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ARTICLE

Climate Change Mitigation in the Aviation Sector: A Critical Overview of National and International Initiatives

Benoit Mayer* and Zhuoqi Ding**

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Abstract
Climate change mitigation calls for the limitation and reduction of greenhouse gas (GHG) emissions across all sectors. However, limiting GHG emissions from aviation has proven to be problematic for technical reasons (e.g., lack of low-carbon alternatives) as well as legal reasons (e.g., international aviation does not readily fall within any one state's jurisdiction). Relevant initiatives have followed two streams. At the international level, the International Civil Aviation Organization (ICAO) has adopted technical standards and, more recently, a market-based mechanism to limit emissions from international civil aviation. In parallel, states have adopted their own policies and measures to regulate emissions from both domestic and international aviation, ranging from tax and technical standards to traffic management and infrastructural development. While much of the literature on climate change mitigation in the aviation sector has focused on international efforts, this article reveals the importance of understanding the tensions and complementarities of the two streams.

Keywords: Climate change mitigation, Civil aviation, ICAO, CORSIA, National regulation

1. INTRODUCTION

States have agreed that anthropogenic emissions of greenhouse gases (GHG) are altering our climate system in dangerous ways.[1] Accordingly, they have agreed on the need

* The Chinese University of Hong Kong, Faculty of Law (Hong Kong).
Email: bmayer@cuhk.edu.hk.
** The Chinese University of Hong Kong, Faculty of Law (Hong Kong).
Email: zhuoqi.ding@link.cuhk.edu.hk.
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1 United Nations Framework Convention on Climate Change (UNFCCC), New York, NY (United States (US)), 9 May 1992, in force 21 Mar. 1994, para. 3, available at: https://unfccc.int/resource/docs/convkp/conveng.pdf.

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for broad international cooperation on climate change mitigation.[2] Achieving the 2°C and 1.5°C targets,[3] or carbon neutrality, in the second half of the century[4] requires substantive mitigation achievements across all sectors. However, mitigation action in the aviation sector raises considerable technological and legal challenges. On the one hand, there is no demonstrated, scalable alternative technology for transporting people and goods rapidly over long distances without affecting the climate system. On the other hand, there is no consensus on how to allocate responsibilities for reducing international aviation emissions among states. As a result of this perfect storm, GHG emissions in the aviation sector have increased more quickly and more steadily in the last three decades than in almost any other sector; no state has achieved a durable, absolute reduction in GHG emissions from civil aviation.[5]

This article explores the policies and measures that have been implemented to regulate civil aviation emissions.[6] It includes a doctrinal analysis, complemented with comparative and critical perspectives building on an interdisciplinary literature, in order to assess the effectiveness of existing developments and consider the potential for further action. It shows that, despite the greater attention they have generally received,[7] the initiatives adopted under the International Civil Aviation Organization (ICAO) are only part of a broader picture, and perhaps not the main part. Another major stream of action on climate change mitigation in the aviation sector consists of policies and measures adopted by states, ranging from carbon pricing (direct or indirect) and technical standards (such as aircraft efficiency and renewable-fuel content) to air-traffic management and infrastructure development.

These two streams may appear to be unrelated: while the ICAO addresses *international* civil aviation,[8] one could expect that each state would seek only to address GHG emissions within its own territory[9] – that is, emissions from domestic aviation. In reality, however, climate treaties (with the historical exception of the Kyoto

2 Ibid., Art. 2.

3 Paris Agreement, Paris (France), 12 Dec. 2015, in force 4 Nov. 2016, Art. 2(1)(a), available at: http://unfccc.int/paris_agreement/items/9485.php.

4 Ibid., Art. 4(1).

5 See Section 2.1 below.

6 Military aviation raises similar technological issues but different regulatory challenges, as attribution to a state is generally unproblematic (with the notable exception of emissions from multilateral operations).

7 E.g., B.P. Kerr, 'Clear Skies or Turbulence Ahead? The International Civil Aviation Organization's Obligation to Mitigate Climate Change' (2020) 16(1) *Utrecht Law Review*, pp. 101–6; M.T. Ahmad, *Climate Change Governance in International Civil Aviation: Towards Regulating Emissions Relevant to Climate Change and Global Warming* (Eleven Publishing, 2016); B. Martinez Romera, 'The Paris Agreement and the Regulation of International Bunker Fuels' (2016) 25(2) *Review of European, Comparative and International Environmental Law*, pp. 215–27.

8 Convention on International Civil Aviation, Chicago, IL (US), 7 Dec. 1944, in force 4 Apr. 1947 as amended, Art. 44, available at: https://www.icao.int/publications/Documents/7300_9ed.pdf (Chicago Convention).

9 On the assumption that states' mitigation obligations are purely territorial, see *Greenpeace* v. *The Netherlands*, Rechtbank, The Hague (The Netherlands), 9 Dec. 2020, ECLI:NL:RBDHA:2020:12440, para. 4.4; *Natur og Ungdom* v. *Norway*, Case No. 20-051052SIV-HRET, 22 Dec. 2020, para. 159, unofficial English translation available at: https://www.xn–klimasksml-95a8t.no/wp-content/uploads/2021/01/judgement_translated.pdf.

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Protocol)[10] leave it essentially for each party to decide whether its national policies and measures on climate change mitigation are to address the GHG emissions from international transportation.[11] Some national policies and measures do regulate GHG emissions from international civil aviation or apply indiscriminately to domestic and international aviation. However, even when they apply only to domestic aviation, national actions may interact with international civil aviation, for instance, by achieving economies of scale on the deployment of more efficient aircraft or by causing carbon leakage when less efficient aeroplanes are redeployed. As such, devising effective efforts to reduce the climate impact of aviation requires close coordination between national and international efforts.

This article has two complementary objectives. Firstly, it documents the international and national streams of mitigation action. It shows that the focus on ICAO initiatives is misplaced: thus far, international initiatives have failed to deliver tangible benefits, while national initiatives have been (partially) successful. Secondly, the article highlights the interactions between the two streams. In so doing, it illustrates the need to think about climate law beyond the traditional divide between national and international law, through what could be called a 'transnational' analysis.[12] The decarbonization of the aviation sector does not depend entirely on international *or* national action, but on the way in which the two interact.

The article is organized as follows. Section 2 flags the unique technological and legal challenges to climate change mitigation in the aviation sector. Sections 3 and 4 identify, respectively, international and national initiatives adopted to date. Section 5 analyzes the relations between these two streams.

2. AVIATION AND CLIMATE CHANGE MITIGATION

This section exposes the stakes and challenges of climate change mitigation in the aviation sector. It documents the sector's increasing climate impact before identifying the technological and regulatory challenges faced by any initiatives aimed at reducing this impact.

2.1. *GHG Emissions from Aviation*

Aviation is of particular concern for climate change mitigation for three reasons. Firstly, its impact on the climate system is significant. Data compiled by the Organisation for Economic Co-operation and Development (OECD) suggests that civil aviation resulted in 883 megatonnes (Mt) of carbon dioxide (CO_2) emissions in 2018, two-thirds of which from international flights.[13] Aviation CO_2 emissions represent about 2.4% of

[10] Kyoto Protocol to the UNFCCC, Kyoto (Japan), 10 Dec. 1997, in force 16 Feb. 2005, available at: http://unfccc.int/kyoto_protocol/items/2830.php.

[11] See Section 2.3 below.

[12] E. Fisher, 'The Rise of Transnational Environmental Law and the Expertise of Environmental Lawyers' (2011) 1(1) *Transnational Environmental Law*, pp. 43–52, at 49.

[13] OECD, 'Air Transport CO_2 Emissions', 2020, available at: https://stats.oecd.org/Index.aspx?DataSetCode=AIRTRANS_CO2 (tier 3A methodology).

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global anthropogenic CO_2 emissions.[14] However, these numbers do not account for all of aviation's climate impact: beside CO_2, aircraft produce short-term radiative forcers (such as nitrous oxide and soot particles) and contrails, the climate impact of which is significant, albeit relatively poorly understood.[15] Recent studies suggest that the non-CO_2 climate impact of aviation may exceed its CO_2 impact,[16] especially on a short- to medium-term horizon.[17] When all factors are taken into account, in one estimate aviation contributes to 'roughly 5% of the total anthropogenic warming'.[18]

Secondly, the climate impact of aviation is increasing more rapidly than that of almost any other sector. OECD statistics show that aviation's global CO_2 emissions increased by 28% from 2013 to 2018.[19] According to data from the International Energy Agency (IEA), emissions from international aviation increased 2.9 times from 1980 to 2017, compared with 1.9 times for overall CO_2 emissions from fuel combustion.[20] Aviation emissions have increased markedly more quickly than emissions from other modes of transportation.[21] Measures taken in response to the COVID-19 pandemic have led to emissions reductions, which, however, are not expected to alter long-term trends.[22] Air traffic is predicted to increase several fold during the first half of the 21st century, which, despite market-driven fuel-efficiency gains, will significantly increase the sector's climate impact.[23]

Thirdly, states are yet to find ways to reduce significantly the climate impact of aviation, especially with regard to international flights. While much of the increase in

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14 Our calculation based on 2018 global GHG emissions (including land use, land-use change and forestry activities) from CAIT Climate Watch, available at: https://www.climatewatchdata.org.

15 D.S. Lee et al., 'Aviation and Global Climate Change in the 21st Century' (2009) 43(22–23) *Atmospheric Environment*, pp. 3520–37; L. Bock & U. Burkhardt, 'Contrail Cirrus Radiative Forcing for Future Air Traffic' (2019) 19(12) *Atmospheric Chemistry and Physics*, pp. 8163–74; V. Grewe, S. Matthes & K. Dahlmann, 'The Contribution of Aviation NOx Emissions to Climate Change: Are We Ignoring Methodological Flaws?' (2019) 14(12) *Environmental Research Letters*, article 121003.

16 EU Aviation Safety Agency (EASA), 'Updated Analysis of the Non-CO_2 Climate Impacts of Aviation and Potential Policy Measures pursuant to the EU Emissions Trading System Directive Article 30(4)', Sept. 2020, p. 7, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2020:277:FIN; D.S. Lee et al., 'The Contribution of Global Aviation to Anthropogenic Climate Forcing for 2000 to 2018' (2021) 244 *Atmospheric Environment*, article 117834; V. Naik et al., 'Short-Lived Climate Forcers', in V. Masson-Delmotte et al. (eds), *Climate Change 2021: The Physical Science Basis* (accepted version subject to final editing, IPCC, 2021), s. 6.6.2.3.1.

17 See P.A. Arias et al., 'Technical Summary', in Masson-Delmotte et al., n. 16 above, pp. 35–144, at 102, Figure TS.20.

18 Grewe, Matthes & Dahlmann, n. 15 above, p. 1.

19 OECD, n. 13 above.

20 Our calculation based on data from IEA, 'CO_2 Emissions from Fuel Combustion', 30 Oct. 2019, para. II.4, available at: https://doi.org/10.1787/2a701673-en.

21 R. Sims et al., 'Transport', in O. Edenhofer et al. (eds), *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press, 2014), pp. 599–670, at 606.

