Environmental Trends in Aviation to 2050

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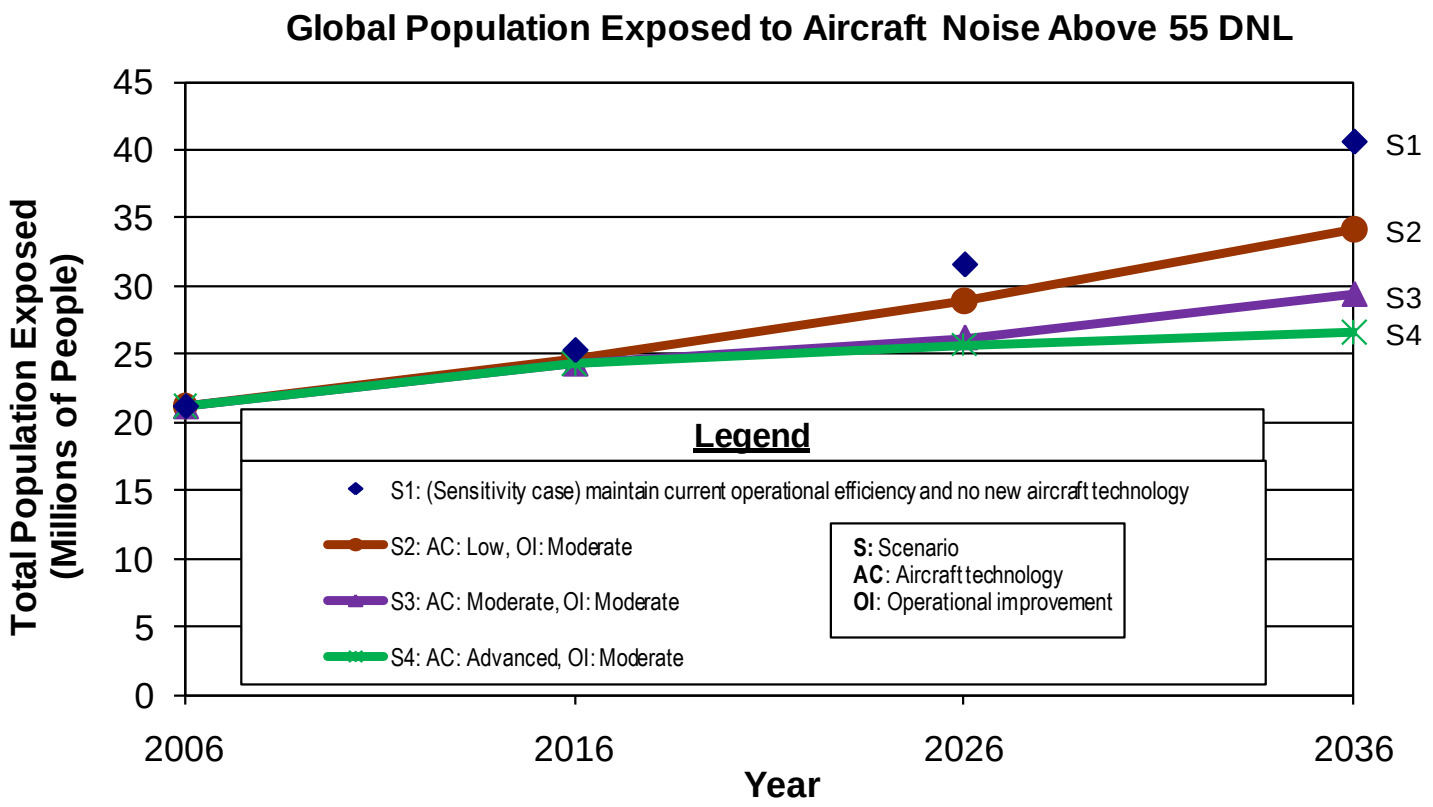
Background

