# Placing Costs Associated with LTAG Integrated Scenarios in Context

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## Introduction

The costs associated with each Long-Term Aspirational Goal (LTAG) Integrated Scenario were assessed as part of the LTAG-Task Group (LTAG-TG) analyses. Given the long-time horizon, from 2020 to 2050, and the scope of the sector considered (i.e., international aviation) some cost numbers run in the $ billions or $ trillions and may appear to be large.

These numbers raise questions such as: *"what do these costs represent in context of the costs of operating the international aviation sector during the next 30 years?"*, and *"what could it mean for an airline or passenger?"*.

The need to place the costs of LTAG Integrated Scenarios in context also became apparent during the ICAO Global Aviation Dialogues (GLADs), a consultative process on LTAG held by ICAO, through a series of five regional events that took place on 27 March to 8 April 2022.

Following the request from States on more detailed information on the costs within the ICAO LTAG Report, the ICAO Secretariat requested support from CAEP to complement the existing assessment to the extent possible with such information. The CAEP Chair and the LTAG-TG leadership provided support to address these questions to help with interpretation of LTAG-TG results and deliberations towards the 41st Session of the ICAO Assembly. This information does not replace or substitute any information agreed at the CAEP/12 meeting but rather complements the results of the assessment by putting it in a more detailed context, using the same assumptions and methodology from the ICAO CAEP LTAG assessment.

## Approach

To place the potential costs associated with LTAG integrated scenarios in context, data from the LTAG-TG analyses on cost and investments were leveraged. Contextual data was also collected using a range of sources including: (1) CAEP Forecasting and Economic Study Group (FESG) traffic forecasts e.g., ATK, ASK, number of flights, (2) ICAO Air Transport Statistics for passenger data, (3) IATA Industry Statistics Fact Sheet (2010–2022) for breakdown of operating costs i.e., fuel and non-fuel costs and profit margins. The incremental costs associated with an LTAG (compared to a baseline scenario) are largely driven by fuels related costs. This analysis therefore focuses on these costs.

## Unit fuel costs in context of historical jet fuel costs

Historically, the international aviation industry has experienced substantial volatility in unit jet fuel prices (measured in $/litre). While the transition to Sustainable Aviation Fuels (SAF), Low Carbon Aviation Fuels (LCAF) and possibly Hydrogen may increase the unit costs of fuels, the increase in unit costs is expected to be gradual and by 2050 within historical volatility ranges of unit fuel prices.

Figure 1 shows the evolution over time of unit fuel prices. Over the last ten years, the average cost of fuels varied from 0.4 to 1.0 $/L (a factor of 2.5×).

When the LTAG-TG analyses conducted by CAEP were completed and documented in November 2021 the baseline scenario assumed a unit cost of conventional jet fuel of 0.60 $/L. As shown on Figure 1, since the LTAG-TG report

