HIGH-LEVEL MEETING ON THE FEASIBILITY OF A LONG-TERM ASPIRATIONAL GOAL FOR INTERNATIONAL AVIATION CO_2 EMISSIONS REDUCTIONS (HLM-LTAG)

Montréal, 19 to 22 July 2022

Agenda Item 1: CO_2 emissions reduction scenarios and options for a long-term global aspirational goal for international aviation

THE COST OF ACHIEVING NET-ZERO CARBON IN AVIATION

(Presented by Air Transport Action Group)

1. INTRODUCTION

1.1 Any discussion on decarbonisation of the economy or a single sector inevitably raises the question on the associated costs and affordability without risking the growth or survival of the industry. This information paper presents the findings of macro-level analysis undertaken to place in context the potential costs of pursing a net-zero carbon strategy for air transport.

1.2 It is challenging to do an accurate assessment of the full cost of any long-term climate goal for the air transport sector. It relies on a range of forecasts and assumptions, building on top of other forecasts and assumptions as well as elements that are simply not known today. Because they are spread over almost 30 years and cover an entire sector, these estimates can run into the trillions of dollars. However, they need to be placed in context of the costs and investments required to run an entire sector such as the global aviation industry over several decades.

1.3 This paper attempts to place these numbers in a historical, current and future cost context, to reassure that although the cost of the transition appears substantial in absolute terms, it is manageable by a global industry such as aviation.

2. SUMMARY OF KEY POINTS

2.1 When looking across a global industry and over a multi-decade time horizon, the total costs can look quite large, but this should be taken into context with costs of inaction and typical industry costs.

2.2 Cost of inaction: Even if the industry does not pursue a net-zero pathway (with associated increase in energy costs through shifting to SAF), there will likely be increases in costs based on the lack of long-term action: higher capital financing costs; carbon costs associated with a patchwork of climate policy measures; higher insurance and adaptation costs of inaction related to climate change. In this scenario, growth is also likely to be constrained and the industry may also face reduced demand through passengers and corporate customers deciding to reduce air travel or forgo travel based on climate concerns, meaning these costs would be borne by a smaller customer base. These factors could all potentially lead to an increase in costs and air fares.

2.3 In the last 30 years, airlines have spent 4.3 trillion US dollars on fuel. In the last decade, airlines have spent 1 trillion US dollars on new aircraft. Industry is spending 15 billion US dollars a year for research and development. All those costs are broadly in line with the projected costs according to the ATAG *Waypoint 2050* report and the ICAO LTAG report.

2.3.1 Capital expenditure on SAF production facilities are estimated at up to $1.45 trillion over 30 years ($48bn a year average). Typical worldwide capital expenditure on all oil and gas production for the eight years 2014-2021 was $3.3 trillion ($420bn / year average).

2.3.2 Sustainable aviation fuels will make up most of the incremental costs to getting to net-zero by 2050. However, SAF from most next-generation sources will reduce in price as economies of scale are exploited. In fact, based on the ICAO LTAG study, the current high oil price ($1,240 per tonne) is cost-competitive with today's SAF sources.

2.3.3 The assumptions on price of SAF over time are based on a scenario where maximum policy support for SAF scale-up is provided by governments. Without these levers, SAF will be significantly more expensive and less available.

2.3.4 The cost of developing new aircraft technology to reach net-zero may range from $180 billion to $350 billion over 30 years ($6-11bn a year on average). This is comparable with current aerospace annual expenditure on efficiency research (around $15bn a year average).

2.4 Whilst airline expenditures to meet net-zero may increase compared to not meeting a long-term climate goal, this may not have a significant impact on air fares at a global average level, assuming historic decreases in air fares continue resulting from a range of factors including declining non-fuel costs and the liberalisation of air traffic.

2.5 In some parts of the world, particularly mature markets with already low fares, air fares may rise slightly to accommodate the cost of shifting to SAF. However, in many emerging markets there is room for non-energy cost related air fare reductions which may offset increases in underlying energy costs.

2.6 The potential increase in overall operating expenses for the industry will likely rise at a lower rate than traffic growth, meaning that costs will be spread over larger numbers of passengers and cargo shippers. However, this outcome is predicated on the availability of maximum policy support for SAF, development of advanced aircraft and engine technologies and increasing efficiency of air traffic control systems globally.

3. FURTHER INFORMATION

3.1 Member States are invited to review the Appendix to this IP for the full analysis.

4. CONCLUSION

4.1 Meeting aviation's climate goals will require collaborative action by all parties. It will also cost both governments and industry. However, given the scope of the challenge (across multiple decades, a growing and global industry) and the potential costs of inaction, the industry believes the costs are manageable and will enable continued growth and connectivity whilst also dealing with climate impacts.

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APPENDIX

FACT SHEET #15 / JUNE 2022

WHAT WILL IT COST TO GET TO NET-ZERO CARBON FOR GLOBAL AVIATION?

FACT SHEET #15 / JUNE 2022

WAYPOINT **2050**

WHAT WILL IT COST TO GET TO NET-ZERO CARBON FOR GLOBAL AVIATION?

Any discussion on decarbonisation of the economy, or a single sector such as aviation will inevitably raise the question: how much will this cost, and can we afford to do it without risking the growth or survival of the industry?

Summary of key points

- It is challenging to undertake an accurate assessment of costs of transition to net-zero over the next 30 years.
- When looking across a global industry and over a multi-decade time horizon, the total costs can look quite large, but this should be taken into context with typical industry costs.
- Capital expenditure on SAF production facilities estimated at up to $1.45 trillion over 30 years ($48bn a year average). Typical worldwide capital expenditure on all oil and gas production for the eight years 2014-2021 was $3.3 trillion ($420bn / year average).
- Sustainable aviation fuels will make up most of the incremental costs to getting to net-zero. However, SAF from most next-generation sources will reduce in price as economies of scale are exploited. In fact, based on the ICAO LTAG study, the current high oil price ($1,240 per tonne) is cost-competitive with today's SAF sources.
- The assumptions on price of SAF over time are based on a scenario where maximum policy support for SAF scale-up is provided by governments. Without these levers, SAF will be significantly more expensive and less available.
- The cost of developing new aircraft technology to reach net-zero may range from $180 billion to $350 billion over 30 years ($6-11bn a year on average). This is comparable with current aerospace annual expenditure on efficiency research (around $15bn a year average).
- Whilst airline expenditures to meet net-zero may increase compared to not meeting a long-term climate goal, this may not have a significant impact on air fares at a global average level, assuming historic decreases in air fares continue resulting from a range of factors including declining non-fuel costs and the liberalisation of air traffic.
- In some parts of the world, particularly mature markets with already low fares, air fares may rise slightly to accommodate the cost of shifting to SAF. However, in many emerging markets there is room for non-energy cost related air fare reductions which could offset the increase in underlying energy costs.
- The potential increase in overall operating expenses for the industry will likely rise at a lower rate than traffic growth, meaning that costs will be spread over larger numbers of passengers and cargo shippers. However, this outcome is predicated on the availability of maximum policy support for SAF, development of advanced aircraft and engine technologies and increasing efficiency of air traffic control systems globally.
- Even if the industry does not pursue a net-zero pathway (with associated increase in energy costs through shifting to SAF), there will likely be increases in costs based on the lack of long-term action: higher capital financing costs; carbon costs associated with a patchwork of climate policy measures; higher insurance and adaptation costs of inaction related to climate change. In this scenario, growth is also likely to be constrained and the industry may also face reduced demand through passengers and corporate customers deciding to reduce air travel or forgo travel based on climate concerns, meaning these costs would be borne by a smaller customer base. These factors could all potentially lead to an increase in air fares.