- Each three-year work cycle the Committee on Aviation Environmental Protection's Modelling and Databases Group (ICAO/CAEP/MDG) develops environmental trends in aviation to include:
  - Noise;
  - Local Air Quality (LAQ); and
  - Greenhouse Gas Emissions (GHG)
- CAEP/MDG aims to use the latest input data and related assumptions
- Work driven by ICAO Assembly Resolution A37-18, "assess the present and future impact and trends of aircraft noise and aircraft engine emissions"

Presentation Overview

- Noise and LAQ trends (37th Assembly)
- GHG Trends (38th Assembly)
  - Assumptions
  - Models and databases
  - Scenarios
  - Results (fuel burn, demand uncertainty, CO_2 and alternative fuels)
- Summary

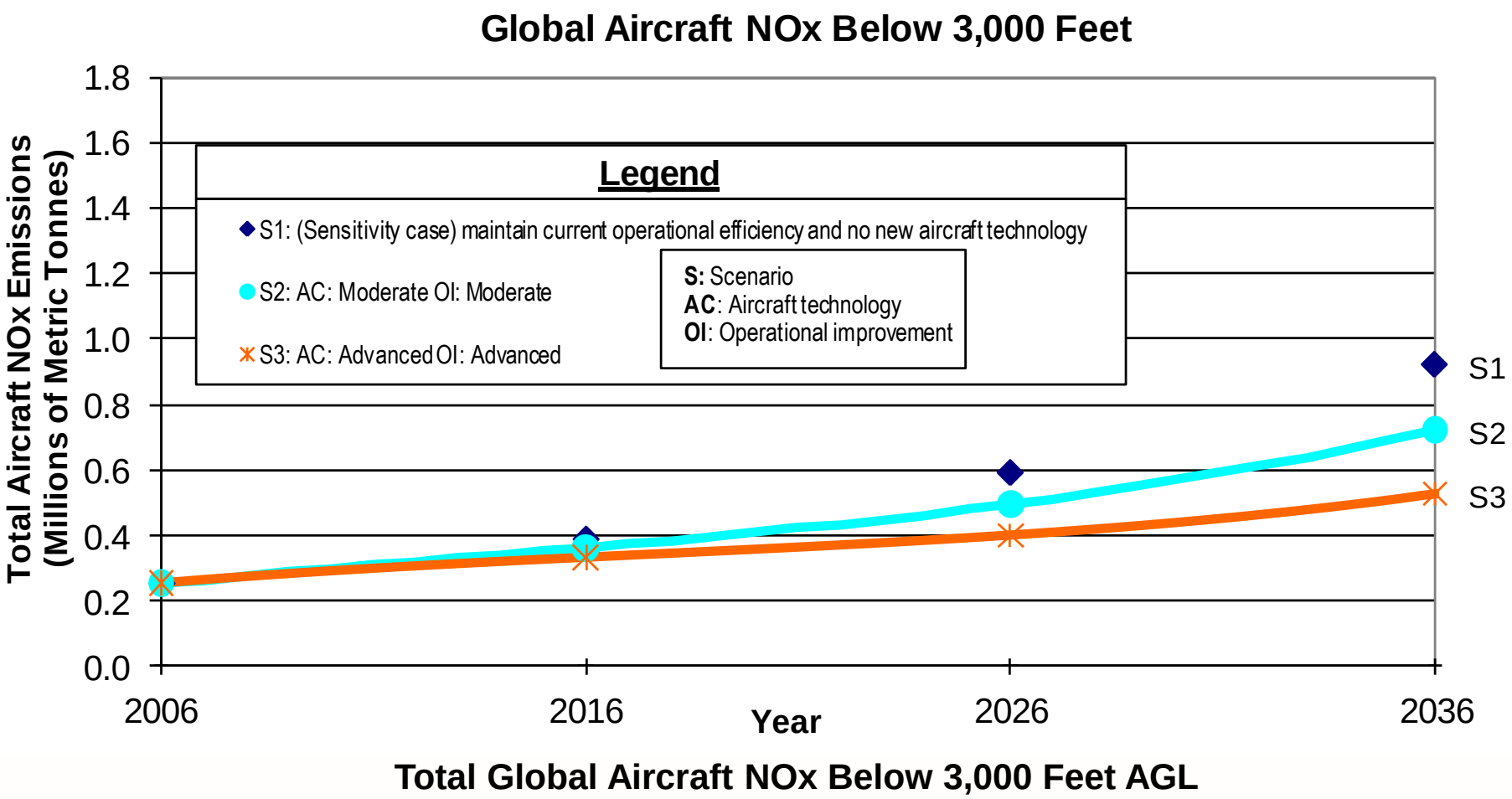
Global Noise Trends, 2006 to 2036



Note: Population exposed relative to 2006 baseline.
Population levels are assumed constant from 2006 to 2036.

