International Civil Aviation Organization

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WORKING PAPER

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 LTAG
Agenda Item 4: Conclusions and Recommendations of the Meeting

TECHNICAL FEASIBILITY OF LTAG SCENARIOS (BUILDING BLOCK 2)

(Presented by the ICAO Secretariat)

SUMMARY

This paper presents the ICAO work on the feasibility of an LTAG since the 40th Session of the Assembly, with a focus on the CAEP technical assessment on the feasibility of various aviation in-sector CO_2 emissions reductions scenarios.

Action by the Meeting is in paragraph 4.

1. INTRODUCTION

1.1 The original request to explore the feasibility of a long-term global aspirational goal (LTAG) for international aviation was made at the 37th Session of the ICAO Assembly in 2010 when the 2 % annual fuel efficiency improvements and 2020 Carbon Neutral Growth aspirational goal were agreed. This request on the feasibility of LTAG was reiterated at the subsequent 38th, 39th and 40th Sessions of the Assembly in 2013, 2016 and 2019, respectively.

1.2 Following the 40th Session of the Assembly and subsequent specific request by the Council, the ICAO Committee on Aviation Environmental Protection (CAEP) undertook its technical work on the feasibility study on LTAG, focused on the attainability and readiness of aviation in-sector CO_2 reduction measures, including aircraft technologies, operations and fuels, as it would be necessary to assess the in-sector CO_2 reduction potentials before considering the need and extent of any complementary measure.

1.3 Following the Terms of Reference (TOR) and overall process/timeline agreed by the Council in March 2020[1], the CAEP undertook: 1) data gathering from internal and external sources in a transparent and inclusive manner; 2) development of combined in-sector scenarios from technology, fuels, and operations that represent a range of readiness and attainability based on the data gathering; and 3) conducted final analysis of the scenarios to understand those impacts on CO_2 emissions and cost associated with the scenarios and economic impacts on aviation growth, noise and air quality, in all countries especially developing countries and the results were placed within the context of the latest consensus scientific knowledge.

[1] Council decision: C-DEC 219/6, paragraph 5 d) refers.

1.4 The CAEP work was performed by the newly-established LTAG Task Group, which also formed its dedicated subgroups on aircraft technology, operational improvements, fuel production, as well as another subgroup on the scenario development that also coordinated the work across other subgroups including the analytical work to examine cost and investment aspects. The LTAG report developed by CAEP consolidated the cumulative efforts, with more than 200 calls, of over 280 experts from governments, aviation industry, environmental NGOs, UN organizations and academia around the world.

1.5 The CAEP/12 meeting in February 2022 unanimously approved the technical report on the feasibility of LTAG[2] including long-term emissions reduction scenarios, highlighting the potential for substantial CO_2 reductions from innovative aircraft technologies, operations and fuels, with the assessment of required costs and investments. In addition, the LTAG report included other outcomes, such as the need for capacity building and assistance for the implementation of CO_2 reduction measures, as well as the need for progress reporting for the achievement of LTAG. This paper summarizes the contents of the LTAG report, and the full LTAG report is provided in HLM-LTAG-IP/2.

2. SUMMARY AND HIGH-LEVEL OBSERVATIONS

2.1 Based on the CAEP analyses, some high-level observations were made in the LTAG report, including the following (refer to HLM-LTAG-IP/2 for the full summary and observations text):

a) While the scenarios show the potential for substantial CO_2 reduction, none of the scenarios reach zero CO_2 emissions through the use of in-sector measures (i.e. technology, operations, and fuels);

b) The overall traffic growth rate has an important impact on residual CO_2 emissions by 2050 and after;

c) Drop-in fuels have the largest impact on residual CO_2 emissions driving the overall reductions by 2050. This is, to some extent, independent of the technology and operations scenarios. Onboard hydrogen is not expected to have a significant contribution by 2050 (with only 1.9% of energy share in 2050) but this may increase in the 2050s and 2060s if technically feasible and commercially viable;

d) Advanced tube and wing aircraft have a clear potential to improve the fuel (energy) efficiency of the international aviation system, as do aircraft with unconventional configurations, which will gradually contribute to efficiency. The technology wedge continues to grow after 2050 when these aircraft types penetrate the fleet;

e) Analysis shows there are opportunities for operations to reduce CO_2 emissions through improvements in the performance of flights across all phases, including unconventional measures such as formation flying; and

f) The costs and investments associated with the scenarios are largely driven by fuels (e.g. Sustainable Aviation Fuel (SAF)) acknowledging that incremental costs of fuels (i.e. minimum selling price of SAF compared to conventional jet fuels) further motivates fuel (energy) efficiency improvements from aircraft technology and operations. This will also require some investments from governments and industry.