It is challenging to do an accurate assessment of the full cost of any long-term climate goal for the air transport sector. It relies on a range of forecasts and assumptions, building on top of other forecasts and assumptions as well as elements we simply don't know today:

- Forecasting the price of oil is challenging enough in the near-term, let alone 30 years out.
- The cost of carbon removal technology is high today when it is used in a small number of test plants.
- Similarly, today's cost of sustainable aviation fuel is higher than jet fuel, but is expected to come down as volumes increase.
- The production and operating costs of aircraft that don't exist yet: such as hydrogen options.

Several expert pieces of analysis have attempted to provide an order of magnitude to the cost associated with CO_2 emissions reductions pathways. The table below shows the cost or investment estimates from the *Waypoint 2050*[1] and *ICAO CAEP LTAG-TG* reports. These costs and investments apply to different categories of stakeholders and are not to be added together as some investments by some stakeholders (such as fuel suppliers) are passed on to customers (aircraft operators) through prices.

Because they are spread over almost 30 years and cover an entire sector, these estimates can run into the trillions of dollars. However, they need to be placed in context of the costs and investments required to run an entire sector such as the global aviation industry over several decades.

This paper attempts to place these numbers in a historical, current and future cost context, to reassure that although the cost of the transition appears substantial in absolute terms, it is manageable by a global industry such as aviation.

Waypoint 2050 can be found: **www.aviationbenefits.org/W2050**

High-level comparison of *Waypoint 2050* and *ICAO LTAG* approaches

	Waypoint 2050	**ICAO CAEP LTAG-TG**
Geographical coverage	✓ International traffic ✓ Domestic traffic	✓ International traffic × Domestic traffic
Cost to aircraft operators	Up to $5.3 trillion 2020-2050 (S2)	Up to $4 trillion 2020-2050 (IS3***)
Annual average* 2020-2050	$170 billion	$130 billion
What this includes	» Incremental costs from SAF (with 90% replacement of fossil jet fuel by SAF) and costs from offsets (or other carbon mitigation / out-of-sector options)	» Incremental costs from SAF, operations and aircraft technology (overall costs largely driven by SAF with 100% replacement of conventional jet fuel by SAF).
Investment by suppliers *(i.e., OEMs and fuel suppliers)*	Up to $1.45 trillion (2020-2050)	Up to $3.6 trillion 2020-2050 (IS3)
What this includes	» Capital expenditure on SAF production facilities	» OEM non-recurring costs (new aircraft programme investments) » Energy industry capital expenditure for production of LCAF, SAF, and hydrogen.
Annual average 2020-2050**	≈ $50 billion	$120 billion
Other costs or investments	» OEM non-recurring costs (new aircraft programme investments) » Government research and development investments » Airport related investments (operations and hydrogen infrastructure) » Implementation costs for ANSP operational measures	» Government research and development investments » Airport related investments (operations and hydrogen infrastructure) » Implementation costs for ANSP operational measures » Any out-of-sector measure to close the gap to a goal was not considered or included in the LTAG analysis
Notes	**Average costs per annum will be lower in early years and higher in later years as traffic (and fuel use) increases.* *** Investments expected to be needed in near-/mid-term to build capacity to produce aircraft, fuels, etc in later years.* **** LTAG Integrated Scenario 3 is most comparable with Waypoint 2050 scenarios that explore extensive emissions reductions measures, especially replacement of fossil fuels with sustainable aviation fuels, low carbon fuels and hydrogen.*	

Comparing the numbers – how do these figures compare with other costs associated with air transport?

Whenever you look out at 30 years of economic activity, especially across a global industry such as aviation, the cost of action tends to appear very high. Tackling climate change will be no exception. We are not used to dealing with trillions of dollars in our daily lives and it can appear daunting. The cost of decarbonisation will be significant, but not disproportionate for a sector of the size and economic value of aviation. In other words, what seem like daunting costs when viewed in isolation are actually manageable given the enormous economic value generated by the sector over decades.

Airlines have spent

$1 trillion

on new aircraft in the last decade

Airlines have spent

$4.3 trillion

on fuel in the last 30 years

Global airline operating expenses over the last 30 years (1990-2019):

$19.3 trillion

(or an average of $670 billion per year)

Annual spend on efficiency research and development by aerospace:

$15 billion

(up to $450 billion over 30 years)

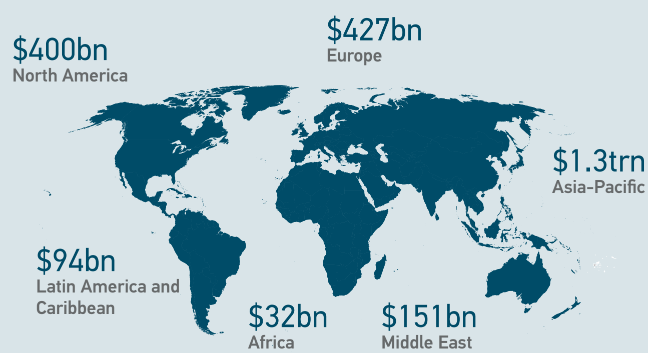
ACI estimates that global airports will need over

$2.4 trillion

in capital expenditure over the next 20 years: for capacity and routine upgrades[14]

Airport capital expenditure needs

2021-2040 total needed capex by region



The next 20 years will require **$2.4 trillion** in airport capex worldwide.

Capital will be needed for SAF build-up, but how does this compare to typical capex in energy?