Total Global Population Exposed to Aircraft Noise Above 55 DNL

Global LAQ Trends, 2006 to 2036



GHG Trends - Assumptions

- Results are based on the latest CAEP central demand forecast
  - Consensus view of CAEP experts, meeting unique requirement of CAEP analyses (i.e., trends, stringency, etc.)
  - Separate forecast for PAX, cargo and business aviation
  - Base year of 2010, using the MDG common operations database (COD)
  - Forecasted years included 2020, 2030 with an extension to 2040; results extrapolated to 2050
- Data presented for 2005 and 2006 were reproduced from prior trends assessments

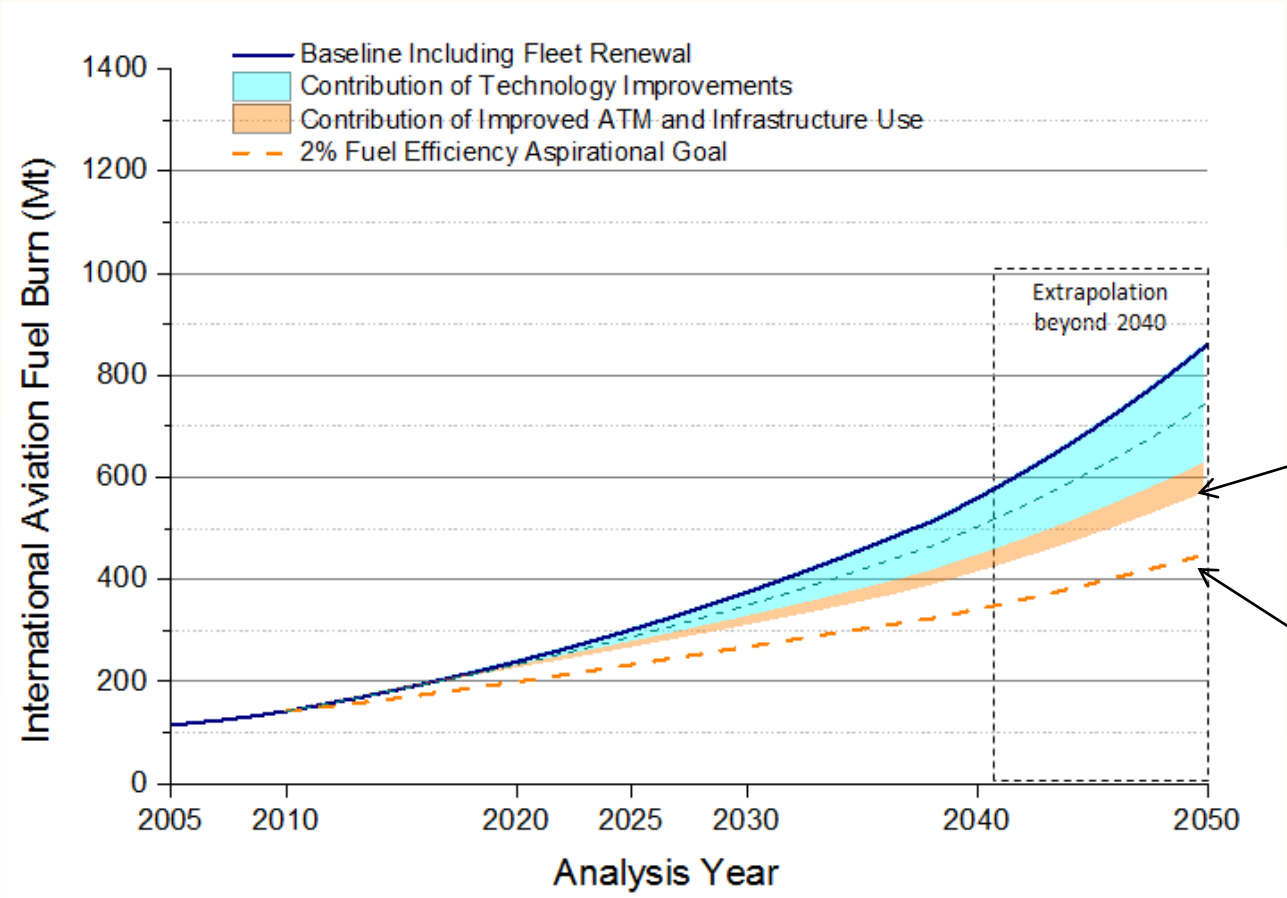
GHG Trends - Models and Database

- Three models contributed results to the GHG trends assessment:
  - FAA's Aviation Environmental Design Tool (AEDT)
  - EUROCONTROL's Advanced Emissions Model (AEM)
  - Manchester Metropolitan University's Future Civil Aviation Scenario Software Tool (FAST)
- Key databases included:
  - Airports database
  - Campbell-Hill and Growth and Replacement Fleet database