22 Lee et al., n. 16 above, p. 15.

23 G.G. Fleming & I. de Lépinay, 'Environmental Trends in Aviation to 2050', in J. Hupe et al. (eds), *2019 Environmental Report, Aviation and Environment – Destination Green: The Next Chapter* (ICAO, 2019), pp. 17–23, at 17; S.J. Davis et al., 'Net-zero Emissions Energy Systems' (2018) 360(6396) *Science*, eaas9793; Sustainable, Low Carbon Transport (SLOCAT), 'Tracking Trends in a Time of Change: The Need for Radical Action towards Sustainable Transport Decarbonisation', Transport and Climate Change Global Status Report, 2nd edn, 2021, pp. 206–14, available at: https://tcc-gsr.com.

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aviation emissions results from the economic development of emerging economies,[24] developed countries have not demonstrated the possibility of decoupling the sector's growth from its climate impact. Emissions from domestic aviation of the European Union (EU) (namely, within a Member State) decreased by 13% from 2000 to 2018, which is broadly in line with the EU's 16% reduction in CO_2 overall emissions during that period; however, emissions from international civil aviation departing from the EU (including flights between Member States) increased by 51% during that same period.[25] Following a comparable pattern, CO_2 emissions from domestic aviation in the United States (US) decreased by 9% from 2005 to 2018, while emissions from international flights departing from the US increased by 34%.[26] Overall, emissions from international flights departing from the developed country parties listed in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC)[27] more than doubled between 1990 and 2018.[28]

2.2. *The Technological Challenge*

Instead of structural changes, policies and measures have frequently focused on efficiency gains in aircraft design,[29] air traffic management,[30] and ground service equipment.[31] These measures are partly economically driven, as they achieve fuel savings and reduce delays. Yet, these economic gains suggest that such measures could produce a 'rebound effect' whereby lower prices would allow airlines to meet additional demand and extend activity, thus even potentially *increasing* their climate impact.[32] At any rate, none of these measures shows a clear path towards a deep decarbonization of the aviation sector.

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[24] Between 2013 and 2018, the CO_2 emissions of domestic aviation in China, India, and Indonesia increased respectively by 57%, 82%, and 52%, according to OECD, n. 13 above.

[25] Our calculation based on data from European Environment Agency (EEA), 'National Emissions Reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism', 21 Dec. 2020, DAT-13-en, available at: https://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-17.

[26] US Environmental Protection Agency (EPA), 'Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2018', 2020, pp. 3–26, available at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018.

[27] N. 1 above.

[28] UNFCCC Secretariat, 'Compilation and Synthesis of Fourth Biennial Reports of Parties included in Annex I to the Convention', 12 Nov. 2020, UN Doc. FCCC/SBI/2020/INF.10/Add.1, para. 42, available at: https://unfccc.int/documents/266354.

[29] National Academies of Sciences, Engineering and Medicine et al., *Commercial Aircraft Propulsion and Energy Systems Research: Reducing Global Carbon Emissions* (National Academies Press, 2016).

[30] M.N. Postorino, L. Mantecchini & F. Paganelli, 'Improving Taxi-out Operations at Airports to Reduce CO_2 Emissions' (2019) 80 *Transport Policy*, pp. 167–76.

[31] Sims et al., n. 21 above, p. 614.

[32] A. Evans & A. Schäfer, 'The Rebound Effect in the Aviation Sector' (2013) 36 *Energy Economics*, pp. 158–65; A. Bows-Larkin, 'All Adrift: Aviation, Shipping, and Climate Change Policy' (2015) 15(6) *Climate Policy*, pp. 681–702, at 692; H. Fukui & C. Miyoshi, 'The Impact of Aviation Fuel Tax on Fuel Consumption and Carbon Emissions: The Case of the US Airlines Industry' (2017) 50 *Transportation Research Part D: Transport and Environment*, pp. 243–53, at 248.

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Despite contrary suggestions from industry associations,[33] societies have yet to come up with realistic, long-term plans for climate-neutral modes of rapid, long-distance transportation.[34] Other modes of transportation (such as high-speed rail) provide realistic alternatives only to short-haul flights, whereas long-haul flights are responsible for most of the sector's climate impact.[35] Reliance on biofuel or hydrogen, or attempts to offset aviation emissions, would face challenges of their own.[36] On the one hand, the production of biofuel is likely to require large spans of arable land,[37] thus competing with food production or otherwise hindering the large-scale deployment of bioenergy with carbon capture and storage as a negative emissions technology.[38] On the other hand, producing clean hydrogen fuel would require substantial amounts of energy, which is unlikely to be economically available.[39] Overall, sustainable aviation fuels would only slightly reduce the non-CO_2 climate impacts of aviation.[40] As such, the only known way to substantially reduce aviation's climate impact in the long term appears to involve a limitation, and possibly a reduction, in aviation activities, an option that faces considerable political challenges.

2.3. *The Regulatory Challenge*

States have not been able to agree on a formula to allocate responsibility for the climate impacts of international civil aviation. Responsibilities could be attributed, for instance, on the basis of the state of departure, arrival or overflight, the nationality of the passengers or of the consumers of the cargo, the country of registration of the aircraft, or the nationality of the airline or that of the aircraft-leasing company.[41] Achieving a political consensus is shown to be impossible because any of these criteria would have important implications for the interests of some states, for instance, because

[33] International Air Transport Association (IATA), 'Resolution on the Industry's Commitment to Reach Net Zero Carbon Emissions by 2050', 4 Oct. 2021, available at: https://www.iata.org/en/pressroom/2021-releases/2021-10-04-03; Oneworld, 'Oneworld Member Airlines Commit to Net Zero Carbon Emissions by 2050', 1 Sept. 2020, available at: https://www.oneworld.com/news/2020-09-11-oneworld-member-airlines-commit-to-net-zero-carbon-emissions-by-2050; A4E et al., 'Destination 2050: A Route to Net Zero European Aviation', 2021, available at: https://www.destination2050.eu.

[34] J. Rogelj et al., 'Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development', in V. Masson-Delmotte et al. (eds), *Global Warming of 1.5°C* (IPCC, 2018), pp. 93–174, at 143; IEA, 'Energy Technology Perspectives 2020', Feb. 2021, pp. 286–304.

[35] W. Rothengatter, 'Intermodal Dimension of Climate Change Policy', in F. Fichert, P. Forsyth & H.-M. Niemeier (eds), *Aviation and Climate Change* (Routledge, 2020), pp. 181–201, at 183.

[36] P. Peeters et al., 'Are Technology Myths Stalling Aviation Climate Policy?' (2016) 44 *Transportation Research Part D: Transport and Environment*, pp. 30–42.

[37] B. Hemmings et al., 'Roadmap to Decarbonising Aviation', in Fichert, Forsyth & Neimeier, n. 35 above, pp. 145–80, at 155.

[38] See O. Edenhofer et al., 'Summary for Policymakers', in Edenhofer et al., n. 21 above, pp. 1–30, at 25.

[39] A. Baroutaji, 'Comprehensive Investigation on Hydrogen and Fuel Cell Technology in the Aviation and Aerospace Sectors' (2019) 106 *Renewable and Sustainable Energy Reviews*, pp. 31–40, at 39.

[40] Grewe, Matthes & Dahlmann, n. 15 above; Bock & Burkhardt, n. 15 above; Lee et al., n. 16 above.

[41] UNFCCC Subsidiary Body for Scientific and Technological Advice, 'Detailed Information on Electricity Trade and International Bunker Fuels', 18 Dec. 1996, UN Doc. FCCC/SBSTA/1996/9/Add.2, available at: https://unfccc.int/documents/1440; U.M. Erling, 'How to Reconcile the European Union Emissions Trading System (EU ETS) for Aviation with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)?' (2018) 43(4–5) *Air & Space Law*, pp. 371–86, at 374.

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they host international aviation hubs, register large airlines, or rely disproportionately on international tourism or trade.[42]

Climate treaties have never formally defined, as a matter of principle, the geographical scope of states' general substantive obligations on climate change mitigation. Confusion often arises between the scope of two distinct obligations under the UNFCCC: the procedural obligation to communicate national GHG emissions inventories following methodologies agreed by the Conference of the Parties (COP)[43] and the substantive obligation to implement 'programmes containing measures to mitigate climate change'.[44] With regard to the former, the COP has agreed to the use of inventory guidelines adopted by the Intergovernmental Panel on Climate Change (IPCC),[45] which build on the assumption that each party should generally report the emissions that are generated within its territory, or, when this would not be practical, from the combustion of fuel sold within its territory.[46] As an exception, these guidelines suggest that international aviation and shipping emissions 'are to be excluded … from national totals' and 'should be reported separately'.[47] On the other hand, nothing in the UNFCCC implies that the latter, substantive obligation on climate change mitigation would be limited to the emissions that the party must inventory and report.

The Kyoto Protocol imposed quantified emissions limitation and reduction commitments on Annex I parties for two commitment periods from 2008 to 2020.[48] For the purpose of accounting for this quantified commitment, the Protocol relied on the IPCC inventory guidelines,[49] excluding emissions from international bunker fuels. The Protocol sought to address this gap by requiring each Annex I party to pursue regulation of international civil aviation through the ICAO.[50] The exclusion of international civil aviation from the scope of quantified commitments under the Kyoto Protocol does not necessarily imply that these emissions are excluded from the scope of the general mitigation obligation under the UNFCCC, nor does the commitment of Annex I parties to pursue an arrangement at the ICAO exclude international civil aviation from the scope of UNFCCC negotiations. Nothing in the UNFCCC or the Kyoto

[42] By contrast, road vehicle emissions are attributed to the state in which fuel is purchased, even though the fuel may be consumed abroad, on the ground that the difference 'is expected to be small': J.T. Houghton et al. (eds), *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (vol. 1, 1996), 'Overview', p. 5.

[43] UNFCCC, n. 1 above, Art. 12(1)(a).

[44] Ibid., Art. 4(1)(b).

[45] E.g., Decision 4/CP.1, 'Methodological Issues', 7 Apr. 1995, UN Doc. FCCC/CP/1995/7/Add.1, para. 1(a)–(b), available at: https://unfccc.int/documents/1168.

[46] Houghton et al., n. 42 above, 'Overview', p. 5; K. Rypdal et al., 'Introduction to the 2006 Guidelines', in S. Eggleston et al. (eds), *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (vol. 1, Institute for Global Environmental Strategies (IGES), 2006) s. 1.4.

[47] Houghton et al., n. 42 above, 'Understanding the Common Reporting Framework' s. 1.4. See also C.D. Waldron et al., 'Mobile Combustion', in Eggleston et al., n. 46 above, vol. 2, s. 3.6.

[48] N. 10 above, Art. 3(1); Doha Amendment to the Kyoto Protocol, Doha (Qatar), 8 Dec. 2012, in force 31 Dec. 2020, Art. 1.F, available at: https://treaties.un.org/doc/Publication/CN/2012/CN.718.2012-Eng.pdf.

[49] Kyoto Protocol, n. 10 above, Art. 5(2).

[50] Ibid., Art. 2(2).

