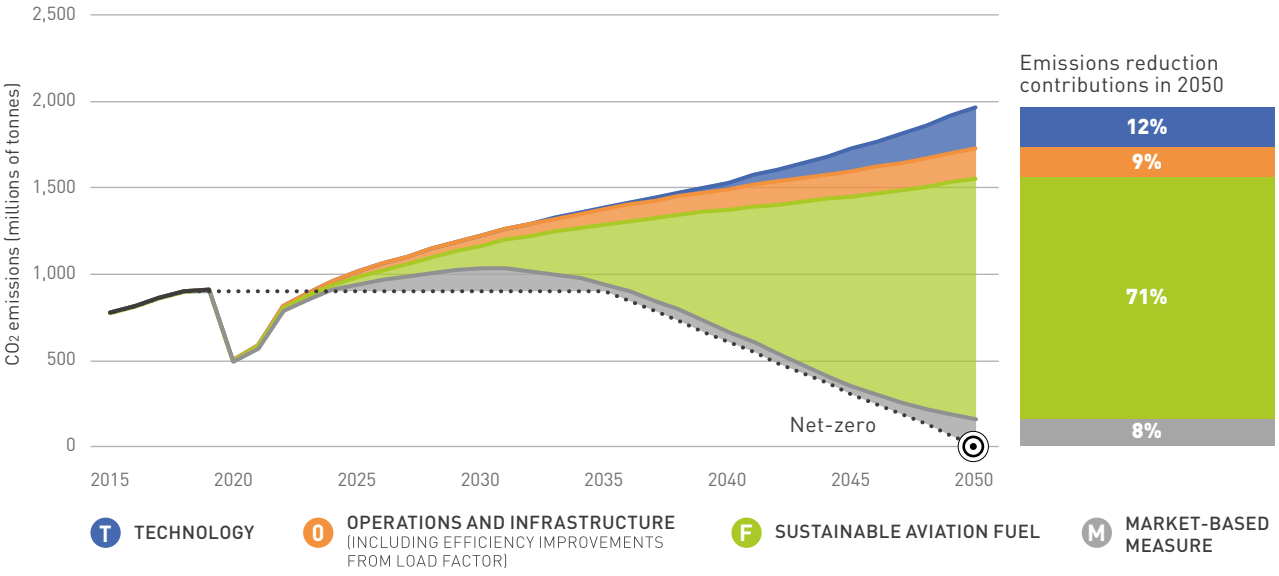
Comparison with industry -50% long-term goal set in 2009

In order to meet the industry long-term goal of -50% by 2050 compared to 2005 levels, Technology would contribute 26% of emissions reductions. Operations and infrastructure improvements 12%. A back-cast to meet the goal would require 320 Mt (400 billion litres) with a 100% emissions reduction factor by 2050 (62% of emissions reductions), or a mix of SAF and offsets in the form of carbon removals.

Scenario 2: aggressive sustainable fuel deployment

Under this scenario, technology improvements are ambitious with new aircraft configurations such as blended wing body options, although those are based on current powerplant and technologies (not a significant shift to electric or hybrid, with the industry prioritising investment in sustainable fuels). Despite mid traffic growth, investments in operations and infrastructure result in some net improvements and CO_2 reductions. The gap between CO_2 emissions after technology and operations and infrastructure improvements and the 2050 carbon goal is fulfilled with sustainable aviation fuels (requiring significant amounts of SAF with high emissions reduction factors). Under this scenario, offsets will be needed to clear up any residual emissions in 2050 but may be required during 2035-2050 as a transition mechanism.

Traffic growth	C	Central scenario: 3.1% CAGR 2020-2050
Technology developments	T_3	New airframe configurations with substantial aerodynamics performance such as blended wing body
Operations and infrastructure improvements	O_2	Mid-range improvements and airline load factor improvements
Sustainable aviation fuel	F_3	Backcast of what is required (around 1,400 Mt CO_2 reduction) to replace 90% of conventional fuel: 445 Mt (555 billion litres) of SAF with a 100% emissions reduction factor by 2050
Offsets (or other carbon mitigation options)	M_2	Around 155 million tonnes worth of offsets may be required to close the emissions gap to net-zero



