



BLUEPRINT FOR A GREEN RECOVERY

A sustainable growth plan for building global connectivity following the worst crisis in aviation history.



SEPTEMBER
2020

A RE-START LIKE NO OTHER

The effect of the 2020 Covid-19 pandemic on the global air transport sector has been stark. At the peak of the shutdown, traffic was down 94% compared with the same period in 2019.

Around two thirds of the world's commercial aircraft were parked or in storage and passengers – business travellers, friends and family and tourists supporting many global economies – were left stranded as governments placed rapid travel restrictions in every part of the globe.

The immediate impact is well known across economies and millions of lives. But the long-term effects of the response to this pandemic, unprecedented in aviation history, are only just becoming clear. It is going to take at least four years for traffic to return to pre-Covid levels. Millions of jobs in aviation will be lost, alongside up to 46 million jobs throughout the rest of the economy that air transport supports. The perilous drop in traffic in 2020 will result in a reduction in traffic forecasts of up to 16% in 2050 – this period is going to have a very long tail.

There have been some silver linings in the dark clouds of the pandemic. A renewed appreciation for clear skies in many parts of the world, clear lakes and seas in others. A reminder of the fact that we can do things better. It has come at a terrible human cost, but like many of the world's citizens, we are looking at the opportunity that the re-start of the economy could provide. How can we continue to connect the peoples and economies of the world, long into the future, but with a much lower footprint? What can we do better?

Aviation has had a long-term climate change plan in place for the last decade and with the publication of the ATAG Waypoint 2050 report this year, the sector has identified several pathways it could take to meet the sector-wide plan to

reduce net CO₂ emissions by 50% in 2050. With the support of governments and the research community, aviation at a global level would be in a position to reach net zero CO₂ emissions around a decade later. Some regions and individual companies should be able to get to net zero earlier than this.

The re-start of aviation is an opportunity to build back the global connectivity and economic benefits air transport provides in a way that sets the industry on a course for decarbonisation. The next decade will be crucial:

- » for government support of the rapid scaling up of new types of fuel so aviation can make an energy transition away from fossil fuels
- » for development of radical new technologies such as electric, hybrid, hydrogen aircraft, as well as radical changes in airframe architecture
- » for collaboration that builds on the already cooperative nature of air transport, but brings in governments, researchers and other sectors
- » to ensure that aviation, along with the rest of the economy, can live up to the Paris Agreement spirit of global cooperation to avoid the worst effects of climate change.

Despite the immense challenges of 2020 and the year or two ahead, the industry is united in ambition and innovation for a green recovery.



IN A NORMAL YEAR...

87.7 million

Jobs supported by aviation worldwide.

\$3.5 trillion

Aviation's global economic impact (including direct, indirect, induced and tourism catalytic).

4.1%

Global GDP supported by aviation.

35%

Air transport carries around 35% of world trade by value and less than 1% by volume.

\$6.5 trillion

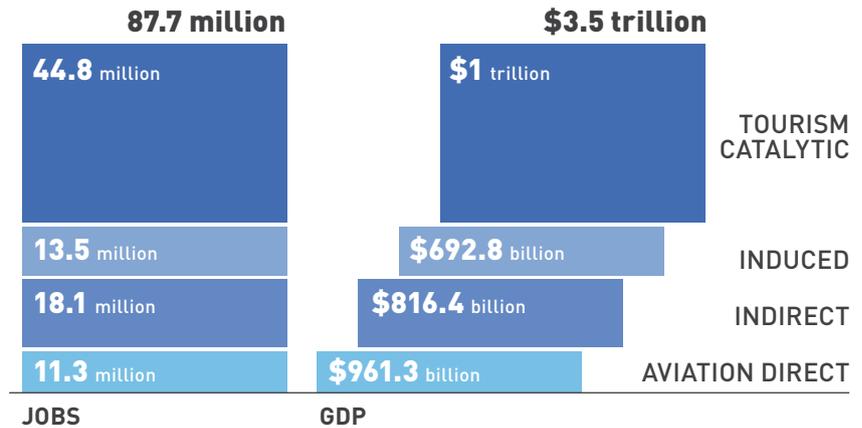
Value of cargo handled by air.

