Appendix 13-6: Climate Change – GHG Assessment – Non-CO2 Emissions

Appendix 13-6 Climate Change – GHG Assessment – Non-CO_2 Emissions

1. Introduction

1.1.1 In addition to the direct climate effects from the combustion of fossil fuels, aviation is known to result in a range of pollutants that can affect the climate in other ways; these include nitrogen oxides and water vapour that can, for example, result in contrails leading to the formation of cirrus clouds.

1.1.2 These non-CO_2 impacts are generally short-lived and reversible, meaning they will dissipate after the aircraft passes. This is in contrast to emissions of CO_2, which remain in the atmosphere causing warming for long time periods.

1.1.3 The methodology for estimating the non-CO_2 effects of aviation activities draws on the European Commission's monitoring, reporting and verification (MRV) framework which came into force in January 2025[1]. This framework introduces the Non-CO_2 Aviation Effects Tracking System (NEATS), an advanced tool designed for aircraft operators to calculate non-CO_2 impacts using detailed, flight-specific inputs. These inputs include flight trajectory networks (e.g. route, distance, latitude and longitude), aircraft and engine characteristics, prevailing meteorological conditions, and fuel properties. While this represents the most comprehensive approach currently available, it is primarily intended for regulatory reporting purposes and requires a high level of data granularity. As such, this approach is not considered proportionate or practical for use within this assessment. This is due to the scale of total flights involved, the extended modelling timeframe to 2050, and the inclusion of a significant number of international flights beyond EU boundaries, which limits the applicability of the tool.

1.1.4 In place of detailed modelling, a simplified factor-based approach was adopted. This approach is informed by established research, including the European Commission's 2020 report on non-CO_2 aviation impacts, which indicates that non-CO_2 effects contribute significantly to overall aviation-induced climate forcing. Specifically, the report estimates that non-CO_2 impacts account for approximately 66% of total aviation effective radiative forcing (ERF). This report also acknowledges a high level of uncertainty in the reporting of non CO_2 emissions and that there is on-going research at the EU level to provide more robust understanding of these emissions.

1.1.5 To reflect these findings, a conservative blanket uplift factor of 2.9 times CO_2 emissions was applied to approximate total aviation climate impacts, including both CO_2 and non-CO_2 effects (such as contrail cirrus, nitrogen oxides, water vapour, and particulate matter). This provides a transparent means of capturing the additional warming effects associated with aviation in the absence of detailed flight-level modelling. However, it is recognised that this approach is a simplification and does not fully capture the variability associated with non-CO_2 impacts, which are influenced by factors such as altitude, routing, atmospheric conditions, and aircraft performance.

1.1.6 Fuel composition is also an important consideration in this context. Conventional aviation fuels typically contain higher levels of aromatic compounds, leading to increased emissions of non volatile particulate matter (nvPM). These particles play a key role in the formation and persistence of contrails, which are a major contributor to non CO_2 climate effects. In contrast, Sustainable Aviation Fuels (SAFs) generally have lower aromatic content, resulting in reduced nvPM emissions and potentially lower contrail formation. Consequently, the application of a 2.9x uplift factor may be conservative, particularly in scenarios where SAF uptake is assumed.

[1] EU Commission. (2020). Updated analysis of the non-CO_2 climate impacts of aviation and potential policy measures pursuant to EU Emissions Trading System. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=C

1.1.7 As a sensitivity analysis, non-CO_2 impacts have been assessed using this approach to provide an estimate of the potential total climate impact of aviation emissions. However, current carbon budgets are limited to GHG emissions covered under the Kyoto Protocol and do not include non-Kyoto Protocol GHG effects. As a result, these impacts cannot be directly compared against current carbon budgets on a like-for-like basis. Instead, the results are presented in this appendix to illustrate the absolute scale of total aviation impacts and subsequently considered in accordance with ISEP GHG assessment guidance to evaluate whether sufficient mitigation measures are in place at both the policy and Proposed Order levels, in line with the Paris Agreement.

1.1.8 Table 13F-1 presents the results uplifting them by 2.9x.

Table 13F-1: Total aviation emissions including non-CO2 impacts (tCO2e)

Year	Permitted Baseline (32mppa)	Current State of Environment (36.4 mppa)	Future Proposed Order State (40 mppa)	Future Do Nothing State (32mppa)
2023	10,182,223.44	-	-	-
2024	10,039,672.32	-	-	-
2025	9,760,529.27	10,782,789.58	10,733,477.58	9,531,700.02
2026	9,582,887.63	10,586,542.81	10,807,762.84	9,358,223.08
2027	9,408,306.90	10,393,677.52	10,624,307.91	9,187,735.28
2028	9,236,736.19	10,204,137.50	10,783,136.60	9,020,186.93
2029	8,855,529.13	10,017,867.44	11,102,026.84	8,855,529.13
2030	8,693,713.80	9,834,812.93	10,899,161.70	8,693,713.80
2031	8,385,460.83	9,486,100.02	10,512,710.18	8,385,460.83
2032	8,084,134.98	9,145,223.44	10,134,943.06	8,084,134.98
2033	7,789,602.71	8,812,032.14	9,765,692.94	7,789,602.71
2034	7,501,732.84	8,486,377.73	9,404,795.37	7,501,732.84
2035	7,220,396.57	8,168,114.48	9,052,088.86	7,220,396.57
2036	6,980,236.11	7,896,431.60	8,751,003.75	6,980,236.11
2037	6,745,384.94	7,630,754.88	8,456,574.82	6,745,384.94
2038	6,515,741.48	7,370,969.41	8,168,674.70	6,515,741.48
2039	6,291,205.93	7,116,962.31	7,887,178.29	6,291,205.93
2040	6,071,680.30	6,868,622.70	7,611,962.73	6,071,680.30
2041	6,005,955.93	6,794,271.63	7,529,565.19	6,005,955.93
2042	5,940,231.55	6,719,920.56	7,447,167.66	5,940,231.55
2043	5,874,507.18	6,645,569.49	7,364,770.12	5,874,507.18

Year	Permitted Baseline (32mppa)	Current State of Environment (36.4 mppa)	Future Proposed Order State (40 mppa)	Future Do Nothing State (32mppa)
2044	5,808,782.80	6,571,218.42	7,282,372.59	5,808,782.80
2045	5,743,058.43	6,496,867.35	7,199,975.05	5,743,058.43
2046	5,469,206.87	6,187,071.22	6,856,651.99	5,469,206.87
2047	5,195,355.31	5,877,275.09	6,513,328.93	5,195,355.31
2048	4,921,503.75	5,567,478.97	6,170,005.87	4,921,503.75
2049	4,647,652.19	5,257,682.84	5,826,682.81	4,647,652.19
2050	4,373,800.63	4,947,886.71	5,483,359.75	4,373,800.63

1.1.9 The figures presented in this appendix should be read in conjunction with the assessment set out in the main Climate chapter (Chapter 13). The same principles, assumptions and methodological approach apply, and the conclusions reached in the main chapter remain valid here. No additional factors have been identified that would alter the findings of the primary assessment.