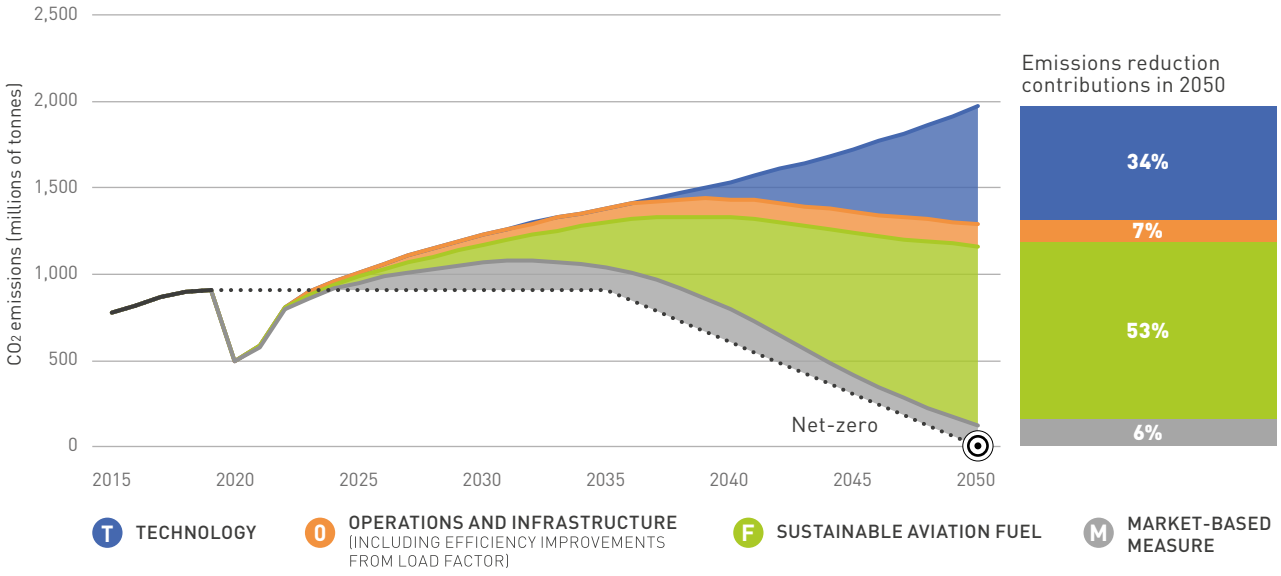
Comparison with industry -50% long-term goal set in 2009

In order to meet the industry long-term goal of -50% by 2050 compared to 2005 levels, Technology would contribute 14% of emissions reductions. Operations and infrastructure improvements 11%. A back-cast to meet the goal would require 390 Mt (490 billion litres) with a 100% emissions reduction factor by 2050 (75% of emissions reductions), or a mix of SAF and offsets in the form of carbon removals.

Scenario 3: aspirational and aggressive technology perspective

Under this scenario, technology improvements are very ambitious with electric aircraft up to 100-seat, zero-emissions aircraft (powered by green hydrogen) for the 100-200 seat segment and hybrid-electric powered unconventional aircraft configuration for larger aircraft. Despite a mid-level of traffic growth, investments in operations and infrastructure result in some net improvements and CO_2 reductions. The gap between CO_2 emissions after technology and operations and infrastructure improvements and the 2050 carbon goal is fulfilled with sustainable aviation fuels (requiring significant amounts of SAF with high emissions reduction factor (ERF)). Under this scenario, offsets will be needed to clear up any residual emissions in 2050 but may be required during 2035-2050 as a transition mechanism.

Traffic growth	C	Central scenario: 3.1% CAGR 2020-2050
Technology developments	T_5	Very aggressive acceleration of the introduction of electric, hybrid and zero-emissions (hydrogen) aircraft in the 2035-2040 timeframe
Operations and infrastructure improvements	O_2	Mid-range improvements and airline load factor improvements
Sustainable aviation fuel	F_4	Backcast of what is required (around 1,000 Mt of CO_2) to replace 90% of conventional fuel: 330 Mt (410 billion litres) of SAF with a 100% emissions reduction factor by 2050
Offsets (or other carbon mitigation options)	M_3	Around 115 million tonnes worth of offsets may be required to close the emissions gap to net-zero



Comparison with industry -50% long-term goal set in 2009
In order to meet the industry long-term goal of -50% by 2050 compared to 2005 levels, Technology would contribute 41% of emissions reductions. Operations and infrastructure improvements 8%. A back-cast to meet the goal would require 260 Mt (330 billion litres) with a 100% emissions reduction factor by 2050 (51% of emissions reductions), or a mix of SAF and offsets in the form of carbon removals.