58%

Percentage of international tourists who travel by air.

Beyond the industry

Aviation's global employment and GDP impact



Direct aviation jobs

648,000
Airport operators
 (operations, planning, engineering, security)

5.5 million
Other on-airport (retail, car rental, government agencies such as customs and immigration, freight forwarders, some catering)

3.6 million
Airlines (flight and cabin crews, executives, ground services, check-in, training and maintenance staff)

1.3 million
Civil aerospace (engineers and designers of civil aircraft, engines and components)

237,000
Air navigation service providers (air traffic controllers, engineers, executives)

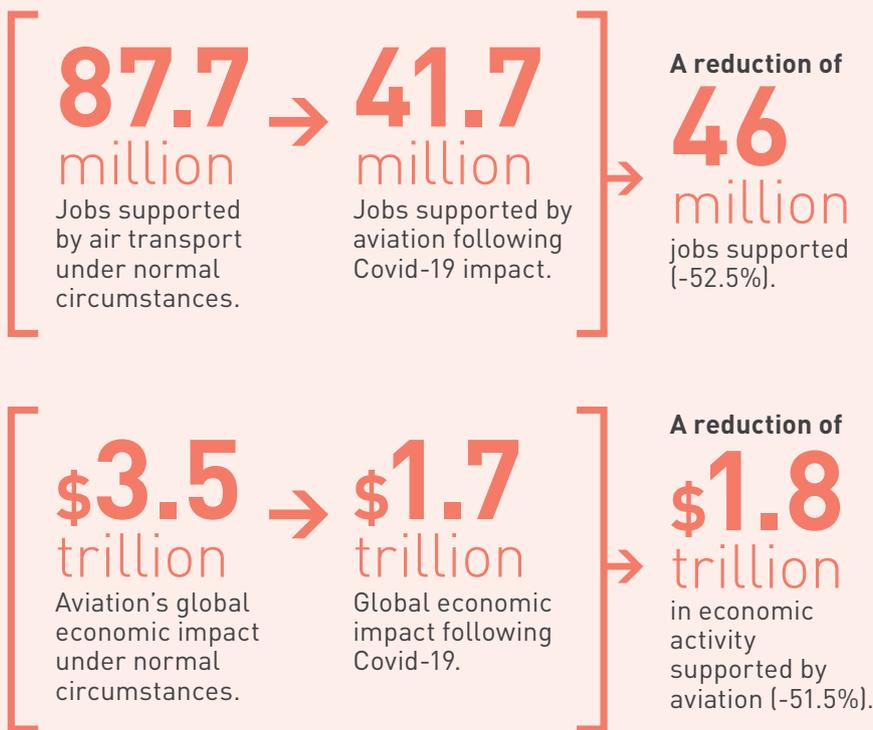
For references to the facts and analysis contained in this summary document, please refer to the ATAG Aviation: Benefits Beyond Borders 2020 and Waypoint 2050 reports available on www.aviationbenefits.org

Region	Jobs supported	GDP supported	Passengers (2019)	% of global passengers
AFRICA	7.7 m	\$63 bn	115 m	2.5%
ASIA-PACIFIC	46.7 m	\$944 bn	1.7 bn	37%
EUROPE	13.5 m	\$991 bn	1.2 bn	26%
LATIN AMERICA AND THE CARIBBEAN	7.6 m	\$187 bn	356 m	7.7%
MIDDLE EAST	3.3 m	\$213 bn	192 m	4.2%
NORTH AMERICA	8.8 m	\$1.1 trn	1 bn	22.7%

COVID-19 IMPACT ON AIR TRANSPORT

Aside from the massive drop in traffic, the shutdown due to the Covid-19 pandemic is going to have longer-term and significant impacts on air transport and the wider economy.