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Protocol creates or implies any obligation for states *not* to regulate emissions from international aviation.[51]

In fact, the COP continued to express concern for international aviation emissions after the adoption of the Protocol. When the COP observed that the GHG emissions of Annex I parties had generally decreased during the 1990s, it also expressed concern that their international aviation emissions had increased by more than 40%.[52] In 2011, the COP agreed 'to continue its consideration of issues related to addressing emissions from international aviation'.[53] No conclusion can be drawn from the absence of any mention of aviation in the Paris Agreement, as this treaty does not contain sector-specific provisions.[54] The Agreement requires states to communicate and pursue nationally determined contributions (NDCs)[55] involving 'economy-wide' action (at least for developed country parties),[56] but it does not specify whether this includes international aviation. Consistently, some parties have expressly included international civil aviation within the scope of their successive commitments, pledges and strategies communicated under the UNFCCC and the Paris Agreement.[57]

3. THE INTERNATIONAL STREAM

This section explores the international initiatives negotiated under the aegis of the ICAO and assesses their limitations.

3.1. *ICAO Initiatives*

Negotiations on mitigation in the aviation sector have been convened by the ICAO, an international organization created by the Chicago Convention on International Civil Aviation,[58] which subsequently became a UN specialized agency.[59] The two main

[51] See, by analogy, *Gloucester Resources Ltd* v. *Minister for Planning* [2019] NSWLEC 7, paras 486–513; M. Doelle & A. Chircop, 'Decarbonizing International Shipping: An Appraisal of the IMO's Initial Strategy' (2019) 28(3) *Review of European, Comparative and International Environmental Law*, pp. 268–77, at 269.

[52] Decision 1/CP.9, National Communications from Parties Included in Annex I to the Convention, UN Doc. FCCC/CP/2003/6/Add.1, 22 Apr. 2004, para. 2(c), available at: https://unfccc.int/documents/3606.

[53] Decision 2/CP.17, 'Outcome of the Work of the Ad Hoc Working Group on Long-Term Cooperative Action under the Convention', 11 Dec. 2011, UN Doc. FCCC/CP/2011/9/Add.1, para. 78, available at: https://unfccc.int/documents/7109.

[54] The negotiators discussed, but rejected, a draft provision encouraging the ICAO to regulate emissions from international aviation; see Decision 1/CP.20, 'Lima Call for Climate Action', 14 Dec, 2014, UN Doc. FCCC/CP/2014/10/Add.1, 2, Annex, para. 47.5, available at: https://unfccc.int/documents/8611; T. Leclerc, 'Aviation et secteur maritime face aux enjeux climatiques', in C. Cournil (ed.), *La fabrique d'un droit climatique: Au service de la trajectoire '1.5'* (Pedone, 2021), pp. 181–201, at 196–8.

[55] Paris Agreement, n. 3 above, Art. 4(2).

[56] Ibid., Art. 4(4).

[57] See references below nn. 109–112.

[58] Chicago Convention, n. 8 above, Art. 43.

[59] Protocol concerning the Entry into Force of the Agreement between the United Nations and the International Civil Aviation Organization, New York, NY (US), 1 Oct. 1947, pp. 315–44, available at: https://treaties.un.org/doc/Publication/UNTS/Volume%208/v8.pdf.

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organs of the ICAO involved in the negotiations are the Assembly of all 193 member states and the Council of 36 elected member states.[60] The Council may adopt and amend 'international standards and recommended practices and procedures' (SARPs) dealing with various aspects of international civil aviation,[61] which are designated as Annexes to the Chicago Convention 'for convenience'.[62] While SARPs are not directly legally binding, a member state is obligated to notify the ICAO if it will not comply with a SARP.[63]

Despite the absence of an express mandate on environmental protection in the Chicago Convention, the Assembly has long sought to 'maintain the initiative in developing policy guidance' on environmental matters in the aviation sector so as 'not [to] leave such initiative to other organizations',[64] and the Council has adopted SARPs that address noise and local air pollution.[65] Consistently, since climate change has been identified as a global concern, the Assembly has sought to keep sectorial mitigation initiatives under the organization's purview.[66] However, it was only in the late 1990s that the Assembly started to envisage the adoption of 'policy options to limit or reduce' GHG emissions from civil aviation[67] (including 'technical solutions', 'market-based measures', and 'operational measures').[68] Not before 2007 did it call upon the Council to 'examine the potential for carbon offset mechanisms'.[69] Since 2010, ICAO negotiations have led to the definition of aspirational goals, the adoption of technical standards, and the creation of a global market-based instrument.

Firstly, the Assembly defined two aspirational goals in 2010. One goal is to achieve 2% global fuel-efficiency improvement per year;[70] the other is to 'keep … the global net carbon emissions from international aviation from 2020 at the same level'.[71] However, as the Assembly emphasized, these goals do not 'attribute specific obligations to individual states'.[72]

Secondly, following a 2013 Assembly Resolution,[73] the Council adopted fuel-efficiency standards in 2017.[74] Similar to Council standards on noise and local

[60] Chicago Convention, n. 8 above, Art. 50(a).

[61] Ibid., Art. 37.

[62] Ibid., Art. 54(1).

[63] Ibid., Art. 38. See B.F. Havel & G.S. Sanchez, *The Principles and Practice of International Aviation Law* (Cambridge University Press, 2014), pp. 61–3, 231–3.

[64] ICAO Assembly Resolution, A22-12 (1977) para. 2. See Havel & Sanchez, n. 63 above, pp. 228–9; R. Abeyratne, 'Carbon Offsetting as a Trade Related Market Based Measure for Aircraft Engine Emissions' (2017) 51(3) *Journal of World Trade*, pp. 425–43, at 428.

[65] ICAO, *Annex 16 to the Convention on International Civil Aviation: Environmental Protection*, Vols I–II (ICAO, 1981).

[66] ICAO Assembly Resolution A29-12 (1992), para. 2.

[67] ICAO Assembly Resolution A32-8 (1998), App. F para. 4.

[68] ICAO Assembly Resolution A33-7 (2001), App. H para. 3(b)–(c).

[69] ICAO Assembly Resolution A36-22 (2007), App. L para. 1(c)(1).

[70] ICAO Assembly Resolution A37-19 (2010), para. 4.

[71] Ibid., para. 6.

[72] Ibid., para. 5.

[73] ICAO Assembly Resolution A38-18 (2013), para. 33(e).

[74] ICAO, *Annex 16 to the Convention on International Civil Aviation: Environmental Protection*, Vol. III (2017).

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air pollution, these SARPs apply to new types of aircraft (from 2020) and to new aeroplanes (from 2028), but not to aircraft the airworthiness of which has previously been approved. The 2019 Assembly asked the Council to consider updating these standards.[75]

Thirdly, a 2016 Assembly Resolution led the Council to create a market-based mechanism in 2018.[76] This mechanism – the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) – seeks to make up for any increase in international aviation emissions from 2020[77] onwards by requiring airlines to acquire and cancel emission units from eligible emissions reduction projects. CORSIA starts with a 'pilot phase' (2021–23) and a 'first phase' (2024–26) to which states are invited to participate on a voluntary basis. It is only from its 'second phase' (2027–35) that CORSIA will be applicable to all member states other than least-developed countries, small-island developing states, and landlocked developing countries.[78] In each phase, offsetting requirements apply only to international flights between participating states.[79] The offsetting requirements are calculated initially on the basis of the evolution of global aviation emissions and allocated to each airline in proportion to its emissions. From 2030 onwards, some weight will gradually be given to the evolution of the airline's emissions, creating a stronger marginal incentive for each airline to limit its emissions.[80] The Council will review the implementation of CORSIA every three years from 2022.[81]

The Assembly has taken note of – but not endorsed – the goal, promoted by some industrial associations, of reducing the CO_2 emissions of international air transport by 50% by 2050, compared with 2005 levels.[82] Instead, the Assembly has agreed only on a 'global aspirational goal of keeping the global net CO_2 emissions from international aviation from 2020 at the same level',[83] an objective that CORSIA seeks to achieve.

3.2. *Limitations*

The ICAO has played a limited role in addressing climate change. Throughout the 1990s member states raised doubts over 'the extent to which civil aviation contributes to' climate change; despite the growing recognition of the need for a precautionary

[75] ICAO Assembly Resolution A40-18 (2019), para. 21(a).

[76] ICAO Assembly Resolution A39-3 (2016), paras 5, 6; ICAO, *Annex 16 to the Convention on International Civil Aviation: Environmental Protection*, Vol. IV (2018). For a detailed account of the negotiations, see Ahmad, n. 7 above, Ch. 6.

[77] Considering the impact of COVID-19 on aviation emissions in 2020, the Council decided to use 2019 emissions as the baseline for the pilot phase; see 'ICAO Council Agrees CORSIA Baseline Change to Protect Covid-stricken Airline Sector from Higher Carbon Cost', *GreenAir*, 1 July 2020, available at: https://archives.greenairnews.com/www.greenaironline.com/news538d.html?viewStory=2715.

[78] ICAO Assembly Resolution A39-3 (2016), para. 9; ICAO *Annex 16* Vol. IV, n. 76 above, s. II.3.1.3(b).

[79] ICAO Assembly Resolution A39-3 (2016), para. 10.

[80] ICAO *Annex 16* Vol. IV, n. 76 above, s. II.3.2.

[81] ICAO Assembly Resolution A40-19 (2019), para. 9 (g).

[82] ICAO Assembly Resolution A37-19 (2010), Preamble para. 22.

[83] ICAO Assembly Resolution A40-18 (2019), para. 6.

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approach in international environmental law forums, they contended that the need for policymaking on climate change mitigation within the aviation regime had 'to be based on information which is as complete and accurate as possible'.[84] To date, the ICAO continues to ignore the non-CO_2 impacts of aviation, presumably on the ground of lack of 'complete' information.[85] While recognizing the importance of regulating aviation emissions in 2007, the Assembly also highlighted the need not to lose 'sight of their proper context in assessing overall GHG emissions' from other sectors.[86] Six years later, the Assembly was still expressing concerns that international aviation could be unfairly 'targeted' as a source of climate finance.[87] After the Copenhagen Accord and the Cancun Agreements defined the objective of holding global warming '*below*' 2°C above pre-industrial temperatures, and suggested the need to consider the subsequent adoption of a 1.5°C target,[88] the ICAO Assembly only noted a somewhat watered-down objective that global warming 'ought *not to exceed* 2°C'.[89]

From the early 1990s to the mid-2010s, the ICAO pre-empted sector-specific negotiations under the climate regime and opposed 'unilateral' measures,[90] while defining no concrete commitments.[91] On the contrary, the Assembly reaffirmed a policy recommendation for 'the reciprocal exemption from all taxes levied on fuel taken on board by aircraft in connection with international air service' and for the reduction or elimination of 'taxes related to the sale or use of international air transport'.[92] This recommendation was at odds with the growing expectation that states would phase out such fossil-fuel subsidies throughout the economy.[93]

The measures that the ICAO did eventually take were immediately viewed as rather ineffective. The EU Member States and the European Civil Aviation Conference criticized the aspirational goals adopted by the Assembly in 2013 for failing to account for the non-CO_2 impacts of aviation.[94] In the same vein, the US and Canadian agencies concluded that the fuel-efficiency standards adopted by the Council were 'technology

[84] ICAO Assembly Resolution A29-12 (1992), Preamble para. 3. See also Resolution A31-11 (1998), App. F Preamble para. 3. But see UNFCCC, n. 1 above, Art. 3(3).