CALLS TO ACTION AS PART OF A DECARBONISATION PATHWAY

A range of actions will be needed to help reduce emissions in line with the scenarios presented in Waypoint 2050. In each section of the report, action points for different stakeholder groups are explored in detail. Here is a summary of the broad areas of action.

Technology

- Significantly scale-up avenues for collaborative approaches – within industry, between industry and governments and with the research community and other stakeholders.

Aviation sector

- Accelerate research into radical airframe designs, electric and hydrogen propulsion.
- Form partnerships with non-aviation technology providers.
- Provide incubator opportunities for new green technology start-ups.
- Work to prepare for new energy requirements for electric and hydrogen aircraft.

Governments and policymakers

- Continue to fund research programmes where they exist, develop projects where they do not.
- Implement the ICAO CO_2 Standard.
- Develop wider energy strategy to, aside from deploying sustainable aviation fuel, include hydrogen and low-carbon electricity requirements of aviation.
- Prepare agencies for certification processes for next generation aircraft, including with unconventional airframe, materials and energy sources.

Research institutions

- Ensure research programmes for new technology reflect real-world requirements.
- Continue research in collaboration with industry into non-CO_2 effects of aviation.

Energy industry

- Plan strategic energy needs, including potential for aviation requirements for low-carbon electricity and low-carbon hydrogen.

Finance community

- Focus on funding new efficient aircraft acquisition and explore sustainable finance opportunities.

Other stakeholders

- Collaborate on synergies with automotive, battery and hydrogen sectors to encourage development of feed-in technology pathways for aviation.

Operations and Infrastructure

- Significantly scale-up avenues for collaborative approaches – within industry, between industry and governments and with the research community and other stakeholders.

Aviation sector

- Work in partnership to implement optimised flight profiles as air traffic volumes recover to pre-pandemic levels.
- Work towards full implementation of fixed electrical ground power, weight-based efficiency measures, continuous approach and departure, airport collaborative decision making, aerodynamic efficiency opportunities and assisted taxiing opportunities.
- Collaborate to speed up investigating, testing and certification of new efficiency measures.
- Encourage efficiency action throughout the system.
- Investigate new approach technologies and procedures at all applicable airports.
- Investigate opportunities for increased use of intermodality, including for connecting air passenger traffic and for passenger access to airports.

Governments and policymakers

- Make military airspace flexible use.
- Implement the ICAO Aviation System Block Upgrades.
- Encourage and fund, where viable, intermodal transport planning.

Research institutions

- Focus on operational procedure improvements for aviation system.

Energy industry

- Work in partnership with airports to ensure low carbon energy supply.

Finance community

- Fund infrastructure upgrades and developments to meet system efficiency needs.

Other stakeholders

- Pursue community and aviation system engagement on new procedures and techniques for air traffic management.

Sustainable aviation fuel

- Significantly scale-up avenues for collaborative approaches – within industry, between industry and governments and with the research community and other stakeholders.

Aviation sector

- All airlines should investigate sustainable aviation fuel opportunities – small or large. Start by doing a first test flight.
- Make substantial and bold SAF offtake agreements at an early stage.
- Make the case to governments and the finance community for SAF scale-up.
- Bring passengers and major customers on board with sustainable aviation fuel financing.

Governments and policymakers

- Foster a clean energy transition push across government, including for sustainable aviation fuel.
- Prioritise aviation (and other hard-to-abate sectors) as a user of alternative fuel.
- Explore potential for SAF development at a national or regional level.
- Support development of SAF industry, including attracting capital to expand SAF capacity through loan guarantee programmes (de-risking the early investment anxiety for new technologies), direct research and development activities for local SAF production pathways and new energy industries, committing to policy certainty.
- Demonstrate leadership with a commitment for government travel to be undertaken on SAF, adopt globally-recognised sustainability standards and work to harmonise global standards, encourage user-friendly sustainable aviation fuel accounting methods and work to harmonise global standards.