The actual job losses may be either more or less severe; firms can and often do take short term losses, cut wages, and reduce dividend payments to retain employees during difficult periods, and this would lessen the number of jobs lost relative to those that are at risk due to muted business activity.



4.8 million

Direct aviation jobs may be lost due to Covid-19 impact (a 43% reduction from pre-Covid levels):

- **1.3 million** at airlines (-36% compared with pre-Covid)
- **220,000** at airport operators (-34%)
- **3.2 million** other on-airport (-55%)
- **151,000** in civil aerospace (-11%)

56.7%

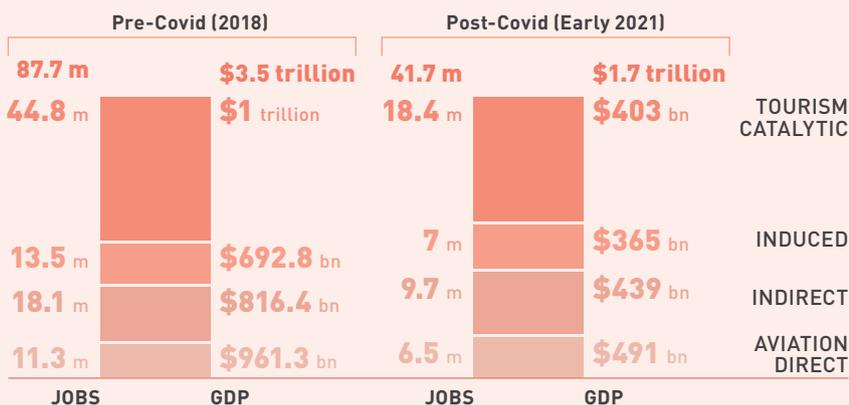
Drop in airport revenues predicted for 2020, reaching a year-on-year peak of 90% globally in the second quarter of 2020 (the hardest hit region is Europe losing close to \$37 billion in revenue).

50%

Drop in revenue for airlines expected for 2020: around \$419 billion, for total losses of \$84.3 billion by the world's airlines.

The impact of Covid-19

Jobs in aviation, throughout the supply chain and in the wider economy will be impacted by Covid-19⁴.



↓ **94.4%**

Drop in passenger traffic April 2020 vs April 2019. This includes a 98.9% drop in international passengers and a 90.7% drop in domestic.

64%

Proportion of the global fleet in storage at the height of the crisis in April.

2.2 billion

Expected number of passengers in 2020, down from 4.5 billion in 2019.

57.6%

Airline load factor in June 2020, down from 84.4% in June 2019.

Impact of Covid-19 on aviation's climate action plan:

- » The severe shutdown in traffic in 2020 has reset the baseline for growth of aviation out until 2050, with an expected 16% reduction in forecast traffic in 2050 compared with the pre-Covid forecasts.
- » The shutdown in aviation and financial crisis for airlines has accelerated older aircraft retirements, so we are likely to see an increase in fleet efficiency. However, this bonus may be offset by a reduction in airlines being able to purchase new model aircraft as they build back their businesses. It is not certain what the outcome will be, but will likely not impact the 2030-2050+ efficiency improvements.
- » The technology and innovation investment environment may be challenging for airlines and aircraft manufacturers for the coming years.
- » However, the industry remains committed to its climate action plan and is looking for ways to work with governments and other stakeholder to accelerate opportunities.



Air transport was not only impacted by Covid-19, it also responded to the needs of countries and citizens across the world:



39,200

Special repatriation flights by airlines transported nearly **5.4 million citizens** to their homes after borders were closed around the world in March 2020.

46,400

Special cargo flights transported some **1.5 million tonnes** of cargo, mostly medical equipment, to areas in need during the height of the pandemic response.