[85] ICAO Assembly Resolution A40-18 (2019), Preamble para. 6; but see references at nn. 15–18 above.

[86] ICAO Assembly Resolution A36-22 (2007), App. J para. 8.

[87] ICAO Assembly Resolution A38-18 (2013), para. 30.

[88] 'Copenhagen Accord' appended to Decision 2/CP.15, 30 Mar. 2010, UN Doc. FCCC/CP/2009/11/Add.1, para. 1, available at: https://unfccc.int/documents/6103 (emphasis added).

[89] ICAO Assembly Resolutions A37-19 (2010), Preamble para. 9; A38-18 (2013), Preamble para. 9 (emphasis added).

[90] ICAO Assembly Resolutions A35-5 (2004), App. A para. 8; A36-22 (2007), App. L para. 1(a)(3); A37-19 (2010), para. 14.

[91] A. Piera Valdés, *Greenhouse Gas Emissions from International Aviation: Legal and Policy Challenges* (Eleven, 2015), p. 108.

[92] ICAO Assembly Resolution A36-22 (2007), App. L Preamble para. 7.

[93] See references at nn. 179–180 below.

[94] Written Statement of Reservation by Belgium, ICAO Resolution A37-17 (2010), available at: https://www.icao.int/Meetings/AMC/Assembly37/Documents/ReservationsResolutions/10_reservations_en.pdf, and by Lithuania on ICAO Resolution A38-18 (2013), available at: https://www.icao.int/Meetings/a38/Documents/Resolutions/Lithuania_en.pdf.

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following standards' which would 'not result in reductions in fuel burn and GHG emissions'.[95]

CORSIA is the only ICAO initiative so far that could possibly achieve tangible mitigation outcomes. Yet, it has major limitations. Firstly, it is not intended to (and will not) lead to a deep decarbonization of the aviation sector. Secondly, it ignores aviation's non-CO_2 climate impacts. Thirdly, it does not aim to *reduce* or *limit* international aviation CO_2 emissions but only to *offset* any increase. Fourthly, as at late 2021, several major players had not indicated their intention to participate in the pilot and first phases.[96] Fifthly, state compliance remains uncertain, all the more given the last-minute adoption of essential modalities of implementation and the relatively convoluted, opaque, and altogether rather 'ambiguous' legal status of SARPs.[97] Sixthly, the incremental incentive that CORSIA would ideally create for emissions reduction is – at least in some analyses – unlikely to induce technological innovation.[98] Seventhly, experience with international transfers of mitigation outcomes, in particular as offset credits, suggests that the complete environmental integrity of emissions reduction projects is unachievable in practice as a result of difficulties in ensuring the additionality of such projects,[99] avoiding double-counting,[100] and preventing carbon leakage,[101] among other things.[102] Eighthly, by financing offsetting projects, CORSIA could create a perverse incentive for states to refrain from making ambitious commitments on climate change

[95] Supplementary information on 'Control of Air Pollution from Airplanes and Airplane Engines: GHG Emissions Standards and Test Procedures' (2021) 86(6) *Federal Register*, p. 2136, at 2164, available at: https://www.govinfo.gov/content/pkg/FR-2021-01-11/pdf/2020-28882.pdf. See also Regulatory Impact Analysis Statement to the Regulation Amending the Canadian Aviation Regulation (CO_2 Emissions), SOR/2020-251, (2020) II.154(25) *Canada Gazette*, p. 3348, available at: https://gazette.gc.ca/rp-pr/p2/2020/2020-12-09/pdf/g2-15425.pdf.

[96] See ICAO, 'CORSIA States for Chapter 3 State Pairs', Sept. 2021 (listing 107 states participating in the pilot phase, including the United States and most European states, but not China, India, and Russia).

[97] Havel & Sanchez, n. 63 above, p. 232.

[98] See D. Rosenbloom et al., 'Why Carbon Pricing Is Not Sufficient to Mitigate Climate Change – and How "Sustainability Transition Policy" Can Help' (2020) 117(16) *Proceedings of the National Academy of Sciences of the United States of America* (*PNAS*), pp. 8664–8; D. Cullenward & D.G. Victor, *Making Climate Policy Work* (Polity, 2020), p. 8.

[99] Additionality refers to the condition that emissions reduction units correspond to emissions reductions that would not have been achieved in a counter-factual business-as-usual scenario; see J.M. Allwood et al., 'Glossary, Acronyms and Chemical Symbols', in Edenhofer et al., n. 21 above, pp. 1249–79, at 1251.

[100] Double-counting occurs when a unique mitigation outcome is considered at the same time as an offset unit and as the implementation of a distinct mitigation commitment (e.g., an NDC); see L. Schneider et al., 'Double Counting and the Paris Agreement Rulebook' (2019) 366(6462) *Science*, pp. 180–3, at 181.

[101] Carbon leakage occurs when emissions reduction in one place results in an increase in emissions somewhere else: Allwood et al., n. 99 above, p. 1265.

[102] See S. Becken & B. Mackey, 'What Role for Offsetting Aviation Greenhouse Gas Emissions in a Deep-cut Carbon World?' (2017) 63 *Journal of Air Transport Management*, pp. 71–83, at 75; C. Lyle, 'Beyond the ICAO's CORSIA: Towards a More Climatically Effective Strategy for Mitigation of Civil-Aviation Emissions' (2018) 8(1–2) *Climate Law*, pp. 104–27, at 115; S. Maertens, W. Grimme & J. Scheelhaase, 'ICAO's New CORSIA Scheme at a Glance: A Milestone towards Greener Aviation', in Fichert, Forsyth & Neimeier, n. 35 above, pp. 117–29, at 124. See also T.A.P. West et al., 'Overstated Carbon Emission Reductions from Voluntary REDD+ Projects in the Brazilian Amazon' (2020) 117(39) *PNAS*, pp. 24188–94; Cullenward & Victor, n. 98, p. 27.

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mitigation in order to present 'additional' projects subsequently as income-generating offsetting.[103]

In conclusion, the ICAO has patently failed to exercise leadership in mitigation action in international civil aviation over the last three decades. This lack of leadership is perhaps unsurprising given the ICAO objective of ensuring 'the safe and orderly growth of international civil aviation',[104] which has limited its focus to 'policy options that will reduce aircraft emissions without negatively impacting the growth of air transport'.[105] Beyond some incremental cost-saving efficiency improvements (which need no or minimal policy incentives and, at any rate, could be counter-productive),[106] effective action would inevitably impose some constraint on the sector. One may even argue that achieving substantial mitigation outcomes in international civil aviation implies the need to reconsider the objective of the sector's continued growth.[107]

4. THE DOMESTIC STREAM

Without waiting for the ICAO, many states have taken the initiative of adopting and implementing their own policies and measures. This section documents the six main types of initiative that they have taken.

4.1. *National Targets*

States have adopted various quantified pledges and commitments on climate change mitigation under climate treaties. These targets, especially those communicated by developed country parties, are increasingly expected or required to be 'economy-wide'.[108] While it is largely understood that domestic aviation ought to be included in such targets, some parties have extended them to international aviation. The EU 2020 pledge under the Cancun Agreements[109] and its 2030 NDC under the Paris Agreement[110] encompass emissions from the entire journey of any departing international flights.

In addition to NDCs, the Paris Agreement invites parties to communicate long-term low-GHG emissions-development strategies (LTS).[111] Parties whose NDC does not address international civil aviation have sometimes considered taking a different

[103] See Cullenward & Victor, n. 98 above, p. 27.

[104] Chicago Convention, n. 8 above, Art. 44(a).

[105] ICAO Assembly Resolution A36-22 (2007), App. K Preamble para. 6. See also Resolution A39-2 (2016), para. 3(b).

[106] On the rebound effect, see n. 32 above.

[107] S. Gossling, 'Risks, Resilience, and Pathways to Sustainable Aviation: A COVID-19 Perspective' (2020) 89 *Journal of Air Transport Management*, article e101933.

[108] See text at n. 56 above.

[109] See EU, 'Second Biennial Report under the UNFCCC', 2015, p. 7, available at: https://unfccc.int/documents/198913.

[110] EU, First NDC, updated 17 Dec. 2020, p. 9; all NDCs are available at: https://www4.unfccc.int/sites/NDCStaging. See also EU, Fourth Biennial Report under the UNFCCC (2019), p. 45, available at: https://unfccc.int/documents/228427.

[111] Paris Agreement, n. 3 above, Art. 4(19).

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approach when devising their LTS. Switzerland decided that its 2050 net-zero emissions target would encompass emissions from departing international flights.[112] New Zealand established a statutory process to consider, by 2024, the inclusion of international aviation in its LTS.[113] After the United Kingdom (UK) communicated its LTS,[114] the government announced its intention to review it to include international aviation. A formal commitment is yet to be made,[115] but Scotland's own net-zero carbon target already covers international aviation emissions.[116] On the other hand, among the states whose LTS does not include international aviation, some have pledged to 'keep emissions from [international aviation] in mind when assessing the achievement of climate targets'[117] and affirmed a commitment to 'international regulation' in the sector.[118] Regrettably, no LTS has outlined a realistic plan for the decarbonization of aviation; instead, those that discuss the evolution of aviation emissions tend to speculate on unproven technological fixes (such as biofuel,[119] hydrogen,[120] and electricity),[121] or 'other measures which will drastically reduce emissions'.[122]

4.2. *Technical Standards*

Various states have adopted technical standards on aircraft fuel efficiency and renewable-fuel content. National standards on fuel efficiency generally reflect the SARPs adopted by the ICAO Council in 2017.[123] Whereas the Chicago Convention applies only to international civil aviation, national measures typically extend the same standards to domestic civil aviation, thus ensuring the interoperability of aircraft.

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[112] LTS of Switzerland (2021), p. 37; all LTSs are available at: https://unfccc.int/process/the-paris-agreement/long-term-strategies. See Federal Council of Switzerland, 'Climate Target 2050: Net Zero Greenhouse Gas Emissions' (2020).

[113] Climate Change Response (Zero Carbon) Amendment Act 2019, No. 61, s. 8 (New Zealand).

[114] LTS of the UK (2018), p. 144.

[115] HC Deb 12 June 2019, vol. 661, col. 682. See Committee on Climate Change (CCC) (UK), 'Net-zero and the Approach to International Aviation and Shipping Emissions', 24 Sept. 2019, available at: https://www.theccc.org.uk/publication/letter-international-aviation-and-shipping; D. Hirst, 'Aviation, Decarbonization and Climate Change', House of Commons Library Briefing Paper No. 8826, 20 Sept. 2021, pp. 18–9, available at: https://researchbriefings.files.parliament.uk/documents/CBP-8826/CBP-8826.pdf.

[116] Climate Change (Scotland) Act 2009, s. 16.