Research institutions

- Implement SAF research programmes into technology pathways, feedstock and emissions reduction factor improvements, production efficiency improvements.

Energy industry

- Demonstrate substantial commitment to sustainable aviation fuel production and scale-up.

Finance community

- Focus funding on SAF opportunities worldwide.

Other stakeholders

- Other transport modes should prioritise best available energy options.

Offsetting or out-of-sector carbon reductions

- Significantly scale-up avenues for collaborative approaches – within industry, between industry and governments and with the research community and other stakeholders.

Aviation sector

- Investigate partnership opportunities with future offset providers.

Governments and policymakers

- Support the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and ensure it continues to evolve.
- Set a long-term CO_2 goal through ICAO.
- Do not duplicate market mechanisms.
- Base any domestic measures on CORSIA principles.
- Work with fellow governments to conclude UNFCCC Article 6 discussions.
- Promote development of carbon capture and removal opportunities.

Research institutions

- Accelerate development of carbon capture and direct air capture efficiency.

Finance community

- Support development of carbon capture and direct air capture opportunities.

Other stakeholders

- Develop additional high-quality carbon credit products.

10 QUESTIONS

Q1

Can aviation meet net-zero CO_2 emissions by 2050?

Yes. But it will take an enormous effort by committed industry experts, governments, the finance sector and the research community to make it a reality. It will mean a rapid and massive transformation of aviation's 'drop-in' liquid energy supply using sustainable aviation fuel – from both traditional sources and new sources such as power-to-liquid – over the course of just 30 years. It will also require an acceleration in aircraft and engine technology development, including faster progress towards new types of propulsion: electric, hybrid and hydrogen powered aircraft. Net-zero will also likely require using carbon removals to deal with residual CO_2 emissions. It is possible, but it is going to be a significant challenge.

Q2

What is the difference between the industry climate goal announced in 2009 and this analysis?

In 2009, the aviation sector became one of the first industries to develop a climate action plan at a global level. The long-term goal was to halve aviation CO_2 emissions by 2050, compared to 2005. This was in line with the 'well below 2°C' goal outlined in the Paris Agreement. As scientific evidence has grown on the difference between that 2°C goal and a 1.5°C trajectory, it has become increasingly apparent that reaching net-zero emissions by mid-century across all sectors is vital to hold off the worst effects of climate change. Therefore, this new analysis details how global aviation could reach net-zero around 2050. It builds on analysis in the First Edition of Waypoint 2050 by increasing the deployment of sustainable aviation fuels and determining the residual CO_2 emissions which would need to be offset to reach net-zero. Reaching the sector's climate goal set in 2009 was shown to be a significant challenge, but achievable. Going beyond our 2009 climate goal by demonstrating increasing ambition for net-zero is an even greater challenge, but with the right support from governments and particularly the energy sector, it is also achievable.

Q3

Will aviation rely on offsets to meet its goals, or to shift to net-zero emissions?

The expectation is that offsets (or other forms of out-of-sector carbon reductions available in 2050) are not primarily relied on to meet the goal, although there will be some emissions that offsets can help mitigate and these will be needed to meet a net-zero 2050 goal. In the near term, high-quality offsets will be key to aviation meeting its climate obligations. In the long term, the removal of CO_2 from the atmosphere will be key, not just compensating for unavoidable emissions. Depending on the progress of technology development (both in carbon capture / direct air capture and for aviation technology and energy deployment), there may be an increased role to play for some form of market mechanism or offsetting as the sector transitions to wider use of new energies.

Q4

Will shifting to sustainable aviation fuels require large amounts of land, or impact food and water use?

No. Airlines have committed to ensuring a shift to sustainable aviation fuel will be done with fuels "which conserve an ecological balance by avoiding the depletion of natural resources". Analysis has shown that 100% of aviation fuel by mid-century can come from sustainable sources – including some (non-food or rotational) crops, waste sources and fuels made from low-carbon electricity and CO_2 removed from the air. Robust mechanisms need to be put in place to ensure the sustainability of these fuels – a global industry can also lead to pockets of less stringent regulation – but a full shift to sustainable sources is possible.