The *ICAO LTAG Report* and ATAG's *Waypoint 2050* both identify the energy question as the most important portion of the cost of decarbonisation. Although there is a price premium for the purchase of SAF, this is likely to come down over time.

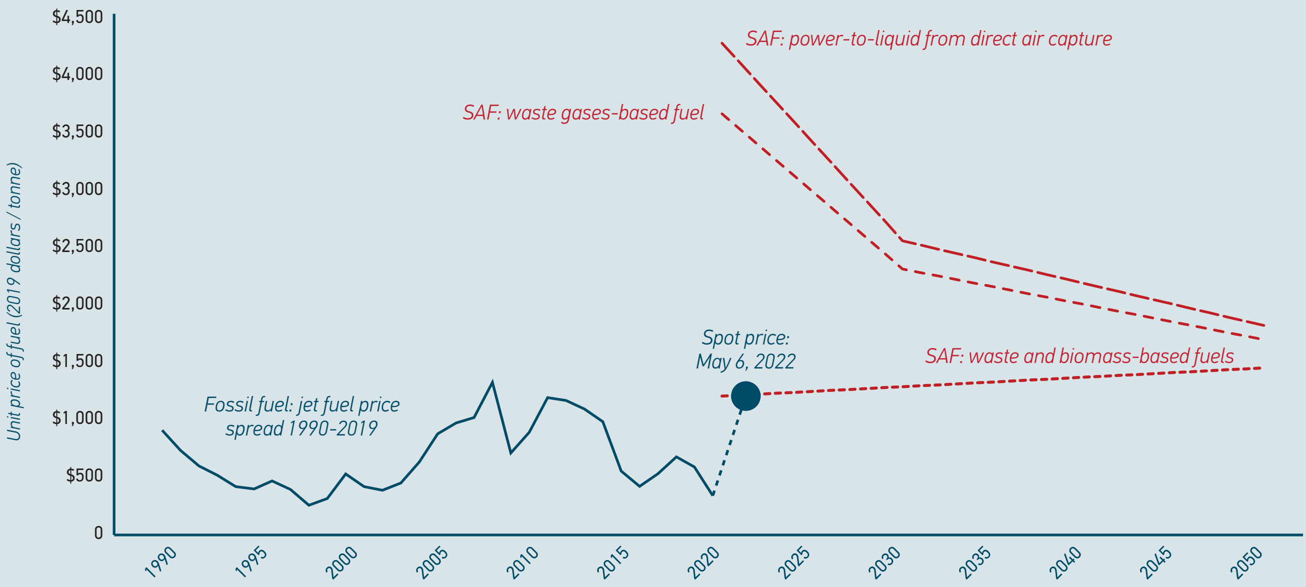
There will be a need for significant capital and investment in new SAF production facilities, but whilst the scale of the challenge is impressive, it is not insurmountable. Indeed, the earlier the process begins, the less steep the investment will need to be in the years leading up to 2050. The shift away from fossil fuel and towards sustainable aviation fuel will also generate green energy industry opportunities in many new parts of the world, can deal with waste issues in some instances, and will generate or sustain up to 14 million jobs worldwide[1].

From 1990 to 2019, the global aviation sector has experienced average annual jet fuel prices that fluctuated from $275 per tonne (1998) to $1,330 per tonne (2008). As of May 6, 2022, the unit price of jet fuel was $1,240 per tonne (in 2019 dollars)[3].

Based on ICAO/CAEP projections and scenarios[4], the unit price of sustainable aviation fuels derived from waste and biomass may range from ≈$1,220 per tonne in 2020 to ≈$1,460 by 2050. Waste gases-based fuels prices could start at ≈$3,650 per tonne in 2020 and decline to ≈$1,700 by 2050. Finally, the unit price of power-to-liquid fuels derived from atmospheric CO_2 could start at ≈$4,250 per tonne in 2020 and decline to ≈$1,280 by 2050. These unit price projections from the LTAG report have been used in the following analysis.

Unit fuel costs across categories of fuel

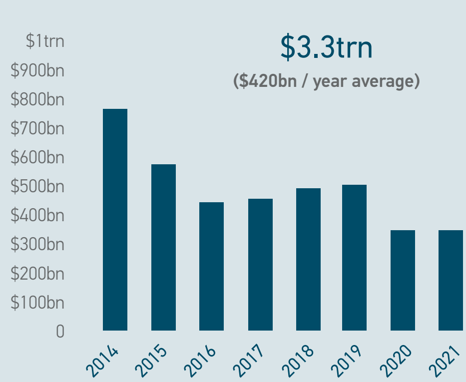
At today's high fossil fuel prices, some SAF is at parity. With the addition of carbon pricing in the future, SAF will not be prohibitively expensive



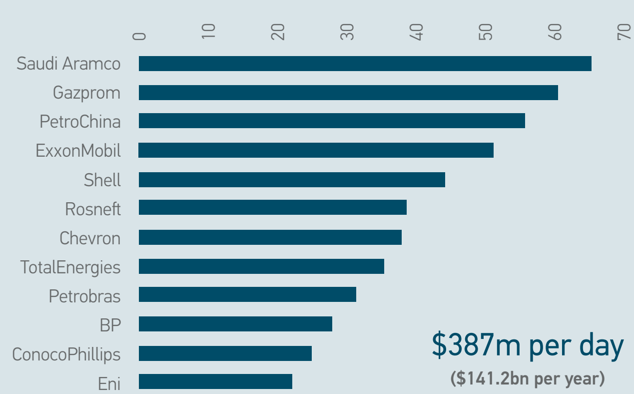
- Annual average oil and gas capital expenditure forecast 2021-2030 (for top 12 companies only, not just aviation-related): $141.2bn
- Annual average total oil and gas capital expenditure 2014-2021 (not just aviation): $420bn[2]
- Annual average capital expenditure requirements for full transition to SAF 2022-2050: $51.8bn.

Oil and gas capital expenditure

2014-2021 capex across whole industry, IEA data



Capex per day 2021-2030 for top 12 companies alone, $m



Why focus this analysis on energy transition, not new technology?

As described in the ICAO LTAG-TG report, the potential incremental costs to aircraft operators resulting from aircraft technology improvements are difficult to isolate and quantify:

- Aircraft transaction prices are generally not publicly available, and it is therefore difficult to extract/isolate the contribution of aircraft technology improvement to aircraft total price.
- The relationship between aircraft acquisition costs and potential fuel savings those aircraft provide is difficult to ascertain.
- Whilst there may be some elements of new technology aircraft (such as hydrogen) that could be more expensive – new systems and larger fuselage to allow for tank space – this may well be balanced out by the reduction in fuel costs per unit of energy and/or lower maintenance costs for simpler propulsion systems.