[117] LTS of Germany (2017), p. 29. See LTS of UK (2018), p. 144.

[118] LTS of Denmark (2020), p. 139.

[119] LTSs of the US (2016), pp. 8, 9, 34, 59; Germany (2017), pp. 35, 51; Canada (2016), pp. 7, 33, 37; Switzerland (2021), p. 4; Austria (2020), p. 50; The Netherlands (2020), p. 5; Sweden (2020), p. 44; Belgium (2020), p. 33; Latvia (2020), p. 42; South Africa (2020), p. 27.

[120] LTSs of Denmark (2020), p. 116; Portugal (2019), p. 36.

[121] LTSs of Germany (2017), p. 29; Portugal (2019), p. 37.

[122] LTS of Fiji (2019), p. 35.

[123] ICAO *Annex 16* Vol. III, n. 74 above. See, e.g., Control of Greenhouse Gas Emissions from Engine Installed on Airplanes, 40 CFR, s. 1030 (US); Regulation Amending the Canadian Aviation Regulation (CO_2 Emissions), SOR/2020-251 (Canada); Commission Delegated Regulation (EU) 2019/897 amending Regulation (EU) No 748/2012 as regards the Inclusion of Risk-based Compliance Verification in Annex I and the Implementation of Requirements for Environmental Protection [2019] OJ L 144/1 (EU).

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The adoption of national fuel efficiency standards has not always been a simple top-down process of implementing ICAO decisions. Several states were already considering the adoption of national standards before the Council 2017 decision.[124] A US Court of Appeal held in 2011 that the Environmental Protection Agency (EPA) had to make 'endangerment findings' under the Clean Air Act with regard to GHG emissions from aircraft engines.[125] As such, the EPA was bound to adopt national fuel-efficiency standards notwithstanding the ICAO's 'initiative' (presumably an attempt of the ICAO to pre-empt national measures). While the ICAO standards imposed no additional efforts on airlines,[126] one cannot exclude the possibility that home-grown standards could have been stringent.

By contrast, standards on renewable-fuel content are entirely home-grown, apply only to some countries, and vary significantly. For instance, Norway introduced in 2020 a 0.5% biofuel-content requirement for aviation fuels.[127] To date, the EU has left it for each Member State to decide in which economic sector to promote the use of renewable energy (for instance, sustainable fuels), acknowledging 'the current technological and regulatory constraints that prevent the commercial use of biofuels in aviation'.[128] Several Member States are considering the adoption of a national biofuel-content standard or supporting the adoption of a pan-EU standard.[129] Some biofuel-producing countries have also been actively supporting research and development on sustainable aviation fuels.[130]

In July 2021, the EU Commission proposed a Regulation which would impose a minimum sustainable-fuel content of 2% by 2025, increasing progressively to 63% by 2050.[131] With this Regulation the EU is seeking to exercise global leadership by driving economies of scale on the production of 'sustainable aviation fuel'. The Commission's Explanatory Memorandum highlights both the likelihood of '[s]pill-over effects … whereby third countries may consider adopting similar

[124] E.g., Government of Canada, 'Action Plan to Reduce Greenhouse Gas Emissions from Aviation', 1 June 2012, s. 6.4, available at: https://tc.canada.ca/en/corporate-services/policies/canada-s-action-plan-reduce-greenhouse-gas-emissions-aviation-0.

[125] *Center for Biological Diversity* v. *EPA* [2011] 794 F.Supp.2d 151.

[126] See references at n. 95 above.

[127] Regulation FOR-2019-04-30-555 (Norway), available at: https://lovdata.no/dokument/LTI/forskrift/2019-04-30-555.

[128] Council Directive (EU) 2018/2001 on the Promotion of the Use of Energy from Renewable Sources (recast) [2018] OJ L 328/82, Art. 3(2); but see Proposal for a Parliament and Council Directive, 14 July 2021, COM(2021)557, Art. 1(16)(c), which would allow sustainable aviation fuels to account for 1.2 times their energy content for the achievement of renewable energy targets.

[129] Luxembourg Government, 'Joint Statement on Sustainable Aviation Fuels: Supported by Denmark et al.', 8 Feb. 2021, available at: https://gouvernement.lu/en/actualites/toutes_actualites/communiques/2021/02-fevrier/08-aviation-fuels.html; Transport & Environment, 'Making Aviation Fuel Mandates Sustainable: An Analysis of Aviation Fuel Mandates in Seven European States', 16 Dec. 2020, available at: https://www.transportenvironment.org/discover/making-aviation-fuel-mandates-sustainable.

[130] See, e.g., D. Calçado et al., 'Brazil's Action Plan on CO_2 Emissions Reduction from Aviation', 3rd edn, Sept. 2019, p. 78, available at: https://www.gov.br/anac/pt-br/assuntos/meio-ambiente/arquivos/BrazilsActionPlanonCO2EmissionsReductionfromAviation3rdEditionBaseYear2018.pdf.

[131] Proposal for a Regulation of the European Parliament and of the Council on Ensuring a Level Playing Field for Sustainable Air Transport, COM(2021)561, 14 July 2021, Art. 4.

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measures'[132] and the need for 'intensified efforts of the EU and its Member States' to establish a global mandate for sustainable aviation fuel at the ICAO.[133] However, many questions remain about the sustainability of such large-scale production of biofuels and synthetic fuel[134] and, more generally, about the non-CO_2 climate impacts that these fuels would not avoid.[135]

4.3. *Carbon Pricing*

Many jurisdictions have adopted multi-sectoral carbon-pricing instruments ranging from simple taxes to more complex cap-and-trade mechanisms.[136] Some jurisdictions have extended the application of these instruments to domestic and, more rarely, international aviation. For instance, British Colombia's carbon tax applies to the purchase of aviation fuel,[137] while Canada imposes a federal carbon charge on the use of aviation fuels in provinces that lack their own carbon-pricing policy.[138] Multi-sectoral cap-and-trade mechanisms have been applied to aviation emissions in the EU,[139] South Korea,[140] New Zealand,[141] Switzerland,[142] and the UK.[143] Half of China's pilot emissions trading schemes (implemented by local governments) included some aviation emissions,[144] and the national government has considered including domestic civil aviation in the scope of a national scheme,[145] although not in its initial phase.[146] By contrast, California (US) and Quebec (Canada) do not include aviation emissions within their cap-and-trade mechanisms.[147]

Applicable carbon-pricing instruments are typically limited to intra-jurisdictional flights, for instance, within New Zealand or within South Korea.[148] Similarly, the carbon tax of the Canadian province of British Colombia applies exclusively to flights

[132] Ibid., p. 7.
[133] Ibid., p. 4.
[134] See nn. 36–39.
[135] See n. 40.
[136] See generally World Bank, 'State and Trends of Carbon Pricing 2021', 25 May 2021, available at: https://openknowledge.worldbank.org/handle/10986/35620.
[137] Carbon Tax Regulation, B.C. Reg. 125/2008, s. 12.
[138] Greenhouse Gas Pollution Pricing Act, S.C. 2018, c.12, s. 186(28).
[139] Directive 2008/101/EC amending Directive 2003/87/EC to include Aviation Activities in the Scheme for Greenhouse Gas Emission Allowance Trading within the Community [2009] OJ L 8/3, Art. 1.
[140] Republic of Korea, Third Biennial Update Report, Nov. 2019, p. 42, available at: https://unfccc.int/documents/202576.
[141] Climate Change Response Act 2002, s. 54.
[142] Federal Act on the Reduction of CO_2 Emissions 2011, SR-641.71, Art. 16a.
[143] Greenhouse Gas Emissions Trading Scheme Order 2020, SI 2020/1265, s. 34.
[144] Aviation emissions were included in the pilot schemes implemented in Beijing, Guangdong, Fujian and Shanghai, but not in Chongqing, Hubei, Tianjin and Shenzhen.
[145] National Development and Reform Commission (NDRC), Notice No. 1989 (2017) (in Chinese), available at: https://www.ndrc.gov.cn/xxgk/zcfb/tz/201712/t20171215_962618.html.
[146] NDRC, Notice No. 2191 (2017) (in Chinese), available at: https://www.ndrc.gov.cn/xxgk/zcfb/ghxwj/201712/t20171220_960930.html.
[147] Regulation respecting a Cap-and-Trade System for Greenhouse Gas Emission Allowances, Q-2 r. 46.1, s. 2 (Quebec); 17 CCR ss. 95121, 95811 (California).
[148] See references nn. 140 and 141 above.

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within the province,[149] whereas Canada's federal charge applies only to flights that take place within or between listed provinces subject to the Pan-Canadian carbon-pricing regulation (for instance, Ontario).[150] As such, flights between two jurisdictions that are individually subject to their own carbon-pricing instruments (such as from New Zealand to South Korea, or from British Columbia to Ontario) are not covered by any national carbon-pricing instrument. Given the prevalence of emissions from medium- to long-range flights, this observation highlights the limited effectiveness of national carbon-pricing instruments, especially those applicable to smaller jurisdictions.

The EU Emissions Trading Scheme (ETS), by contrast, applies directly to 30 countries[151] and is integrated with two other national ETSs:[152] it 'prices' emissions from international flights between any of the 32 participating countries. In addition, the EU initially decided to extend its ETS to all international flights which either depart from, or arrive at, an airport within the territory of a participating country (including flights originating from or destined for third countries).[153] This measure proved to be politically contentious, and questions were raised about its compatibility with international aviation law.[154] The EU eventually agreed to suspend the application of its ETS to flights to and from third countries in the light of the progress made, largely as a reaction to the EU initiatives, at the ICAO towards a global market-based mechanism.[155] Following the adoption of CORSIA, the EU is likely to continue to apply the ETS to intra-regional flights, while applying CORSIA only to other international flights.[156]

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[149] Bulletin MFT-CT 004 (2018).

[150] Greenhouse Gas Pollution Pricing Act, n. 138 above, ss. 1, 28(A).

[151] The 27 EU Member States and three other members of the European Economic Area (Iceland, Lichtenstein and Norway); see Directive 2003/87/EC establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and amending Council Directive 96/61/EC [2003] OJ L/275/32; EEA Joint Committee Decision 146/2007 amending Annex XX (Environment) to the EEA Agreement [2008] OJ L 100/92.

[152] Agreement between the European Union and Swiss Confederation on the Linking of Their Greenhouse Gas Emissions Trading Systems [2017] OJ L 322/3; Trade and Cooperation Agreement between the European Union and the European Atomic Energy Community, of the one part, and the United Kingdom of Great Britain and Northern Ireland, of the other part [2020] OJ L 444/14, II-XI Ch. 1, Art. 7.3(4); Greenhouse Gas Emissions Trading Scheme Order, n. 143 above, Sch. 1 para. 1.

[153] Directive 2008/101, n. 139 above, Art.1(3)(b)(r).

[154] See, e.g., N.L. Dobson, 'Competing Climate Change Responses: Reflections on EU Unilateral Regulation of International Transport Emissions in Light of Multilateral Developments' (2020) 67 *Netherlands International Law Review*, pp. 183–203.