  - Common operations database (COD)

GHG Trends - Scenarios

Scenario	Name	Technology Improvement	Operational Improvement
1	Baseline Including Fleet Renewal	None	None
2	Low Aircraft Technology and Moderate Operational Improvement	0.96%/annum, 2010-2015 0.57%/annum, 2015-2050	CAEP/8 IE Lower Bound
3	Moderate Aircraft Technology and Operational Improvement	0.96%/annum, 2010-2050	CAEP/8 IE Lower Bound
4	Advanced Aircraft Technology and Operational Improvement	1.16%/annum, 2010-2050	CAEP/8 IE Upper Bound
5	Optimistic Aircraft Technology and Advanced Operational Improvement	1.50%/annum, 2010-2050	CAEP/8 IE Upper Bound
6	Low Aircraft Technology and CAEP/9 Independent Expert (IE) Operational Improvement	0.96%/annum, 2010-2015 0.57%/annum, 2015-2050	CAEP/9 IE
7	Moderate Aircraft Technology and CAEP/9 IE Operational Improvement	0.96%/annum, 2010-2050	CAEP/9 IE
8	Advanced Aircraft Technology and CAEP/9 IE Operational Improvement	1.16%/annum, 2010-2050	CAEP/9 IE
9	Optimistic Aircraft Technology and CAEP/9 IE Operational Improvement	1.50%/annum, 2010-2050	CAEP/9 IE