[2] ICAO LTAG report website: https://www.icao.int/environmental-protection/LTAG/Pages/LTAGreport.aspx

3. LTAG SCENARIOS AND ANALYSES (CAEP LTAG REPORT)

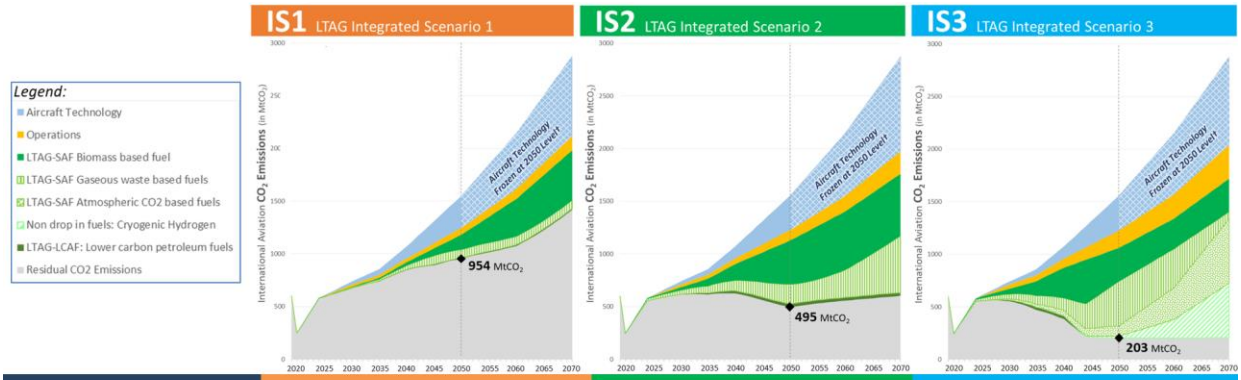
Three integrated LTAG scenarios

3.1 In the LTAG report, three integrated scenarios (IS1, IS2 and IS3) were developed, over a time frame extended to 2070, to cover a range of readiness, attainability, and aspiration, as follows:

1) under the low/nominal scenario (IS1), emissions in 2050 would be reduced by 39%, broken down into 20% from aircraft technologies, 4% from operations and 15% from fuels, meaning emissions could reach approximately 950 $MtCO_2$ in 2050 (or 1.6 times the 2019 CO_2 level);

2) under the middle scenario (IS2), CO_2 emissions could reach approximately 500 $MtCO_2$ in 2050 (0.8 times the 2019 CO_2 level), meaning emissions in 2050 would be reduced by 68%, broken down into 21% from aircraft technologies, 6% from operations, and 41% from fuels; and

3) under the most ambitious scenario (IS3), residual CO_2 emissions could reach approximately 200 $MtCO_2$ in 2050 (a third of the 2019 CO_2 level), meaning a reduction by 87%, broken down into 21% from aircraft technologies, 11% from operations and 55% from fuels.



Metrics	IS1	IS2	IS3
CO_2 Emissions in 2050 after Reductions	**≈950 $MtCO_2$** in 2050 *(**160%** of 2019 CO_2 emissions)*	**≈500 $MtCO_2$** in 2050 *(**80%** of 2019 CO_2 emissions)*	**≈200 $MtCO_2$** in 2050 *(**35%** of 2019 CO_2 emissions)*
Reduction in 2050 from the Baseline	**39% total** through: Technologies - 20%, Operations - 4%, Fuels - 15%	**68% total** through: Technologies - 21%, Operations - 6%, Fuels - 41%)	**87% total** through: Technologies - 21%, Operations - 11%, Fuels - 55%
Cumulative residual Emissions from 2020 to 2070	23 $GtCO_2$ (2020 to 2050) 23 $GtCO_2$ (2051 to 2070)	17 $GtCO_2$ (2020 to 2050) 11 $GtCO_2$ (2051 to 2070)	12 $GtCO_2$ (2020 to 2050) 4 $GtCO_2$ (2051 to 2070)

Scientific context

3.2 The LTAG report also summarized the present state of knowledge of CO_2 that could be emitted from all anthropogenic sources to limit global warming to 1.5 and 2°C above the pre-industrial levels, in order to place the LTAG feasibility study results within the perspective of the latest consensus scientific knowledge.

3.3 The cumulative amount of aviation CO_2 emissions provides a good correlation in the context of the global average temperature goals. The estimated cumulative worldwide anthropogenic CO_2 emissions from the start of 2020 to limit global warming to 1.5°C is 400$GtCO_2$ with 67 percent probability, while the remaining allowed carbon emissions to limit global warming to 2°C are estimated to be 1150$GtCO_2$ with 67 percent probability. Comparing the cumulative worldwide CO_2 emissions with the cumulative residual emissions from international aviation in the three LTAG scenarios (IS1, IS2 and IS3), the international aviation share could be between 4.1 and 11.3 percent for the 1.5°C limit, and between 1.4 and 3.9 percent for the 2°C limit (also HLM-LTAG-WP/3 refers).

Overall cost impacts

3.4 The LTAG report also included the required costs and investments under the three LTAG scenarios and associated impacts on different stakeholders. Fuels (e.g., Sustainable Aviation Fuels (SAF)) are largely driving the costs and investments associated with the emissions reductions. Incremental fuel costs (i.e., minimum selling price of SAF compared to conventional jet fuels) further motivates fuel (energy) efficiency improvements from aircraft technology and operations, and the development and deployment of such fuels would require government and industry investment.