[155] Decision 377/2013/EU derogating temporarily from Directive 2003/87/EC establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community [2013] OJ L 113/1, Art. 1; Regulation (EU) 2017/2392 amending Directive 2003/87/EC to continue Current Limitations of Scope for Aviation Activities and to prepare to implement a Global Market-based Measure from 2021 [2017] OJ L 350/7.

[156] See Commission Delegated Regulation (EU) 2019/1603 supplementing Directive 2003/87/EC as regards Measures Adopted by the International Civil Aviation Organisation for the Monitoring, Reporting and Verification of Aviation Emissions for the Purpose of Implementing a Global Market-based Measure [2019] OJ L 250/10, Art. 2; Proposal for a Directive amending Directive 2003/87/EC as regards Aviation's Contribution to the Union's Economy-wide Emission Reduction Target and Appropriately Implementing a Global Market-based Measure, COM(2021)552 final, 14 July 2021, Art. 1(6);

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Notwithstanding their level of regulatory sophistication, carbon-pricing mechanisms are only as effective as the price they impose on GHG emissions. Taxes imposed on aviation fuel are relatively low,[157] while cap-and-trade mechanisms often rely largely on free allocation of allowances ('grandfathering'), which further reduces average prices.[158] Like CORSIA, these national carbon-pricing mechanisms do not take into consideration the non-CO_2 impacts of aviation. The resulting price signal is a small fraction of fuel prices, creating little additional incentive for airlines to reduce emissions, or for passengers to fly less. For instance, the EU Commission estimates that the EU ETS imposes an increase in flight ticket prices of only 0.4 to 0.9%.[159]

4.4. *Ticket Taxes*

Various jurisdictions have imposed taxes on flight tickets. These taxes may aim to cover the cost of running airports and civil aviation services, or they may be devised as carbon-pricing mechanisms, but in practice the distinction is not always obvious. France,[160] Germany,[161] the Netherlands,[162] Sweden,[163] and the UK[164] levy fixed-rate taxes on passengers of any domestic or international flight, with varying rates applicable to groups of countries for different distances and, sometimes, according to the flight class – thus reflecting, albeit approximately, the greater climate impact of long-haul flights and premium classes. For instance, a long-haul international passenger leaving the UK would need to pay £26 in economy, £176 in business or first class, or £528 on a private aircraft.[165]

Ticket taxes do not always apply in the same way to domestic and international flights. For instance, the US imposes a small, fixed-rate tax on all domestic or international flights and an additional tax, proportional to the price of the ticket, on domestic flights.[166] By contrast, Australia[167] and South Africa[168] impose only one, fixed-rate

Council General Secretariat, 'Fit for 55 Package', 14585/21, 6 Dec. 2021, p. 10, available at: https://data.consilium.europa.eu/doc/document/ST-14585-2021-INIT/en/pdf.

[157] See, e.g., Greenhouse Gas Pollution Pricing Act, n. 138 above, Sch. 2 (setting a federal charge applicable to kerosene at Ca$0.0516 per litre); by comparison, jet fuel was selling at Ca$0.478 per litre on 29 Jan. 2021; see IATA, Jet Fuel Price Monitor, available at: https://www.iata.org/en/publications/economics/fuel-monitor.

[158] See, e.g., Regulation 2017/2392, n. 155 above, Art. 1(2) (85% grandfathering), but see Directive Proposal, n. 156 above, Art. 1(2)(b) (which would put an end to the grandfathering of aviation allowances by 2027).

[159] Commission, 'Impact Assessment Accompanying the Document Proposal for a Regulation of the European Parliament and of the Council', COM/2017/054, 3 Feb. 2017, p. 34.

[160] Code général des impôts, Art. 302*bis*K(VI.1).

[161] Luftverkehrsteuergesetz, 9 Dec. 2010, BGBl. I, ap. 1885, s. 11.

[162] Wet belastingen op milieugrondslag, Art. 77.

[163] Lag om skatt på flygresor (SFS 2017:1200) s. 7.

[164] Finance Act 1994, s. 30.

[165] Ibid.

[166] 26 U.S.C. § 4261(a), (b)(1), (c)(1).

[167] Passenger Movement Charge Act 1978, s. 6.

[168] Customs and Excise Act 91, 1964, para. 47B.

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tax on outbound international flights perhaps because, unlike the US and many other jurisdictions, these two countries subject domestic flights to consumer taxes.

Ticket taxes could incentivize consumers to consider alternative modes of transportation or to travel less. On the other hand, unlike direct carbon pricing, ticket taxes do not incentivize efficiency gains, as the amount to be paid by a passenger does not depend on the flight's actual per passenger emissions. The effectiveness of ticket taxes is also limited by the frequent exemption of transiting and transferring passengers (aimed at avoiding trade distortions),[169] which often applies to high-emitting long-haul flights. Lastly, fewer jurisdictions levy equivalent taxes on cargo flights.[170]

4.5. *Phasing Out Tax Exemptions*

States have long supported aviation, sometimes through direct subsidies to airlines or airports and other infrastructures,[171] but more often by exempting airlines and their passengers from various taxes to which they would otherwise be subject. Most jurisdictions exempt civil aviation from fuel excise duties[172] or apply a discounted rate.[173] In addition, airlines engaging in international transportation are often exempted from value-added tax (VAT) on the goods and services they purchase (including fuel),[174] and passengers are not required to pay VAT on the purchase of tickets.[175] A 2019 OECD survey of 44 OECD and G20 members concluded that fuels used in domestic aviation are 'sometimes taxed but rarely reflect a low-end carbon benchmark', while fuels used in international aviation are not taxed 'at all'.[176] Most states also provide for income tax exemptions,[177] following here also ICAO policy recommendations.[178]

These tax exemptions go against a growing trend towards the phasing out of fossil-fuel subsidies. Following a series of declarations of the G20,[179] states agreed at COP26

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[169] Finance Act 1994, s. 31(3) (UK); Code général des impôts, Art. 302*bis*K(VI.2) (France); Lag om skatt på flygresor (SFS 2017:1200), ss. 4(4)–(5) (Sweden). These exemptions have the aim of avoiding distortion of competition between airports.

[170] For two notable exceptions, see Code général des impôts, Art. 302*bis*K(II.1) (France); 26 USC, §§ 4271–4272 (US).

[171] See European Court of Auditors, *EU-Funded Airport Infrastructures: Poor Value for Money* (EU, 2014); J.W. Lee, 'Airlines Subsidies: Can the Law Play a Role in Regulating Them?' (2018) 52(6) *Journal of World Trade*, pp. 897–915.

[172] E.g., Directive 2003/96/EC restructuring the Community Framework for the Taxation of Energy Products and Electricity [2003] OJ L 283/51, Art. 14(1)(b); NDRC, Notice No. 190, 15 Jan. 2009 (in Chinese), available at: http://www.gov.cn/zwgk/2009-01/15/content_1206163.htm.

[173] E.g., 26 USC s. 4081(a)(2)(C).

[174] E.g., Directive 2006/112/EC on the Common System of Value Added Tax [2006] OJ L 347/1, Art. 148.

[175] Directive 2006/112, ibid., Arts 370–1, 375–90c.

[176] OECD, 'Taxing Energy Use 2019: Using Taxes for Climate Action', 2019, p. 11, available at: https://www.oecd.org/tax/tax-policy/brochure-taxing-energy-use-2019.pdf.

[177] IATA, 'Guidelines for Taxation of International Air Transport Profits', May 2015, p. 3, available at: https://www.iata.org/contentassets/a72d8d3cfaf84529bcdef6b2dc59f224/taxation_intl_air_transport20profits_final.pdf.

[178] ICAO Council, Resolution on Taxation of International Air Transport, 24 Feb. 1999, Doc. 8632, para. 2, available at: https://www.icao.int/publications/Documents/8632_cons_en.pdf. See also reference at n. 92 above.

[179] G20 Pittsburgh Summit, 'Leaders' Statement', 24–25 Sept. 2009, para. 29, available at: https://www.oecd.org/g20/summits/pittsburgh/G20-Pittsburgh-Leaders-Declaration.pdf; G20, 'G20

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that they should 'accelerat[e] efforts towards the … phase-out of inefficient fossil fuel subsidies'.[180] Both the EU and the US have engaged in comprehensive reviews of these subsidies,[181] and the EU is considering a directive that would require phasing out the tax exemption on aviation fuels for intra-EU flights while allowing states to do the same for extra-EU flights '[w]ithout prejudice to international obligations'.[182]

The support that tax exemptions provide to civil aviation far outbalances the effect of even the most stringent carbon-pricing policies. For instance, an average airline flying within the EU in 2019 had to pay a marginal price of €0.062 per litre of kerosene for emissions allowances; this resulted (taking into account the free allocation of 85% allowances) in an average cost of €0.009 per litre.[183] By contrast, were it not for their exemption of excise duties, airlines would need to pay at least the pan-EU minimal rate of €0.33 per litre of kerosene.[184] Phasing out the exemption of EU excise duties would roughly double airlines' fuel acquisition costs in this market,[185] creating a clear incentive for airlines to reduce emissions or for passengers to fly less. A study commissioned by the EU Commission suggests that phasing out the exemption of fuel excise tax on airlines would increase ticket prices by 10% and reduce aviation CO_2 emissions by 11%;[186] which would be an order of magnitude more effective than the EU ETS.[187]

Likewise, the benefits of VAT exemption on ticket sales often outbalances the costs imposed by ticket taxes.[188] By contrast to VAT, ticket taxes rarely increase the overall price of the ticket by more than a single-digit percentage point.[189] In one estimate,

Hamburg Climate and Energy Action Plan for Growth', Rome Leaders' Declaration, 2021, para. 27, available at: https://www.mofa.go.jp/files/000272306.pdf.

[180] Decision -/CP.26, 'Glasgow Climate Pact', advance unedited version, Nov. 2021, para. 20, available at: https://unfccc.int/sites/default/files/resource/cop26_auv_2f_cover_decision.pdf. See also Kyoto Protocol, n. 10 above, Art. 2(1)(a)(v).

[181] See Executive Order 14008, 'Tackling the Climate Crisis at Home and Abroad', 27 Jan. 2021, (2021) 86(19) *Federal Register*, p. 7619, at 7625 (§ 209), available at: https://www.regulations.gov/document/EPA-HQ-OPPT-2021-0202-0012; EU Commission, 'The European Green Deal', COM/2019/640, 11 Dec. 2019, p. 10.

[182] Proposal for a Council Directive Restructuring the Union Framework for the Taxation of Energy Products and Electricity, COM/2021/563, 14 July 2021, Art. 14.

[183] Our calculation, based on an average auctioning price of €25 per tonne CO_2, as indicated in EEA, 'The EU Emissions Trading System in 2020: Trends and Projections', 10 Dec. 2020, p. 6, available at: https://www.eea.europa.eu/publications/the-eu-emissions-trading-system-1. We assume that a tonne CO_2 is emitted by burning 396 litres of jet kerosene as per IPCC default net calorific values and emission factors: A. Garg et al., 'Introduction', Eggleston et al., n. 46 above, vol. 2, ss. 1.18, 1.23. On grandfathering, see reference at n. 158 above.

