Long-Term Aspirational Goal Scenario Development

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Introduction

As is made clear elsewhere in this supplement, the ICAO LTAG feasibility study is based closely on the methods and models used for the CAEP Trends assessment, with important differences.

Most importantly, the LTAG analysis is not aimed at forecasting future emissions trends in aviation but is explicitly a scenario-based analysis. This means that it aims to show not what is *likely to happen*, but what *could happen* if certain conditions are met. This approach reflects the need for 'aspiration' in this analysis.

External conditions (primarily level of policy effort) were assumed to allow an assessment of the full range of feasibility, while "readiness and attainability" of in-sector measures (aircraft technology, operational improvements and alternative fuel use) were carefully considered by the LTAG experts in line with the Terms of Reference. This ensured that the study focussed on technical feasibility without prejudging political decisions yet to be made.

The Scenario Development Sub-Group was formed after the 2020 CAEP Steering Group to lead the development of integrated scenarios, coordinate the final analysis and lead communication and outreach. It had around 110 members and held 23 virtual meetings. The Cost Estimation ad hoc (CEahg) group was also established to review and develop an approach and methodologies for estimating cost and investments associated with the LTAG-TG Integrated Scenarios.

Importance of scenario development work

ICAO's LTAG analysis sits in the context of a multitude of similar exercises carried out in recent years by states, industry and others. These include the ATAG Waypoint 2050 report, the Destination 2050 report from European industry and many others.[2]

Drawing on this prior work, but consciously aiming to take the most inclusive possible approach, it was important that the scenarios considered responded directly to the request of the ICAO Council to consider the full "range of readiness and attainability" of "in-sector measures".

Unlike some other reports, CAEP was not asked to consider out-of-sector measures such as market-based measures. Indeed, consideration of policies required to implement the technical measures analysed by CAEP would be a matter for policymakers in ICAO, states and regional organisations, such as direct governmental and private investment, finance, technology assistance and capacity building to support implementation in developing states. The selection of these in-sector measures and out-of-sector measures is for states to consider.

The LTAG report therefore provides the technical evidence basis for consideration and possible future decision-making by the ICAO Council and Assembly, without pre-judging what those fora may decide.

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1 The co-Leads David Moroz (Department for Transport, UK) and Yuxiu Chen (Civil Aviation University of China) would like to acknowledge the invaluable contribution of the 111 members of the Long-Term Aspirational Goal Task Group's Scenario Subgroup.

2 https://aviationbenefits.org/media/167187/w2050_full.pdf, https://www.destination2050.eu/

LTAG integrated scenarios

CAEP was requested to "create integrated in-sector scenarios of technology, fuels and operations that represent a range of readiness and attainability".

Rather than exhaustively define "readiness and attainability" in a quantitative way, an overarching narrative was developed for three scenarios to cover the range of feasibility.[3] Technology, operations and fuels sub-scenarios were then developed and integrated to ensure internal consistency.

These three integrated scenarios range from the most easily attainable scenario, relying on measures with a high level of readiness, but the lowest climate ambition (IS1) to the least attainable scenario, relying on measures with a low level of readiness, but the highest climate ambition (IS3).

A baseline or 'frozen technology' scenario is also used for reference which assumes no technological, operational or fuels improvements after 2018 (IS0). Figure 1 summarises the integrated scenarios.

These are overlaid on ICAO's COVID-impacted air traffic forecasts to give nine series of results, as presented elsewhere in this supplement.

Using a cost minus baseline approach, CEahg assessed the costs and investments associated with integrated scenarios, including costs or savings from technology, operations and fuels measures across stakeholders. This assessment is described in more detail elsewhere in this supplement.

Comparison to Trends

As mentioned above, it is important to understand the similarities and differences between the LTAG analysis and the ICAO Environmental Trends assessment.

While both use the same models, base year and underlying traffic forecasts, they are intended for different purposes.

This means that, for the LTAG analysis, not only was the time horizon extended to 2070 to capture the impact of new technology entering the fleet up to 2050, but more innovative, radical and aggressive emission reduction measures are considered, within the limits of technical feasibility.

It is also important to note that the LTAG study only considers international aviation, meaning that some measures that may have an impact on domestic aviation (e.g. electrification) do not feature prominently.