Fuel Burn Trends from International Aviation, 2005 to 2050

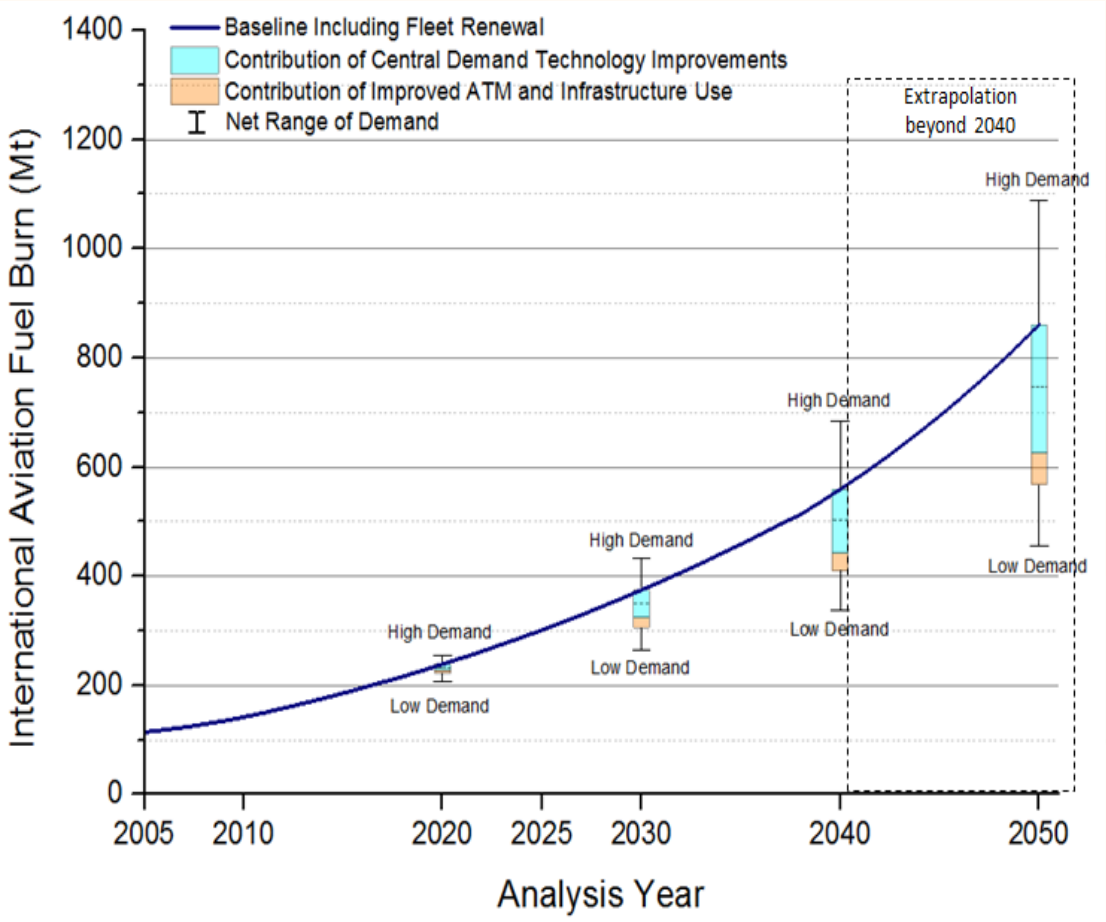


1.39% fuel efficiency

2% fuel efficiency

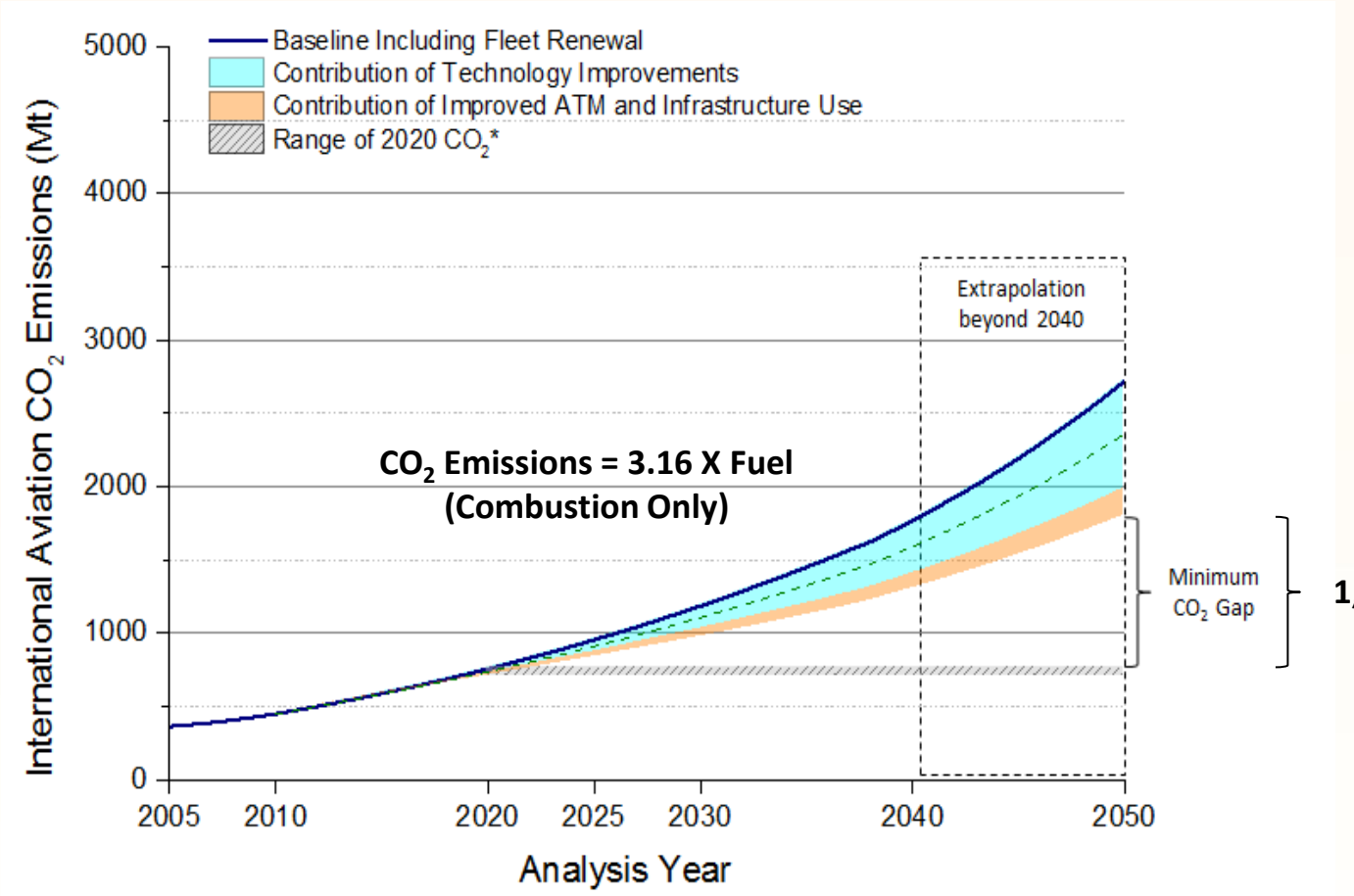
*Dashed line in technology contribution sliver represents the "Low Aircraft Technology Scenario."
Note: Results were modelled for 2005, 2006, 2010, 2020, 2025, 2030, and 2040 then extrapolated to 2050.

Range of Uncertainties Associated with Demand Forecast, 2005 to 2050



Note: Fuel burn was only modelled for the central demand forecast. The effects of the high and low demand sensitivities shown are based on the ratio of forecasted revenue passenger kilometres for high/low demand relative to central demand.