[184] Directive 2003/96, n. 172 above, Annex I.

[185] Jet fuel was selling at $59.5 per barrel on 29 Jan. 2021, or €0.31 per litre; see IATA, Fuel Price, n. 157 above.

[186] European Commission, Directorate-General for Mobility and Transport, *Taxes in the Field of Aviation and Their Impact: Final Report* (EU, 2019), p. 114, available at: https://data.europa.eu/doi/10.2832/913591.

[187] See text at n. 159 above.

[188] A notable exception is the US federal ticket tax on domestic flights, the rate of which (7.5%) exceeds the sales tax applicable in some US states.

[189] See references at nn. 160–5 above.

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imposing a 19% VAT rate on all flights departing from the EU could achieve an 18% reduction in CO_2 emissions from such flights.[190]

4.6. *Sectorial Governance*

Beyond subsidies, states are often active partakers in the aviation sector: they influence the sector's development, for instance, by approving airport construction and by regulating routes and traffic. Sectorial policies have relatively complex implications for the climate impacts of aviation. For instance, limited airport capacity, if ill-managed, can cause traffic congestion, resulting in additional CO_2 emissions,[191] but a scarcity of landing and take-off slots could also incentivize airlines to maximize seat occupancy, hence improving carbon efficiency.[192] In many jurisdictions the climate impacts of relevant projects are subject to environmental assessment procedures, although national authorities generally maintain considerable discretion in making the final decision.[193]

Improving routing and traffic management could reduce aviation's climate impact while also improving its economic efficiency. Accordingly, several jurisdictions have adopted or are considering measures to promote, for instance, more direct routes and continuous descent approaches.[194] In general, these measures apply indiscriminately to domestic and international aviation but, like other efficiency-driven measures, they run the risk of a rebound effect.[195]

5. RELATIONS BETWEEN THE TWO STREAMS

This last section examines the interactions between national and international mitigation actions in the aviation sector. It shows that these two streams of mitigation action are generally compatible from a legal perspective and complementary from a policy perspective. In fact, the rapid decarbonization of the aviation sector is unlikely without a combination of national and international initiatives.

5.1. *Compatibility*

One could question whether national mitigation action in the aviation sector is compatible with states' international law obligations. As far as international climate law is

[190] European Commission, n. 186 above, p. 114.

[191] D. Irvine et al., 'The Environmental Effects of Peak Hour Air Traffic Congestion: The Case of London Heathrow Airport' (2016) 55 *Research in Transportation Economics*, pp. 67–73.

[192] See C. Rizet, C. Cruz & M. Mbacké, 'Reducing Freight Transport CO_2 Emissions by Increasing the Load Factor' (2012) 48 *Procedia – Social and Behavioral Sciences*, pp. 184–95; J.J. Lee et al., 'Historical and Future Trends in Aircraft Performance, Cost, and Emissions' (2001) 26 *Annual Review of Energy and Environment*, pp. 167–200, at 169.

[193] B. Mayer, 'Climate Assessment as an Emerging Obligation under Customary International Law' (2019) 68(2) *International & Comparative Law Quarterly*, pp. 271–308. See also *R (Friends of the Earth Ltd)* v. *Heathrow Airport Ltd* [2020] UKSC 52.

[194] See India, 'Second Biennial Update Report under the UNFCCC', 31 Dec. 2018, p. 121, available at: https://unfccc.int/documents/192316; EU Commission, 'A Fresh Look at the Single European Sky,' 22 Sept. 2020, COM/2020/579; US Federal Aviation Administration (FAA), 'The Future of the NAS', June 2016, available at: https://www.faa.gov/nextgen/media/futureofthenas.pdf.

[195] See n. 32 above.

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concerned, the question is relatively straightforward: notwithstanding whether international climate law requires states to implement mitigation action in international aviation, it certainly does not prevent such measures.[196]

A more complex question relates to the compatibility of national mitigation initiatives with international aviation law. It bears repeating that reducing air transport may be the only way to reduce its climate impact substantially:[197] as such, there is an obvious tension, even possibly a contradiction, between the climate regime's objective of carbon neutrality[198] and the ICAO objective of a 'safe and orderly growth of international civil aviation'.[199] If a direct normative conflict is avoided on the international front between climate and aviation law, it is in large part as a result of the open-ended and bottom-up nature of commitments on climate change mitigation.[200] However, the tension between these two policy objectives re-emerges when states seek to implement their obligations. Aviation pundits have interpreted the Chicago Convention as 'placing strong legal constraints on unilateral action'.[201] The ICAO's attempt at keeping mitigation action under its purview[202] reflects a distrust not only of initiatives adopted under the UNFCCC regime, but also of any national ('unilateral') measures 'which would adversely affect the orderly development of international civil aviation'.[203]

There remains undoubtedly a regulatory space for national mitigation action in the aviation sector. Few, if any, observers have questioned the right of states to decide how to develop national infrastructure and manage air traffic within their territory, to adopt non-discriminatory technical standards on planes or fuel, or to define national mitigation targets applicable to all aviation activities under their control. Rather, legal controversies have centred on the legality of two types of national measure: the phasing out of tax exemptions and the imposition of a carbon price.[204] As the following shows, some bilateral air service agreements require states to maintain some tax exemptions, but many other national mitigation measures in the aviation sector, including carbon-pricing mechanisms, appear to be consistent with international aviation law.

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196 See Section 2.3.

197 See Section 2.2.

198 Paris Agreement, n. 3 above, Art. 4(1).

199 Chicago Convention, n. 8 above, Art. 44(a).

200 For instance, the Paris Agreement does not expressly require its parties to act consistently with its objective of achieving climate neutrality in the second half of the century: B. Mayer, 'Temperature Targets and State Obligations on the Mitigation of Climate Change' (2021) 33(3) *Journal of Environmental Law*, pp. 585–610, at 597.

201 Havel & Sanchez, n. 63 above, p. 235.

202 See Section 3.1.

203 ICAO Assembly Resolution A36-22 (2007), App. L para. 1(a)(3); see also, e.g., Resolution A40-9 (2019), App. A para. 3.

204 See M.T. Ahmad, 'The CJEU's Radical ETS Judgment: Destabilizing the Chicago Convention System' (2013) 13(1) *Issues in Aviation Law and Policy*, pp. 139–58; P. Mendes de Leon, 'Enforcement of the EU ETS: The EU's Convulsive Efforts to Export Its Environmental Values' (2012) 37(4/5) *Air and Space Law*, pp. 287–306; B. Mayer, 'Case C-366/10, *Air Transport Association of America and Others* v. *Secretary of State for Energy and Climate Change*, Judgment of the Court of Justice (Grand Chamber) of 21 December 2011' (2012) 49(3) *Common Market Law Review*, pp. 1113–40.

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5.1.1. *Tax exemptions phase-out*

Exemptions from excise duties and VAT impede climate change mitigation in the aviation sector. These exemptions are often presented as a legal requirement under international aviation law.[205] Yet, such requirement arises not from any general norms reflected in multilateral treaties, but from ad hoc bilateral arrangements, which a state is more likely to be able to renegotiate.

The Chicago Convention does not require its contracting parties to exempt airlines from VAT or excise duties. The ICAO Council interpreted this treaty as making a distinction between '*charges*', referring to 'levies to defray the costs of providing facilities and services for civil aviation', and '*taxes*', which are 'levies to raise general national and local government revenues that are applied for non-aviation purposes'.[206] In that sense, VAT and excise duties are not 'charges' but 'taxes'. Yet, while the Chicago Convention regulates the imposition of 'charges', it is silent on the issue of 'taxes'. Article 15 is interested only in 'airport and similar *charges*'.[207] While Article 24 prohibits the imposition of 'customs duty' on any fuel on board an international flight on arrival and retained on board until departure, it does not preclude the imposition of excise duty on the purchase of additional fuel.[208]

The ICAO Council has formulated 'policies' advocating an exemption for international civil aviation from excise duties and VAT,[209] though these are not legally binding. The Assembly has recommended compliance with these policies but, since 1992, it has also noted that 'taxes are increasingly being imposed by some states in respect of certain aspects of air transportation'.[210] The latter observation rules out any argument based on the interpretation of the Chicago Convention in the light of subsequent practice of the parties[211] as it establishes that this practice lacks consistency. Since 2016, the Assembly has reflected the evolution of state practice by putting more emphasis on the need to avoid 'discriminatory taxes' (referring to discrimination between aviation and other modes of transport) and 'double taxation',[212] rather than calling for a complete exemption. VAT or excise duties are unlikely to be imposed in ways that discriminate against aviation[213] or result in double taxation.[214]

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[205] Directive 2003/96, n. 172 above, Preamble para. 23.

[206] ICAO Council, Resolution on Taxation, n. 178 above, Preamble para. 3. See also ICAO Assembly Resolution A40-9 (2019), App. B Preamble para. 2.

[207] Chicago Convention, n. 8 above, Art. 15 (emphasis added). See also International Air Services Transit Agreement, Chicago, IL (US), 7 Dec. 1944, in force 30 Jan. 1945, Art. I.4(2), available at: https://www.icao.int/secretariat/legal/Administrative%20Packages/transit_en.pdf.

[208] Havel & Sanchez, n. 63 above, pp. 45–6.

[209] ICAO Council, Resolution on Taxation, n. 178 above.

[210] ICAO Assembly Resolutions A29-18 (1992), Preamble para. 4; A33-19 (2001), App. E Preamble para. 4; A35-18 (2004), App. E Preamble para. 3; A36-16 (2007), App. E Preamble para. 3; A37-20 (2010), App. E Preamble para. 3; A39-15 (2016), App. B Preamble para. 3; A40-9 (2019), App. B Preamble para. 3.

[211] Vienna Convention on the Law of Treaties, Vienna (Austria), 23 May 1969, in force 27 Jan. 1980, Art. 31(3)(b), available at: https://treaties.un.org/doc/Publication/UNTS/Volume%201155/volume-1155-I-18232-English.pdf.

[212] ICAO Assembly Resolutions A39-15 (2016), App. B paras 1–2; A40-9 (2019), App. B paras 1–2.

[213] Other modes of international transportation are typically subject to VAT and excise duties.

[214] The risk of double taxation arises in relation to the imposition of income tax; see ICAO Council, Resolution on Taxation, n. 178 above, para. 2(c).

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Rather than the Chicago Convention, the main legal obstacle to imposing taxes on international civil aviation lies in the (mainly bilateral) air service agreements through which states allow one another's airlines to operate flights between or within their territories.[215] Some of these treaties provide for excise duty exemptions, on the basis of reciprocity, for the fuel used for these flights.[216] By contrast to multilateral treaties, these bilateral agreements can more easily be modified through bilateral negotiations. The EU has already promoted air service agreements that allow the application of excise duties on fuel, at least, for intra-EU flights operated by foreign airlines.[217] Overall, as far as the authors are aware, no air service agreement prevents VAT and ticket taxes, provided that such measures are applied in a fair and non-discriminatory manner to national and foreign airlines.