Given the ATAG *Waypoint 2050* and LTAG scenarios showing that, before 2050 at least, SAF will make up a majority of the emissions reductions, this analysis focuses on that aspect.

However, the LTAG report did quantify investments by OEMs towards new aircraft programmes (non-recurring costs) over the next 30 years, estimated to range from $180 billion (IS1) to $350 billion (IS3). This represents an average of about $6-11 billion per year - in line with current OEM development costs. As noted in the report, these aircraft development investments are global figures, including both domestic and international aviation as the development and production of aircraft cannot be broken down into domestic or international only.

Will the cost of flying increase? And will this impact growth of air transport connectivity?

The short answer to "will air fares go up to pay for decarbonisation?" is "we don't know". There are so many variables that make up the price of an airline ticket and it is challenging to provide an accurate assessment of how new technology and new fuels may impact the cost of air transport to consumers. It is clear that air fares have fallen significantly since deregulation in the 1970s, although the reduction in air fares has not been uniformly experienced.

However, in high-level macro analysis based on current expectations of the price of sustainable aviation fuels and continued efficiency improvements, the graphs (page 6) show the evolution of operating expenses for the global aviation industry from 1990 including the *Waypoint 2050* scenarios from 2020 to 2050. Expenses are broken down into non-fuel and fuel expenses as well as potential costs from offsetting (or other carbon removal options in the mid- to long-term).

Historically, fuel costs were generated by fossil fuels. Over the last 30 years, the cumulative cost to airlines from fossil fuels represented $4.3 trillion (in 2019 dollars). For this scenario-based analysis, an average price of fossil jet fuel over the last 10 years ($825 per tonne) has been used, although if fossil jet fuel was to stay at today's levels (≈$1,240 per tonne), the differential cost of SAF (and therefore cost of transition) would be significantly less.

The assumptions on price and availability of SAF used in this report are based on a scenario where maximum support for SAF scale-up is provided by governments through policy mechanisms, incentives and other instruments. Without these levers, SAF will be significantly more expensive and less available.

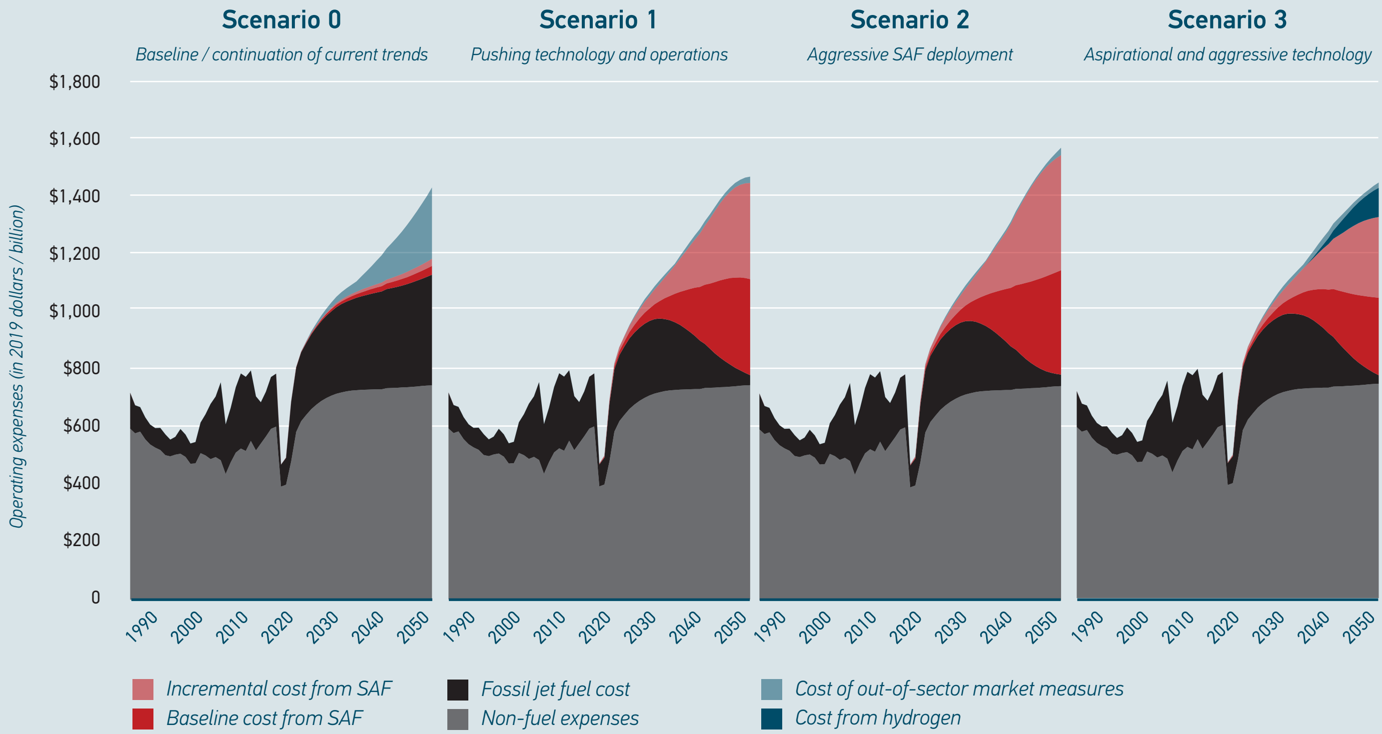
As global aviation's fuel mix transitions to SAF, the share of fossil fuel costs would decline. The costs of SAF are broken down into:

1. baseline fuel costs which would be incurred if fossil fuels were used instead of SAF; and
2. incremental costs from SAF resulting from the unit price premium of SAF (the minimum selling price minus baseline fossil jet fuel price).

This second component represents the incremental cost from SAF associated with a *Waypoint 2050* scenario. The figure also shows the potential cost of offsets (or other out-of-sector options) required to meet the net-zero emissions goal by 2050. For the purpose of first order estimates and illustration, a scenario for price of carbon based on the CO_2 price expectations under IEA's *Net Zero by 2050* Scenario[5] was leveraged (a range between $40 per tonne in 2025, going up to $170 per tonne in 2050).