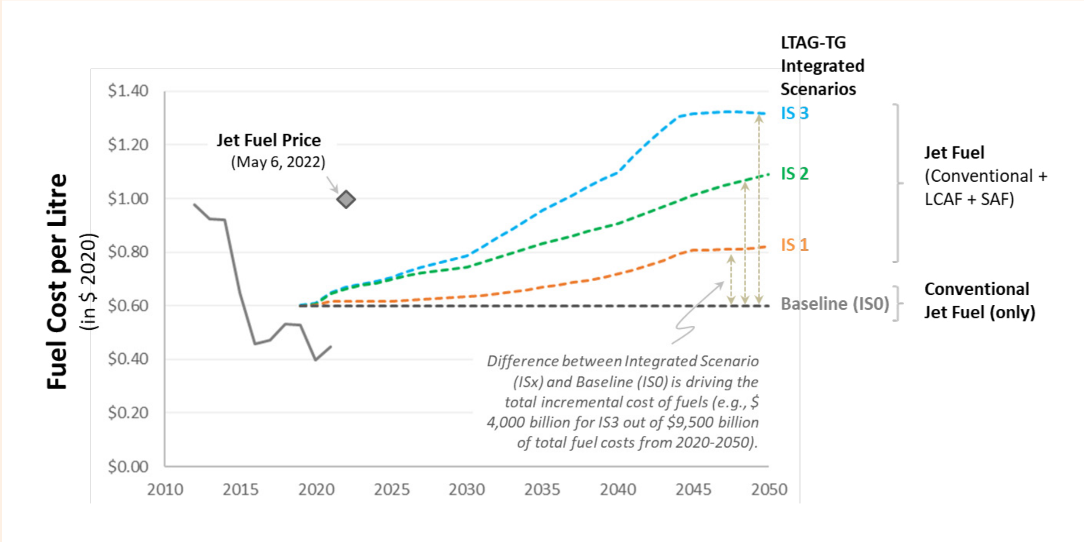


**FIGURE 1:** Unit fuel costs in context of historical jet fuel costs

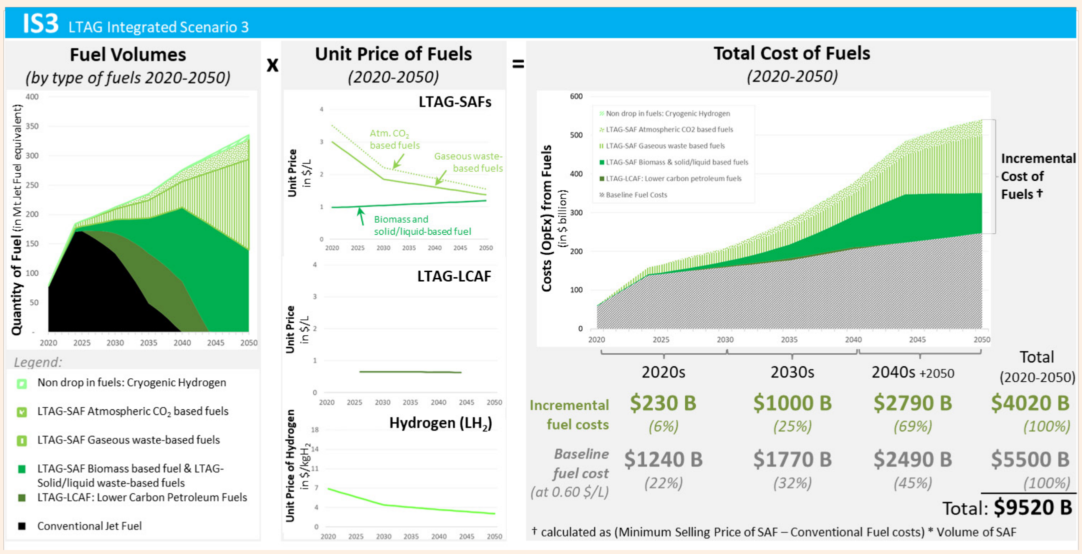


**FIGURE 2:** Total cost of fuels driven by fuel volumes and unit prices

was published, jet fuel price has increased to about 1 $/L in May 2022. It should be noted that this price in May is punctual and unlike the baseline 0.6 $/L does not represent an average annual price. Future conventional jet fuels are also uncertain.

As the shares of SAF and LCAF start to increase in the 2020s (under an LTAG Integrated Scenario 1), the average fuel cost per litre would increase slightly to 0.63 $/L by 2030 and 0.82 $/L by 2050 (1.4x baseline fuel cost). Under an LTAG Integrated Scenario 2, the average fuel cost per litre would reach 1.09 $/L by 2050 (1.8x). Under an LTAG Integrated Scenario 3, where 100% of conventional jet fuel is replaced by SAF starting in 2044, the average fuel cost per litre would reach 1.32 $/L by 2050 (2.2×).

Under (higher) baseline fuel cost, such as jet fuel price experienced in May 2022, the incremental costs from Fuels (e.g., SAF, hydrogen) would be substantially reduced, making these fuels more competitive to acquire and use.