3.5 The cumulative incremental fuel costs to airlines from 2020 to 2050 were estimated to range from $1.1 trillion in the IS1 scenario to $4 trillion in the IS3 scenario, when conventional jet fuel is completely replaced beginning in 2040. Fuel suppliers' cumulative investments from 2020 to 2050 would vary from $1.3 trillion to $3.2 trillion.

3.6 It should be noted that these costs and investments by different stakeholders cannot be added towards a total cumulative cost related to fuels, since the investments by fuel suppliers could be passed on to airlines as part of the fuel price, for example; and the costs to airlines could be passed on to passengers as part of the ticket price.

Regional and individual State impacts

3.7 The LTAG report provides an analysis of the overall CO_2 reduction benefits and cost impacts from technologies, operations and fuels on a global basis. However, regarding the impact at the country level and the cost for developing countries, CAEP undertook the regional impact analysis, although it was limited due to available data for individual State level. In order to support States that wish to conduct their specific analysis, upon Council's approval, CAEP's data (in the form of a spreadsheet) will be made freely available to all ICAO Member States, along with the explanatory cover paper, for their own analysis, with the caveat that any additional analysis done by States will not be considered as part of CAEP's work.

3.8 It is important to note that the ICAO global aspirational goals are the international aviation sector's collective goals, without any attribution of specific obligations in the form of emissions reduction goals to individual States, and States can contribute to the achievement of collective goals by different sets of measures. At this stage, such information on the sets of measures is not available in the majority of States, and the impact analysis at individual State levels was not possible to be conducted. CAEP/12 meeting recognized the fact that the CAEP completed its technical work, considering the data, time and resources available.

3.9 Also of note is that LTAG report did not include the cost of inaction by the aviation sector to address climate change, which in general may affect higher adaptation costs to address the consequential impacts of climate change, compared to the CO_2 mitigation costs by taking earlier action, according to the findings by the IPCC.

3.10 According to the IPCC Assessment Report 6 (AR6), global warming, reaching 1.5°C in the near-term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans. The level of risk will depend on concurrent near-term trends in vulnerability, exposure, level of socioeconomic development and adaptation. Near-term actions that limit global warming to close to 1.5°C would substantially reduce projected losses and damages related to climate change in human systems and ecosystems, compared to higher warming levels, but cannot eliminate them all.

3.11 In accordance with AR6, evidence of observed impacts, projected risks, levels and trends in vulnerability, and adaptation limits, demonstrate that worldwide climate resilient development action is more urgent than previously assessed in AR5. Comprehensive, effective, and innovative responses can harness synergies and reduce trade-offs between adaptation and mitigation to advance sustainable development.

Other findings

3.12 The LTAG report pointed out that there could be potential needs for capacity building and assistance to realize the emissions reduction scenarios, such as on solutions that States can implement to contribute to the achievement of LTAG, by raising understanding of costs, and assistance on monitoring and measuring CO_2 emissions from international aviation, as part of an overarching training programme that could be similar to the successful ICAO Assistance, Capacity-building and Training for CORSIA (ACT-CORSIA) programme (HLM-LTAG-WP/7 refers).

3.13 Regarding progress reporting for the achievement of LTAG, the LTAG report recommended that the ICAO State Action Plans initiative could be utilized to report progress towards the LTAG every three years (HLM-LTAG-WP/6 refers). This would also allow the triennial CAEP meeting and Assembly session to review progress and recommend/decide on any adjustments, in a similar way to the periodic reviews of CORSIA. Such LTAG review could use the information collected through the reporting processes as well as contextual information such the latest scientific knowledge on climate, as summarized by the CAEP Impacts and Science Group (HLM-LTAG-WP/8 refers).

4. ACTION BY THE HLM-LTAG

4.1 The HLM-LTAG is invited to:

a) recognize that the *ICAO Report on the Feasibility of a Long-Term Aspirational Goal for International Civil Aviation CO_2 Emission Reductions*, which assessed the technical feasibility of various aviation in-sector CO_2 emissions reduction scenarios, serves as the basis for the consideration of an LTAG, and that the largest potential impact on aviation CO_2 emissions reduction will come from fuel-related measures, while observing an unprecedented level of emerging new technologies and innovations towards green aviation transition;

b) recognize that comprehensive actions to reduce aviation in-sector CO_2 emissions by ICAO and its Member States with relevant organizations are required, such as policies, incentives and investments for the research, development and deployment of new aircraft with zero carbon emissions operation, and necessary changes to the airport and energy supply infrastructure, as well as Sustainable Aviation Fuel (SAF), Lower Carbon Aviation Fuel (LCAF) and other cleaner energy sources for aviation, aiming at the cost competitive production on a commercial scale; and

c) use the information contained in this paper, for consideration of possible outcomes of the HLM-LTAG related to the LTAG Building Block 2: *Technical Feasibility of LTAG Scenarios*, including concrete actions that need to be taken by ICAO and its Member States and relevant stakeholders on aviation CO_2 emissions reduction measures in the areas of aircraft technology, operations and fuels.

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