MDG/FESG Baseline (for context)	LTAG-TG Scenarios		
Integrated Scenario 0 (IS0)	**Integrated Scenario 1 (IS1)**	**Integrated Scenario 2 (IS2)**	**Integrated Scenario 3 (IS3)**
• 'Frozen' scenario	• 'Low / nominal' scenario	• 'Increased / further ambition' scenario	• 'Aggressive / speculative' scenario
• Projection of current technologies available in the base year (through fleet renewal)	• Current (c. 2021) expectation of future available technologies, operational efficiencies and fuel availability	• Faster rollout of future technologies, increased operational efficiencies and higher fuel availability	• Maximum possible effort in terms of future technology rollout, operational efficiencies, fuel availability
• No additional improvements from technology, operations and no emissions reductions from fuels (SAF)	• Expected policy enablers for technology, ops and fuels	• Increased policy enablers for technology, ops and fuels	• Maximum policy enablers for technology, ops and fuels.
• No systemic change – e.g. infrastructure changes to accommodate growth only	• Low systemic change – e.g. no substantial infrastructure changes	• Increased systemic change – e.g. limited infrastructure changes	• High, internationally aligned systemic change - e.g. significant and broad change to airport and energy infrastructure

Decreasing readiness and attainability. Increasing aspiration.

FIGURE 1: LTAG integrated scenarios

3 The interpretations of 'readiness and attainability' adopted for technology, operations and fuels measures are described in the LTAG final report https://www.icao.int/environmental-protection/LTAG/Pages/LTAGreport.aspx

Climate science context

CAEP was requested to place the results of the LTAG feasibility study "within the context of the latest consensus scientific knowledge", namely the allowable global emissions remaining within the temperature goals set out in the Paris Agreement.

The results of the LTAG analysis were therefore compared to the Shared Socioeconomic Pathways from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment report, as summarised by CAEP.[4] This comparison "provides factual information to allow decision makers to do their work and does not seek to advise on a share of global carbon budgets that international aviation should consume".[5]

This comparison shows that, over the 2020–2070 period, international aviation could represent approximately 4.1–11.3% of the global carbon budget for limiting global warming to 1.5°C (with 67% probability), depending on the integrated scenario. For limiting global warming to 2°C (with 67% probability) aviation's share could be approximately 1.4–3.9%. For comparison, historical CO_2 emissions from global aviation (including domestic) represent approximately 1.5% of all global CO_2 emissions.

Sensitivity analysis

In developing the integrated scenarios, LTAG recognised that there could be multiple combinations of technology, operations and fuels measures to form alternative integrated scenarios. In particular, sensitivity analysis was conducted to examine the impact of lower technology and operations improvements, coupled with high reductions from fuels.

This shows that there are multiple paths that may result in similar levels of emissions but that in all cases the contribution from fuels is critical to decouple the growth in international air traffic from its emissions. It also shows that there is robustness in the LTAG scenarios and analysis.

Implementation considerations

"Roadmaps for realisation" or implementation of the scenarios were also considered, mindful of the use of these words in the report of the 40th ICAO Assembly. Some technical considerations were identified without pre-judging future decisions.

Anticipating a process for reporting progress towards any goal and the need not to duplicate existing process or place undue burden on non-state actors, it is identified that the ICAO State Action Plan process could be used by states to report progress towards any goal. Building on the expertise gained through the development of CORSIA, future work could be conducted in the process of implementation on possible metrics and reporting mechanisms.

Similarly, a triennial review process could be considered similar to the CORSIA Periodic Review, anticipating a need to review any goal adopted in light of information such as progress towards the goal, technological developments, progress in other sectors, costs and other impacts as well as the latest scientific knowledge on climate change mitigation and adaptation.

There is also a potential need for capacity building and assistance in order to realise any goal. This could include workshops on possible measures and associated costs, or assistance with monitoring and measuring emissions could form part of an overarching training programme similar to the successful ACT-CORSIA programme, as well as other assistance and support that could be considered in future.

4 https://www.ipcc.ch/assessment-report/ar6/, https://www.icao.int/environmental-protection/LTAG/Documents/ICAO_LTAG_Report_AppendixS1.pdf

5 https://www.icao.int/environmental-protection/LTAG/Documents/ICAO_LTAG_Report_AppendixR3.pdf