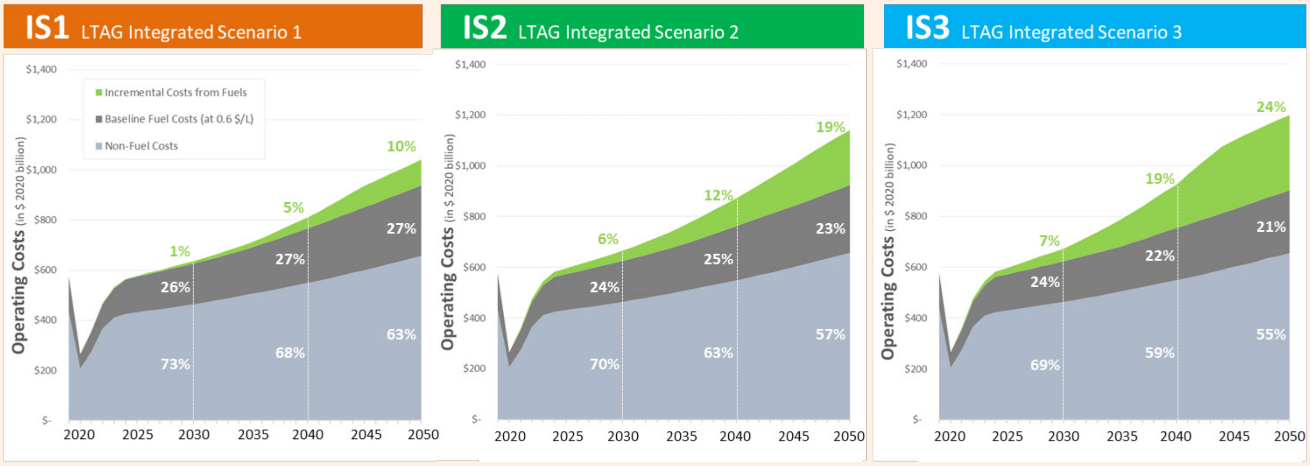


**FIGURE 3:** Incremental costs from LTAG scenarios in context of operating costs from international aviation

## Costs in context of fuel and operating costs

Fuel costs are borne by airlines and aircraft operators and are part of their total operating costs. Figure 2 shows the total costs of fuels from 2020 to 2050 for the illustrative LTAG integrated scenario 3. The incremental costs of Fuels are driven by fuel volumes and unit prices. The incremental costs of Fuels are expected to slowly increase in the 2020s due to the gradual replacement of conventional jet fuels by LCAF, SAF and Hydrogen despite higher unit prices of these fuels. Approximately 6% of incremental fuel costs would be borne in the 2020s and 69% in the 2040s. The total incremental fuel costs of ≈$4000 billion from 2020 to 2050 also need to be placed into context of the baseline fuel costs (i.e., costs of fuel if conventional jet fuel at 0.6 $/L was used instead) that would represent ≈$5,500 billion from 2020 to 2050.

It should also be noted that aircraft technology and operational improvements, that improve from LTAG integrated scenarios 0 to 3, help to mitigate the incremental costs of Fuels. Under a baseline scenario (IS0) where technology and operational improvements are limited, the cumulative baseline fuel costs would be ≈$6,800 billion from 2020 to 2050.

Total fuel costs represent a portion of the total operating costs by airlines and should be put in context of ≈ $15,500 billion for non-fuel costs from 2020 to 2050. Figure 3 shows the evolution over time of incremental costs of Fuels, baseline fuels costs and non-fuel costs. By 2030, the incremental costs of Fuels associated with LTAG scenarios may represent from 1% to 7% of total operating costs by the international aviation industry (under IS1 and IS3 respectively). This may represent 5% to 19% by 2040 and possibly 10% to 24% in 2050.