Incremental costs associated with net zero goal in context of expenses

Athough the cost of SAF may add to airline expenses, the likely cost of carbon will also add to a scenario without an energy transition

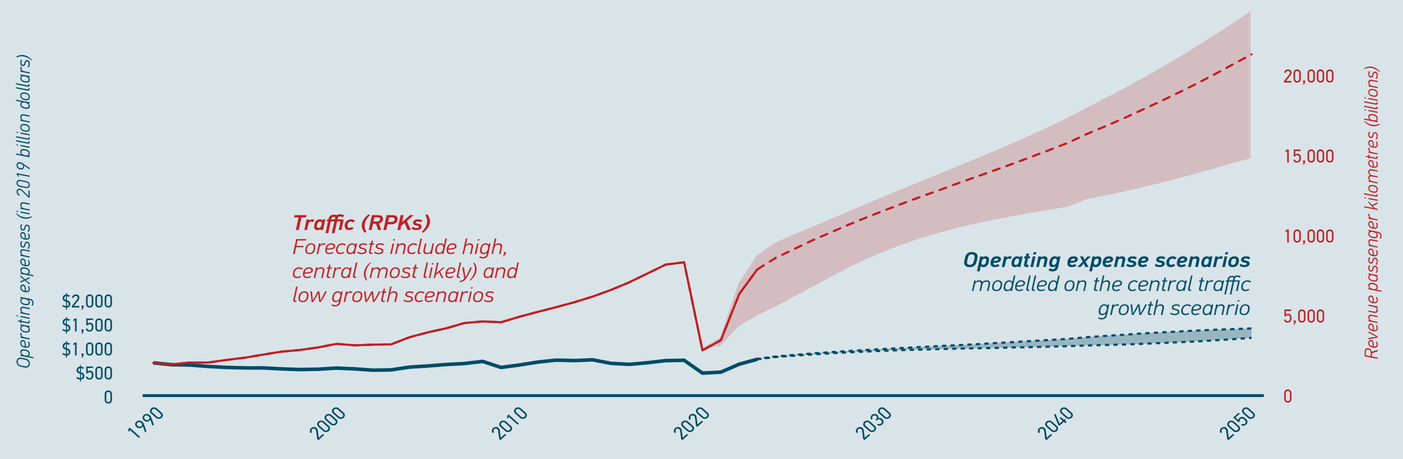


Waypoint 2050 Scenario	Notes
S0 *Continuation of current efficiency improvements, some gradual increase in SAF deployment at a limited rate and no real technology shifts*	The baseline/continuation of current trends scenario outlines a limited reliance on SAF by 2050 and incremental cost from SAF that may represent less than 2% of non-fuel and fuel operating expenses in 2050. Conventional fuel costs would equal $9.4 trillion over the period. Under this scenario, the goal would be met using large quantities of offsets or other out-of-sector measures (16.7 $GtCO_2$ of offsets for a total cost of $2.3 trillion).
S1 *Pushing technology (but not hydrogen) and operations*	In a scenario focusing on aircraft technology and operations, while cumulative incremental costs from SAF from 2020-2050 may represent $4.2 trillion, this represents a part of the $9.3 trillion of cumulative baseline fuel costs (that would be incurred if fossil jet fuel was used). The incremental costs from SAF may represent 23% of non-fuel and fuel operating expenses in 2050. Finally, to close the gap to the net zero goal by offsetting about 135 $MtCO_2$, the cost from out-of-sector measures would be limited to $23 billion in 2050 (1.5% of total operating expenses).
S2 *Aggressive SAF deployment focus*	Under this scenario, the cumulative incremental costs from SAF from 2020-2050 may represent $5.1 trillion out of $9.8 trillion of cumulative baseline fuel. The incremental costs from SAF may represent 26% of non-fuel and fuel operating expenses in 2050. Under this scenario, the cost of out-of-sector measures may represent $26 billion in 2050 and a cumulative total of $230 billion from 2020 to 2050.
S3 *Aspirational technology (including hydrogen for short haul)*	Finally, under an aspirational and aggressive technology perspective, the incremental costs of SAF in 2050 may represent 19% of non-fuel and fuel operating expenses. In this scenario, 115 $MtCO_2$ of offsets or other carbon mitigation options may be required to close the gap to the net zero emissions goal and may represent 1.3% of total operating expenses.

In each of the above scenarios, net-zero is reached. But in Scenario 0, aside from the cost of meeting net-zero through offsets (or other out-of-sector measures), the industry may also face additional costs to finance fleet and capacity increases, as net-zero guidance for the finance community (SBTi or green taxonomy) does not allow offsetting to be a primary driver of reaching net-zero. It should also be noted that the cost of fossil fuel used is a relatively conservative estimate based on historical averages - using today's high fuel price would change the calculations significantly.

Operating expenses and the evolution of traffic

Costs for the industry may rise, but those costs will be able to be spread across more passengers



While operating expenses may increase from 1990 to 2050 by a factor of 2x (scenario 0) to 2.2x (scenario 2), this needs to be placed in context of the substantial increase in global aviation traffic, measured in billions of RPKs, which are expected to be multiplied by a factor of 11.5x from 1990 to 2050.

However, external costs to the operation should not be overlooked. In the decade before Covid-19 hit the industry, airlines paid an average of $111 billion a year in tax to governments[6]. Some of this was in the form of value-added tax on some routes and corporate tax, but in some areas of the world there are significant levels of departure tax or tourist tax which are simply revenue generators. Countries concerned about the cost increases due to decarbonisation goals in aviation may also like to look at the impact that taxes have on potential passenger growth.

The projection of average fuel costs is heavily dependent on the unit price of fossil jet fuels especially during the next two decades. The baseline scenario assumes fossil jet fuel at $825 per tonne (in 2019 dollars), although we are currently experiencing $1,240 per tonne (in 2019 dollars) and these higher levels could continue for some time. Under Waypoint scenario 0 (basically 'business as usual') and given the modest uptake in SAF, the system wide average fuel cost may increase to $890 per tonne by 2050 under this scenario.