Q5

When will passengers be able to board electric or hydrogen aircraft?

Already, there are small commercial aircraft being test flown using retro-fitted electric engines. The mid-2020s may see up to 19-seat aircraft flying on new forms of energy. Scaling this up to regional and some short-haul aircraft will take the next 15-20 years, but passengers might be able to purchase tickets for electric, hybrid-electric or hydrogen flights around the 2035 timeframe. There is a lot of work still to be done. Battery technology is progressing quickly but needs to be accelerated to provide enough energy for the right size of aircraft over reasonable distances. Hydrogen is an increasingly viable option, but aircraft and engine systems need to be developed and storage must be progressed. And then the manufacturers must complete safety and operational certification in completely new types of technology, as well as sell these novel aircraft types to airlines. Importantly for both options: increased production and new distribution systems of low carbon electricity and green hydrogen are required to make them a reality.

Q6

Can we speed up the transition to fully sustainable aviation?

With enough money, anything can be sped up, but only as far as technology, materials and politics allow. At the same time as aviation is trying to decarbonise its energy system and develop radical new technologies, the rest of the world is also tasked with decarbonising other sectors in the economy. We believe the Waypoint 2050 scenarios presented here to be a realistic and still aspirational timeline for development. There is a good case for current fossil fuel subsidies around the world to be re-directed towards low-carbon energy which would help speed up the transition.

Q7

Will tickets cost more in future to pay for new technologies or new fuels?

It is likely that the cost of travel may increase, however this is not an easy question to answer, as airline ticket prices comprise a range of costs and the price to the public doesn't always reflect the underlying costs of things such as fuel or aircraft purchases. In addition, while the cost of sustainable aviation fuel may be higher than fossil fuel, it is unknown how much the cost of fossil fuel may evolve (particularly as other transport modes shift to electricity or hydrogen). Based on today's estimates, it is likely the cost of energy for aviation may be higher in the future, but this could also be partially offset by an increase in efficiency with new technologies and improvements in operational performance. What we do know is that aviation will continue to serve global connectivity in all parts of the world, even if tickets are more expensive in the future.

Q8

Is it not easier to simply reduce passenger growth?

Reducing passenger growth (either by reducing supply with fewer seats or reducing demand by increasing ticket taxes) will not necessarily reduce CO_2 emissions in the way many think and will inevitably restrict air travel for less wealthy citizens. The steps taken in this report and our recommendations will allow us to restrict the growth of CO_2 emissions, but not the connectivity, societal or economic benefits that come from air travel being available to people everywhere. The growth rates identified in this report are also at a lower level, generally, than aviation has experienced in the last decade, signifying a shift to slightly lower levels of growth (and that growth taking place mainly in emerging economies whose citizens should have the chance to enjoy economic prosperity experienced in more established parts of the world for years).

Q9

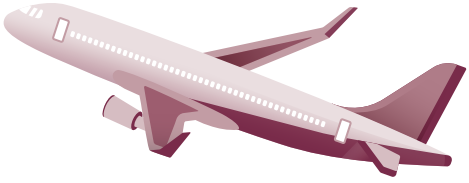
How has Covid-19 and the shutdown of air traffic impacted the analysis?

Aviation has never experienced an impact on the system as severe as the one caused by Covid-19 in 2020. The immediate hit on the industry is obvious, but there will likely be a very long-term reduction in growth projections as a result of the slow recovery. The central traffic forecast used for Waypoint 2050 has reduced by around 8% in 2050, compared with the pre-Covid forecast. However, despite the severe financial state of the sector over the next few years, commitment to climate action remains strong.

Q10

Some countries or regions have specific roadmaps for aviation climate action, how does this compare?

The Waypoint 2050 analysis is on a global basis and has tried to take into account the varying rates of decarbonisation and geopolitical environments in regions and countries around the world. Due to the nature of a global analysis, the timeframe and roadmap cannot be as precise as that for a specific country (or individual company), but the various technology and energy solutions should be aligned. ATAG encourages all parts of the industry to focus on how they can play a role in accelerating a decarbonisation pathway.



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