## Incremental costs per flight

From an airline perspective, the incremental cost from Fuels in 2030 may represent an additional $650 to $3300 (in $2020) per flight for an average flight of about 2700 km from Montreal (Canada) to Denver (U.S.). While these costs run in the hundreds or thousands of dollars this represent an increment on top of an average costs to operate such flight of $42,900-$41,600 (in $2020) under IS1 and IS3 respectively. Placing this cost in a per seat context, this represents about $3 to $15 per seat equivalent.

Furthermore, the incremental cost per flight would be driven by flight distances. The incremetal costs per flight for a short haul flight (e.g., ≈630 km such as Zurich to Amsterdam) would range from $130–660 per flight or $0.8 to $4.4 per seat. As expected, the incremental costs would be higher for long-haul flights.

By 2050, the incremental Fuel costs may add $3,500 to $10,000 (in $2020) on top of an average flight may cost about $31,000 to $30,000 (in $2020) to operate.

| Flight Distance<br>*Illustrative Origin & Destination* | | Incremental Cost* per Flight<br>*(Incremental Cost* per Seat**)*<br>in 2030 | in 2050 |
|---|---|---|---|
| **Short** *Haul Flight*<br>630 km<br>(≈10th percentile of int. aviation flights)<br>**Zurich** → **Amsterdam**<br>*Switzerland* *Netherlands*<br>(LSZH) (EHAM) | IS1 | $ 130<br>($0.8) | $ 780<br>($4.4) |
| | IS2 | $ 520<br>($3.3) | $ 1600<br>($9.2) |
| | IS3 | $ 660<br>($4.3) | $ 2200<br>($13) |
| **Average** *Haul Flight*<br>2700 km<br>(average for international aviation)<br>**Montreal** → **Denver**<br>*Canada* *U.S.*<br>(CYUL) (KDEN) | IS1 | $ 650<br>($3) | $ 3500<br>($15) |
| | IS2 | $ 2600<br>($12) | $ 7200<br>($31) |
| | IS3 | $ 3300<br>($15) | $ 10,000<br>($43) |
| **Long** *Haul Flight*<br>5800 km<br>(≈90th percentile of int. aviation flights)<br>**Singapore** → **Dubai**<br>*Singapore* *UAE*<br>(WSSS) (OMDB) | IS1 | $ 1600<br>($5) | $ 8000<br>($25) |
| | IS2 | $ 6600<br>($20) | $ 17,000<br>($53) |
| | IS3 | $ 8300<br>($26) | $ 23,000<br>($73) |

** Costs in $ 2020 (adjusted for inflation).*
*** Seat equivalent including available seats for passenger, equivalent seats for freighters and 13 seats (default) for business jets.*

**FIGURE 4:** Incremental costs per flight and per seat equivalent

| | | Potential impact on ticket price*<br>in 2030 | in 2050 |
|---|---|---|---|
| **Average** *Passenger Trip Length*<br>2900 km | IS1 | $ 3 | $ 13 |
| | IS2 | $ 11 | $ 28 |
| | IS3 | $ 14 | $ 38 |

** Proxy based on revenue per passenger, assuming an average 3% profit margin and 75% revenue from passenger (based on historical global averages from 2010-2019).*

**FIGURE 5:** Potential impact on ticket price

## Incremental costs per passenger

From a passenger perspective in 2030, the costs associated with IS1 could represent ≈ $3 to a ticket price and ≈ $14 in an IS3 scenario. While difficult to forecast, average ticket price may be on the order of $190–$200 (in $2020) in 2030. By 2050, the incremental costs associated with IS1 and IS3 may represent ≈ $13 to $38 per passenger in context of an average fare of ≈$140–$160 (in $2020).

This analysis also assumes that unit non-fuel costs will decline at historic rates observed due to further liberalization of the aviation sector and airline productivity improvements. It is important to understand that like average ticket prices, any forecast of unit non-fuel costs over the period 2020–2050 will have a large amount of uncertainty.