Unit fuel costs: historical and *Waypoint 2050* scenarios

As the industry transitions to sustainable aviation fuels, the unit costs of fuel may slowly increase over time but not far beyond historical highs

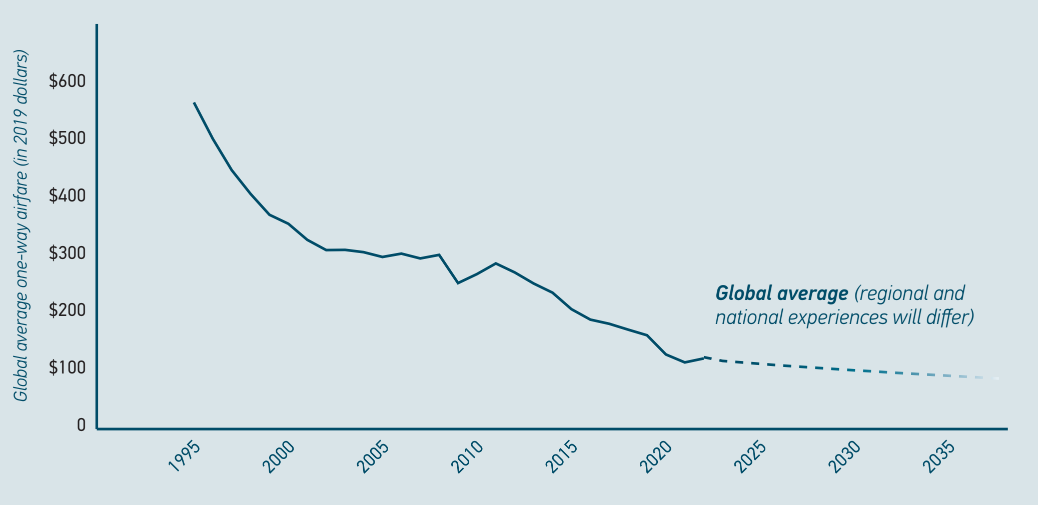
Shifting to *Waypoint 2050* scenarios 1, 2 and 3 where 90% of fossil jet fuel is replaced with SAF by 2050, the average unit fuel costs increase over time as the volumes of SAF increase. While there are some differences across scenarios due to differences in the share of types/categories of fuels, overall, by 2050 the average cost of fuel reaches +/- $1,600 per tonne. While this is close to twice the baseline fuel cost, it is in range with high fuel cost experienced historically (for example, in 2008, 2010 and 2022).

In addition, the cost of carbon (through emissions trading schemes, carbon pricing mechanisms and so forth) will need to be considered. The chart above (page 7) depicts a carbon price scenario based on IEA's *Net Zero by 2050* analysis[7] ($40 per tonne of CO_2 in 2025, $80 in 2030, $135 in 2040 and $170 in 2050) and has been added to the baseline fossil unit fuel cost: the cost of carbon will need to be built into airline business planning, either through CORSIA or other pricing mechanisms.

As shown below, the average one-way fare (in $2019) was cut by a factor of 4 between 1995 and 2019. This trend was driven by several elements including: airline operational efficiency improvements (such as load factor improvements, airspace efficiency improvements and technology), continued liberalisation and the emergence of low-cost carriers. Given historical trends, base air fares at a global level could be expected to continue to decline. The modelling below is driven by assumptions on non-fuel costs that are assumed to decline by 2.8% per annum on a unit basis, a conservative estimate given historical trends that ranged from -4.8% to -2.3% per annum from 1990 to 2019).

Historical trend in underlying air fares

Air fares at a global level have exhibited remarkable declines and there is no indication that this trend will not continue



As the global aviation industry transitions towards a net zero goal by 2050 and the cost of SAF declines due to increased supply and efficiency, the incremental costs associated with CO_2 emissions reductions measures under scenarios 1, 2 and 3 may represent an increase in the illustrative global average one-way fare by about $1 to $7 (in 2019 dollars) compared to a scenario 0, where out-of-sector measures need to be used to reach net-zero.

A sensitivity analysis was also run to check what the comparison would be if no out-of-sector measures were used and net-zero was not reached. The difference between the *Waypoint 2050* scenarios 1-3 and this alternative scenario (without out-of-sector measures and not hitting net-zero) range from $13 to $19 (in 2019 dollars) in 2050. Despite this increment in air fare due to fuels and out-of-sector measures, the illustrative global average air fare could still be lower in 2050 compared to 2020, based on a conservative continuation of historical efficiency improvements.

Decarbonisation will require aircraft operators to invest in new technology and SAF, incurring costs that will be reflected in their business models.

Analysis indicates that despite these costs airlines will be able to provide greatly expanded air transport services, continuing to drive economic growth and deliver benefits throughout the world (such as the 87.7 million jobs and 4.1% of global GDP supported in 2018), at air fares similar to today's (likely lower in some parts of the world but perhaps higher in more mature markets).

Historically, the airline industry has experienced low margins compared to many other sectors. For example, from 2004 to 2019 operating margins averaged 4% (with a range from -0.2% to 8.6%) and net profit margins averaged 1.6% (range: -4.6% to 5.0%). The scenario-based analysis contained in this paper assumes that airlines will continue to operate in a highly competitive environment with returns on investment in line with historic levels.

In some regions of the world, there is room for more efficiency improvements or liberalisation opening markets. Other regions, particularly more mature markets, may see a slight increase in fares. It is important to emphasise that air fares are estimated based on a range of assumptions – this illustrative analysis is considered fit for purpose to place costs in broader context. It is not meant to represent a forecast of future air fares. In addition, the cost of inactions discussed in the following sections are not considered and embedded in the alternative scenario where net-zero is not reached.

The increment to get to net-zero may be partially compensated by continuing declining base fares, or improvements in efficiency, or even if the average price of fossil jet fuel remains high. However, it is also often outweighed by ticket taxes in many parts of the world. For example, Mexico has a tourism tax of $31.83 per passenger, Argentina's departure tax is $57, the United Kingdom Air Passenger Duty ranges from $104 to $228 per long-haul passenger, Colombia's departure tax ranges from $40 to $47 per passenger (and a tourism tax of $15), Australia charges $42 for international flights and Mauritania $55 per passenger.

Whilst the impact on air fares of switching to sustainable aviation fuel may increase ticket prices compared to where they would be with no net-zero pathway, there will also be an air fare impact to not taking this action, with cost increases in a range of areas making their way onto the ticket:

- The industry may experience more costly financing for aircraft or airport developments due to a lack of net-zero pathways.
- Constrained growth could lead to a change in supply / demand dynamics.
- Carbon costs, including potentially fragmented taxes and emissions trading schemes could increase the cost of travel.
- Eventually, the cost impacts of adapting aviation infrastructure to a changing climate would need to be built into the cost structure of the industry.