254,500

Free tickets made available to medical staff to allow transfer of resources between hospitals.

WAYPOINT 2050

Waypoints are neither the start nor the end of a journey, but a guide to where a flight needs to go. The industry has taken this philosophy to acknowledge that 2050 is not a destination, but a marker on a path towards zero carbon emissions from air transport.

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; CO₂ 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 270,000 flights have taken off on sustainable aviation fuel (which wasn't even certified until 2011); the world's first CO₂ 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 has 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.

Air transport has committed to cutting its net CO₂ emissions to half of what they were in 2005, by 2050 (which would result in a total of 325 million tonnes of CO₂ in 2050). Whilst many countries are putting in place net-zero emissions goals for 2050, there are different speeds of decarbonisation underway in different parts of the world; and the lack of readily-available solutions for aviation means that the sector falls into a category of 'hard to abate' parts of the economy.

The ATAG Waypoint 2050 analysis 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 a decade or so after 2050 (and some regions and companies able 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.

In order to reduce the complexity of forecasting across a wide range of variables, Waypoint 2050 has identified three specific scenarios that meet the sector's 2050 goal. These are built on a range of sub-scenarios covering traffic growth forecasts, technology developments, operations and infrastructure improvements, sustainable aviation fuel, and the role of offsets to fill any remaining gaps.

The scenarios outline how the industry would use technology, operations, infrastructure and sustainable aviation fuels to bring this down, meeting the industry goal by 2050 and going beyond it in the years following. The baseline (scenario 0) is a continuation of the current efficiency trends across all pillars of action, with no acceleration of improvements.

a) reviewing traffic forecasts

By 2050, it is expected that over 10 billion passengers will be carried by air some 20 trillion kilometres each year and, without any additional improvement in technology, fuels or improvements in operations, this activity would generate some 1,800 megatonnes (Mt) of CO₂. 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% 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 possible limits to growth: 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 them 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- and hydrogen-powered propulsion have the potential to serve regional, short-haul and perhaps 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 to 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 CO₂ from the operation, with collaboration playing a vital role. Importantly, increasing congestion can degrade airspace efficiency, so continual improvements are needed to maintain (or enhance) existing operational 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 around 450-500 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 CO₂ and low-carbon electricity. The scale-up will be a significant challenge, although with the right support from government and the energy sector, it is far from insurmountable. 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).

e) investing in out-of-sector carbon reduction measures (offsetting)

Aviation will need to turn to carbon offsets in the medium-term to stabilise CO₂ 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 CO₂ emissions, even if aviation manages to meet 100% of its energy requirements from SAF, and progresses radical new technologies. But the types of 'offsets' available in 2050 will likely be restricted as demand from other sectors also grows. Forestry, natural carbon sinks and carbon removal opportunities may play a role in 2050 and beyond.

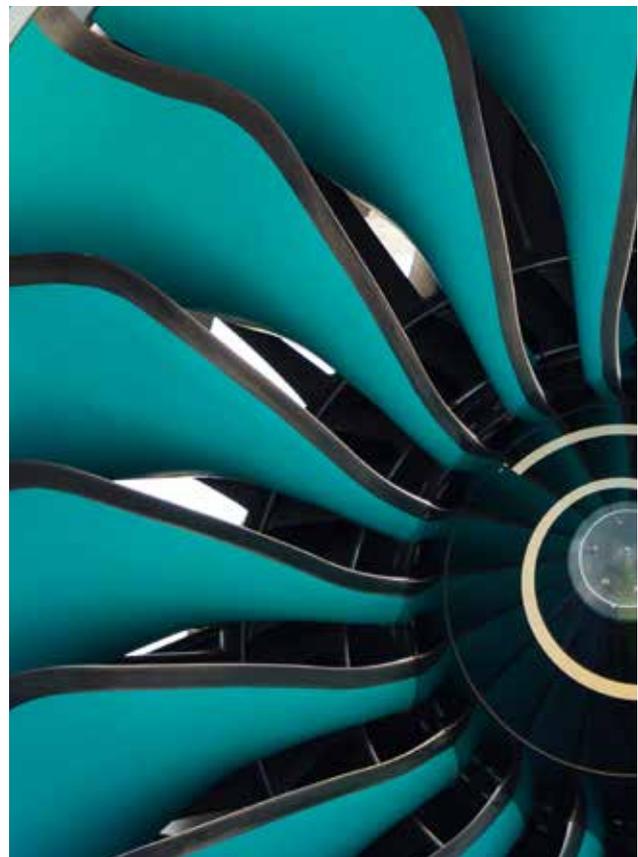
Waypoint 2050 explores three consolidated scenarios for how air transport can meet its goal. Which of these scenarios plays out over time will be determined by a number of decisions in the course of the coming decades, including:

- » 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 meet its ambitious -50% climate goal in 2050 and pursue net-zero emissions by 2060/65 at a global level, with some parts of the world hitting that point earlier. There is enough feedstock to produce the necessary SAF and hydrogen is a realistic 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 2050.

The different scenarios are explored in the ATAG Waypoint 2050 report:

www.aviationbenefits.org/W2050



10 QUESTIONS

Detailing the future — uncertain at the best of times — always throws up many questions. Here are 10 of the most important questions Waypoint 2050 attempts to answer:

Q1

Can aviation meet its climate goal in 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 current 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. It is possible, but it is going to be a significant challenge.

Q2

Is net-zero emissions possible in aviation?

Yes. Based on aggressive scenarios developed for Waypoint 2050 and a shift to low carbon energy with some use of 'offsets', net-zero emissions from aviation will likely be possible worldwide sometime in the decade or so after 2050 (with some regions able to move faster towards this point). But in order to meet this goal, collaborative action across the ecosystem (governments, research, finance, energy sector and aviation itself) will be needed. Unlike most other sectors, aviation does not yet have readily available solutions. But aviation also has a strong track record of innovation and collaborative action which makes it a strong candidate for achieving such a monumental shift.

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 inevitably be some emissions that offsets can help mitigate. 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. In the long term, the removal of CO₂ from the atmosphere will be key, not just compensating for unavoidable emissions.

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 in 2050 can come from sustainable sources – including some (non-food or rotational) crops, waste sources and fuels made from renewable electricity and CO₂ 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?

Sooner than may be expected! Already, there are small commercial aircraft being test flown using retro-fitted electric engines. Scaling this up to regional and 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

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 16% in 2050, compared with the pre-Covid forecast. However, despite the severe financial state of the sector over the next five years, commitment to climate action remains strong.

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 CO₂ 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 CO₂ 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

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

This is not an easy question to answer, as airline ticket prices comprise a range of costs and the price to the public does not 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 a little more expensive in the future.

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 speeds 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.

WHAT NEEDS TO BE DONE?

As with all complex issues, a coordinated approach will be needed to ensure success. This is not just an action area for the industry, but for governments and other stakeholders. Summary of the main action items:

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 ICAO CO₂ Standard.
- Prepare agencies for certification processes for next generation aircraft, including with unconventional airframe, materials and energy sources.
- Develop wider energy strategy to, aside from deploying sustainable aviation fuel, include hydrogen and low-carbon electricity requirements of aviation.

Research institutions

- Ensure research programmes for new technology reflect real-world requirements
- Continue research in collaboration with industry into non-CO₂ 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 re-build air traffic volumes based on perfect flight principles
- 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 the aviation system.

Energy industry

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

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

- Provoke 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

- 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 CORSIA and ensure it continues to evolve.
- Set a long-term CO₂ target 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 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 carbon credit products.

These action items are explored in much greater detail in the Waypoint 2050 report:

www.aviationbenefits.org/W2050