CO_2 Emissions Trends from International Aviation, 2005 to 2050

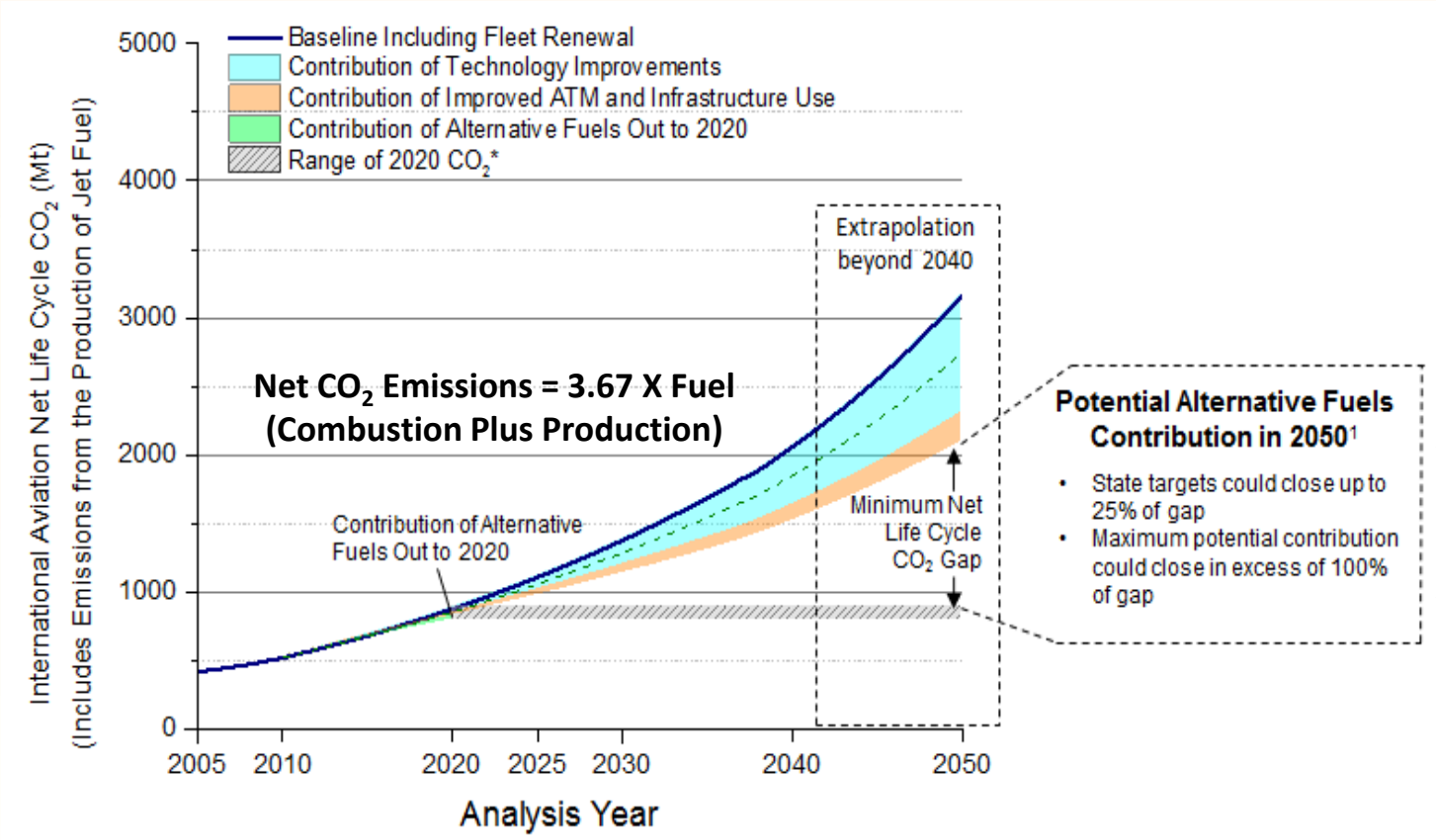


*Actual carbon neutral line is within this range
Dashed line in technology contribution sliver represents the "Low Aircraft Technology Scenario."
Note: Results were modelled for 2005, 2006, 2010, 2020, 2025, 2030, and 2040 then extrapolated to 2050.

Consideration of Alternative Fuels

- CAEP Member State and Observer Organization provided targets for alternative fuel production in 2020 and 2050
- Alternative fuels considered in terms of net life cycle CO_2 – both combustion (X3.16) and production (X0.51)
- Approach based on best available scientific literature, but not fully vetted and endorsed by ICAO
- Approach does not represent a change of practice/paradigm
- Work needed to further develop methodologies to take account of aviation net life cycle CO_2 emissions

Net Life Cycle CO_2 Emissions Trends from International Aviation, 2005 to 2050



*Actual carbon neutral line is within this range
Dashed line in technology contribution sliver represents the "Low Aircraft Technology Scenario."
[1]If all alternative fuels in 2050 were zero net carbon
Note: Results were modelled for 2005, 2006, 2010, 2020, 2025, 2030, and 2040 then extrapolated to 2050.

Summary

- Population exposed to aircraft noise, emissions that affect LAQ and CO_2 emissions that affect the climate are expected to increase, but at a rate slower than aviation demand
- The uncertainty associated with future aviation demand is notably larger than the range of contributions from technology & operational improvements
- International aviation fuel efficiency is expected to improve to 2050; but measures in addition to those considered in this analysis will be required to achieve the 2 percent annual fuel efficiency aspirational goal
- Considering only aircraft technology and operational improvements, additional measures will be needed to achieve carbon neutral growth relative to 2020
- Sustainable alternative fuels have the potential to make a significant contribution; insufficient data are available to confidently predict their availability over the long term