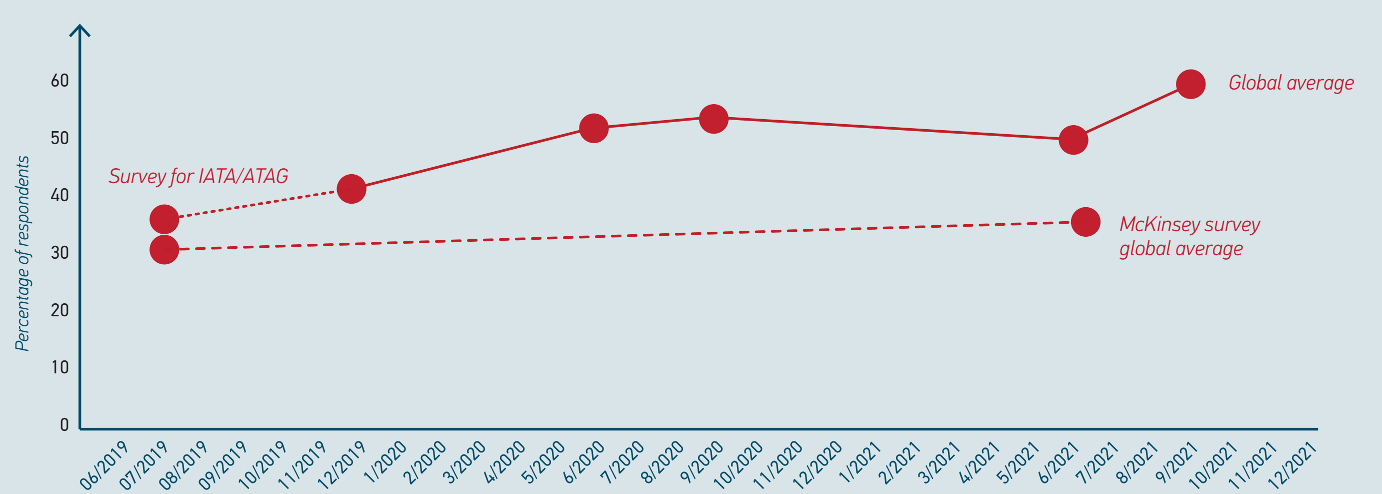
The cost of inaction – some of the costs without a global goal

There have been a range of assessments of the cost, both financially and ecologically, to not reaching our collective global targets to reduce emissions. For a sector such as aviation, the negative impacts are also going to be felt: from impacts of increased weather activity to our operations; the ability for our equipment to deal with changes in climate; shifts in markets as some routes get too hot at certain times of the year; and possibly wholesale impacts on our destinations, particularly island nations and low-lying airports and cities.

None of these can be fully quantified right now at a global level, some studies have been done looking at adaptation costs for airports in Europe. However, the industry also needs to factor in another possible shift: will our growth and continued operation be impacted by reduced acceptability of air transport if we do not address our climate footprint?

Potential passenger response to climate inaction?

***Agrees** with the statement "In the future, I will avoid flying if I do not think airlines are reducing their carbon footprint"*



Survey: "Plan to reduce air travel for climate reasons"

McKinsey Survey of 5,500 people in 13 countries, 2021

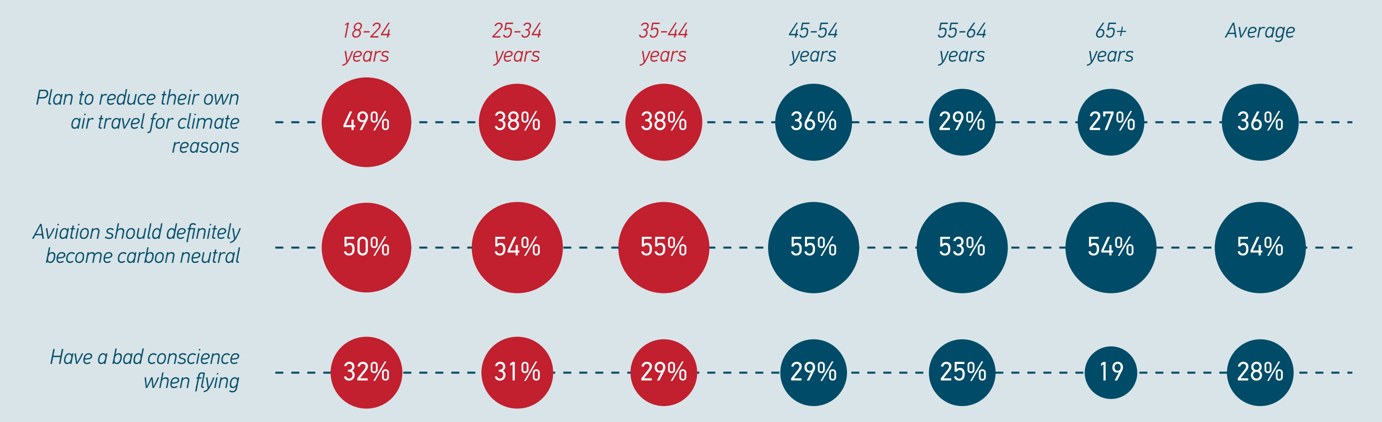
Age	Germany	Spain	Sweden	Poland	UK	USA	Canada	Australia	Japan	Saudi Arabia	China	India	Brazil
18-24	**50%**	32%	**75%**	33%	**70%**	**55%**	**67%**	38%	22%	**45%**	**54%**	**51%**	**55%**
25-34	**48%**	31%	**44%**	29%	39%	**53%**	22%	**47%**	**45%**	37%	31%	**52%**	36%
35-44	31%	31%	38%	29%	37%	**43%**	**40%**	38%	14%	39%	**42%**	**44%**	**40%**
45-54	14%	32%	**44%**	36%	25%	28%	38%	27%	11%	**46%**	**46%**	**52%**	39%
55-64	26%	34%	27%	**46%**	26%	31%	19%	23%	7%	6%	**48%**	34%	33%
Average	34%	32%	46%	35%	40%	42%	37%	35%	20%	35%	44%	47%	41%

Before Covid-19 hit the industry, the topic of 'flightshame' was gaining prominence, particularly in Europe. Whilst it had not started to impact individual passenger bookings by that point, IATA conducted a series of surveys of passengers in several markets to understand what the possible impact of a shift in attitudes to flying may bring. Despite Covid, the responses to the statement "In the future, I will avoid flying if I do not think airlines are reducing their carbon footprint" have continued to increase across all markets – a similar trend has been seen in a wider range of markets surveyed by McKinsey[8].

The McKinsey survey across 13 countries also showed a generational shift, with a higher proportion of younger respondents saying they would reduce air travel for climate reasons. This group already makes up the largest proportion of passengers and will be almost the entire passenger market by 2040. Additionally, it is clear that the intention of reducing air travel is not just related to those markets where climate is highest on the agenda, with over 50% of under 24-year olds in most of the markets surveyed saying that they plan to reduce air travel.

Younger passengers say they are more likely to act

***McKinsey** survey of 5,500 passengers in 13 countries, 2021*



Corporate customers

Whilst large numbers of individual passengers are not currently making air travel decisions based on climate concerns, even in European countries where the debate is highest, there is a significant shift in corporate travel policy from large customers of aviation. Anecdotal evidence suggests travel policies for many government agencies and public institutions are starting to deny air travel if it can be replaced with other forms of transport, or severely limiting particularly long-haul flights. Sometimes this is based on budget processes (the last two years have seen some significant savings for corporations), but in many cases, climate awareness is seen as the key driver.

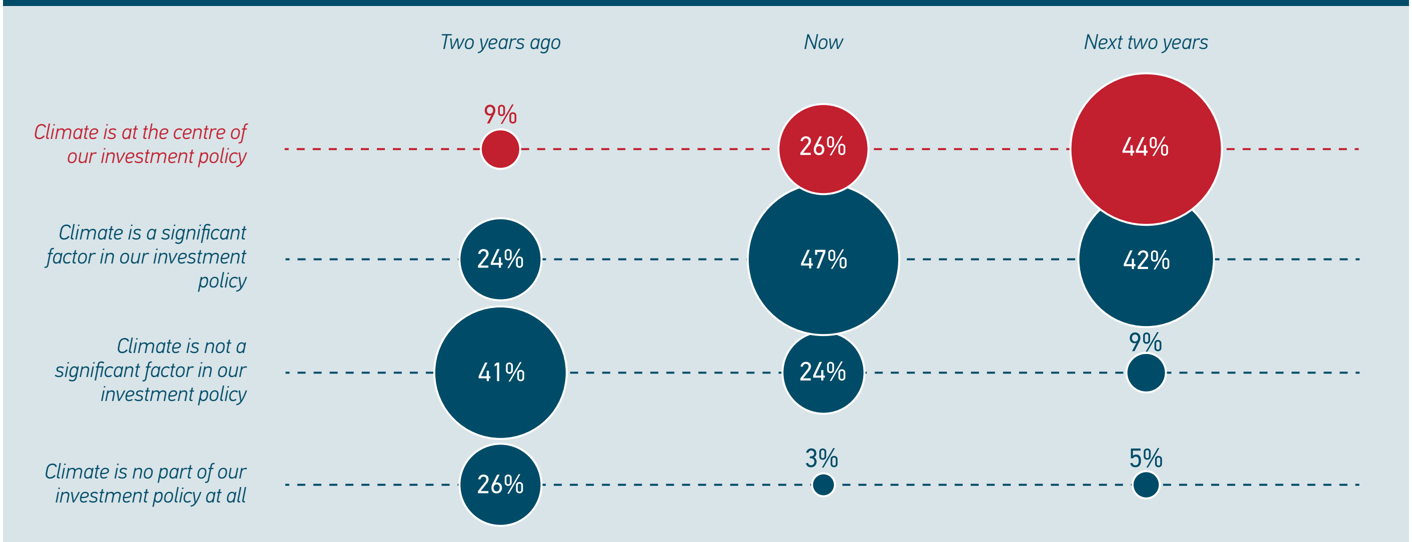
For airlines, corporate travellers represent 12% of passengers and generate billions in revenue — as much as 75% of profit on certain flights[9]. As such, business travellers represent an essential segment.

A large number of companies are also starting to implement goals for CO_2 reductions from their business travel. These could be tackled in several ways: through reducing absolute travel of their staff; by purchasing offsets; or by purchasing SAF. We can expect this trend to continue in companies across the world as they respond to calls to account for so-called ‘scope three’ emissions from their operations.

This will inevitably have an impact on airlines not only in their home markets, but also across the world. A large corporate may have special deals with home carriers, but given the global nature of travel it is likely that they will normally purchase tickets on carriers all over the world.

Investors are prioritising climate action

Robeco survey of 300 global investment companies, 2021



The investment and finance community

Aviation needs finance. A global survey of investors in 2021[10] also found that there is a rapid shift in focus by very large investors towards climate ambition, with 86% of investors saying that climate change will be the centre of their investment policy, or a significant part of it, in the next two years. The same survey showed that nearly 20% of institutional investors’ overall portfolios will be divested from carbon-intensive assets over the next five years.

Increasingly, airlines are being required to report climate-related data to institutional and retail shareholders and demonstrate a robust climate action plan when seeking investment. This will impact airlines’ ability to purchase new aircraft and airports’ ability to fund expansion plans. Indeed, capital is global and many of the world’s largest financial institutions fund activities all over the world: not just in mature markets.

In addition, Climate 100+, a group of 615 investors which are responsible for $65 trillion in assets under management, have set a Paris Agreement-aligned pathway for air transport which will force the industry to meet stringent emissions reduction goals[11]. And the Transition Pathway Initiative[12], bringing together 124 investors with $40 trillion under management is now ranking airlines based on their adherence to climate-aligned pathways. The Science-Based Targets Initiative has also been established to provide a benchmark for corporate climate action and has published aviation-specific guidance[13]. Despite our misgivings to the methodology of a number of these initiatives, they are already having an impact on decisions by asset managers as to where they will allocate capital opportunities in the future.

References

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[8] McKinsey survey of 5,500 passengers in 13 countries, half of them women, ranged in age from 18 to over 75. From the US, the UK, Sweden, Spain, Poland, Germany, Saudi Arabia, India, China, Japan, Australia, and Brazil. 2021 survey: www.mckinsey.com/~/media/mckinsey/industries/travel%20logistics%20and%20infrastructure/our%20insights/opportunities%20for%20industry%20leaders%20as%20new%20travelers%20take%20to%20the%20skies/opportunities-for-industry-leaders-as-new-travelers-take-to-the-skies.pdf?shouldIndex=false

[8] PwC analysis: www.pwc.com/us/en/industries/consumer-markets/library/corporate-travel-collaboration-essential-for-covid-19-recovery.html

[10] Robeco survey in January 2021 among 300 institutional and wholesale investors in Europe, North America and Asia-Pacific. The investors are based at a range of organizations: insurance companies, pension funds, private banks, fund-of-funds, advisory firms, wirehouse broker/dealers, sovereign wealth funds, endowments and foundations and family offices. They ranged in size from holding less than $1 billion in assets under management (AUM) to over $1 trillion in AUM, with a total AUM for all respondents of approximately $23.4 trillion. $9.3 trillion in Europe, $9.5 trillion in North America and $4.6 trillion in Asia-Pacific. www.robeco.com/docm/docu-202103-robeco-global-climate-survey.pdf

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