5.1.2. *Carbon-pricing mechanisms*

The unilateral application of carbon-pricing mechanisms to international aviation has also proved to be controversial.[218] Yet, neither carbon taxes nor cap-and-trade mechanisms are among the charges and customs duties prohibited under the Chicago Convention. Even if one were to find that these instruments create 'charges' aimed at defraying 'the costs of providing facilities and services for civil aviation',[219] these charges would not fall within the scope of the prohibition, under Article 15, of charges imposed 'in respect solely of' an aeroplane's transit over, entry into, or exit from the state's territory,[220] as these mechanisms are imposed in respect of (and in proportion to) an aeroplane's climate impacts. Nor do carbon-pricing mechanisms create customs duties levied for the importation of fuel 'retained on board', which would be prohibited under Article 24.[221] Articles 15 and 24 do not prevent a state from requiring airlines to take responsibility for their environmental impact, at least in relation to activities taking place within the state's own territory.[222]

A more probable legal obstacle to carbon-pricing mechanisms arises, here again, from bilateral air service agreements that prohibit the imposition of excise duties. For practical reasons, carbon taxes are typically levied on the purchase of fuel – in much the same way as excise duties – rather than directly on the combustion of fuel or on CO_2 emissions.[223] A distinction arguably could be made between carbon taxes and excise duties on the ground that the former apply only to non-sustainable fuels

[215] See generally Havel & Sanchez, n. 63 above, p. 20.

[216] See, e.g., the air transport or services agreements between the EU and the US [2007] OJ L 134/4, Art. 11(2)(c); Australia and Singapore, [1967] ATS 25, Art. VI; Australia and New Zealand, [2003] ATS 18, Art. 9.

[217] EU Model Horizontal Air Services Agreement, 20 Feb. 2006, Art. 4(2), available at: https://transport.ec.europa.eu/document/download/8f63efae-c6a6-4d1a-b640-3673fb56cd93_en.

[218] See references at n. 203 above.

[219] ICAO Council, Resolution on Taxation, n. 178 above, Preamble para. 3.

[220] Chicago Convention, n. 8 above, Art. 15.

[221] Ibid., Art. 24. See Havel & Sanchez, n. 63 above, pp. 236–7.

[222] In this respect the (short-lived) application of the EU ETS to the entirety of every flight originating from *or* destined for an EU Member State is more problematic; see text at n. 153.

[223] See, e.g., Carbon Tax Regulation, B.C. Reg.125/2008, s. 12(1) (British Columbia (Canada)).

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and that revenues are often directed to climate-related funds rather than to the state's general budget. At any rate, provisions on excise duties exemptions in bilateral air services agreements are less likely to affect cap-and-trade mechanisms that impose liabilities on fuel use rather than fuel purchase.[224]

The ICAO Assembly and Council have appeared to recognize the lawfulness of national carbon-pricing mechanisms, in particular cap-and-trade mechanisms. This acceptance was implied, in 2010, when the Assembly adopted a set of guiding principles that states should follow when implementing 'market-based mechanisms'.[225] Subsequently, the Assembly noted that CORSIA 'is the only global market-based measure applying to CO_2 emissions from international aviation' and highlighted the need 'to avoid a possible patchwork of duplicative State or regional MBMs',[226] but these observations do not outlaw national or regional market-based mechanisms. As China then observed, the ICAO Assembly 'has no right to prohibit Member States from using other market measures for addressing aviation emission'.[227]

The concern of the ICAO Assembly with national carbon-pricing mechanisms relates not to their legality but to their political opportunity, especially in conjunction with the adoption of CORSIA. Since 2010, the Assembly has expressed concern that market-based mechanisms could become 'duplicative', and it has suggested that 'international aviation CO_2 emissions should be accounted for only once'.[228] This concern was initially far-fetched, as no market-based mechanism applied to any international aviation emissions beyond the EU ETS, and it remains unfounded as most of aviation's climate impact remains entirely unaccounted for. As CORSIA aims only to offset any increase in CO_2 emissions from international civil aviation, overlapping national or regional carbon-pricing mechanisms could be justified as addressing other aspects of aviation's climate impact – including avoiding (rather than offsetting) an increase in CO_2 emissions, addressing pre-existing levels of CO_2 emissions, and limiting non-CO_2 impacts of international civil aviation.

5.2. *Complementarity*

From a policy perspective, the international and national streams are largely complementary. More specifically, the international stream has important shortcomings, which national action can help to address.

[224] See, e.g., Directive (EU) 2018/410 amending Directive 2003/87/EC to Enhance Cost-effective Emission Reductions and Low-carbon Investments, and Decision (EU) 2015/1814 [2018] OJ L 76/3, Art. 1(22).

[225] ICAO Assembly Resolution A37-19 (2010), paras 14, 17.

[226] ICAO Assembly Resolution A40-19 (2019), para. 18.

[227] ICAO 40th Assembly, Statement of the Chinese Delegation, 8 Oct. 2019, Reservations s. II(14), available at: https://www.icao.int/Meetings/a40/Documents/Resolutions/china_EN.pdf; see also ICAO 37th Assembly, Written Statement of Reservation by Belgium, n. 94 above.

[228] See ICAO Assembly Resolution A37-19 (2010), Annex para. (f); A40-19 (2019), para. 18.

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5.2.1. *ICAO shortcomings*

There are some obvious reasons to wish that states would reach an agreement on effective and ambitious mitigation action via multilateral negotiations convened by the ICAO, rather than taking separate initiatives. The very existence of the ICAO reflects state understanding that unilateral measures may seek to offer a competitive advantage for national airlines and airports[229] or otherwise create a more complex regulatory environment. From a climate perspective, national initiatives run the risk of merely displacing emissions if, for instance, less efficient aeroplanes are redeployed on unregulated routes;[230] they could even be counter-productive if passengers fly longer routes to evade carbon-pricing instruments.

Yet, the ICAO has a limited political capacity to initiate effective mitigation action. In line with the text of the 1944 Chicago Convention, the ICAO has clearly placed the growth of international civil aviation before any environmental or social concerns, such as climate change mitigation.[231] The ICAO has considered measures aimed at improving aviation's carbon intensity,[232] but not measures intended to limit or reduce aviation activities altogether. It has not advanced a coherent, long-term vision of the sector's decarbonization,[233] nor has it questioned the need for, or the possibility of, continued growth in the sector. Arguably, the need to foster interaction and cooperation among nations through the growth of international civil aviation was far more obvious in the midst of the Second World War than in the age of globalization and virtual reality. Overall, the opacity of ICAO negotiations seems to benefit industrial lobbies far more than environmental advocates.[234]

Altogether, the ICAO strategy on climate change mitigation appears to be mainly dilatory: the ICAO took 'initiative' (as it once admitted) only when and in so far as this was necessary to prevent other organizations, or states, from adopting more effective measures.[235] It was only after the US EPA was mandated to define national fuel-efficiency standards that the Council adopted the first SARPs on CO_2 emissions,

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[229] See, e.g., UK, 'Seventh National Communication under the UNFCCC', 30 Dec. 2017, p. 126, available at: https://unfccc.int/documents/198292; UK Department of Transport, 'Beyond the Horizon: The Future of UK Aviation – Next Steps Towards an Aviation Strategy', Apr. 2018, para. 6.16, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698247/next-steps-towards-an-aviation-strategy.pdf.

[230] See L. Dray & K. Doyme, 'Carbon Leakage in Aviation Policy' (2019) 19 *Climate Policy*, pp. 1284–96, at 1285; G. Perino, R.A Ritz & A. van Benthem, 'Overlapping Climate Polices', NBER Working Paper No. 25643, Mar. 2019, available at: https://www.nber.org/papers/w25643.

[231] Chicago Convention, n. 8 above, Art. 44(a).

[232] See Section 3.1.

[233] Discussions on the formulation of a long-term 'aspirational goal' are ongoing, although this goal alone may not outline a concrete strategy; see ICAO Assembly Resolution A40-18 (2019), para. 9; COP26, Declaration of the International Aviation Climate Ambition Coalition, 10 Nov. 2021, para. 2, available at: https://www.gov.uk/government/publications/cop-26-declaration-international-aviation-climate-ambition-coalition/cop-26-declaration-international-aviation-climate-ambition-coalition.

[234] See S. Laville, 'Critics Attack Secrecy at UN Body Seeking to Cut Global Airline Emissions', *The Guardian*, 11 Feb. 2019, available at: https://www.theguardian.com/business/2019/feb/11/critics-attack-secrecy-at-un-body-seeking-to-cut-global-airline-emissions.

[235] See text at n. 64 above.

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pre-empting the adoption of national standards that could have been more effective.[236] Likewise, despite decades of negotiations, it was not until the EU applied its ETS to every international flight that the ICAO could agree to set up a global market-based mechanism.[237] The subsequent implementation of CORSIA would lead the EU to reduce its efforts on mitigation in the aviation sector significantly if it does not decide to maintain its ETS for intra-EU international flights (thus applying CORSIA only to extra-EU international flights).[238]

5.2.2. *The need for national initiative*

States have the capacity to implement various policies and measures that contribute to mitigating climate change in the aviation sector, including from international flights. Their NDCs and long-term strategies under the Paris Agreement could seek not only to improve aviation's climate efficiency, but also to limit or reduce societies' reliance on aviation, an approach that cannot easily be pursued under the ICAO. They can do so, for instance, by developing alternative modes of transportation (such as high-speed rail) as well as alternatives to transportation (such as local resorts and tele-conferencing). The policy tools available to states in this respect range from fiscal policies, carbon pricing, and technical standards, to infrastructure development, land-use regulation, and subsidies.

The ICAO distrust of 'unilateral' measures[239] is unwarranted: while a state's initiative could always be considered 'unilateral',[240] the national initiatives on climate change mitigation in the aviation sector are not usually promoting national interests at the expense of foreign and global interests.[241] A state is typically not pursuing any uniquely national interest when implementing carbon-pricing measures, phasing out subsidies, or imposing technical standards on aircraft. Indeed, when these measures do distort international competition, it is almost always *at the expense of the state's own airlines and airports*. Contrary to what the word 'unilateral' may suggest, these

[236] See text at nn. 95 and 125 above.

[237] A. Bradford, *The Brussels Effect: How the European Union Rules the World* (Oxford University Press, 2019), pp. 220–1.

[238] See discussion in European Commission, 'Assessment of ICAO's Global Market-Based Measure (CORSIA) pursuant to Article 28b and for Studying Cost Pass-through pursuant to Article 3d of the EU ETS Directive', Sept. 2020, p. 15, available at: https://www.actu-environnement.com/media/pdf/news-37353-Etude-commission-europenne-corsia-compensation-carbone-aviation.pdf; EU Commission, 'Inception Impact Assessment: Revision of the EU Emission Trading System Directive 2003/87/EC concerning Aviation', 3 July 2020, Doc. Ares(2020)3515933, pp. 3–4, available at: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=PI_COM:Ares(2020)3515933; M. Jaśkowski, 'External Aspects of the EU ETS in Aviation in Light of CORSIA' (2021) 23(2–3) *International Community Law Review*, pp. 271–82, at 271. See also references at n. 156 above.

[239] See n. 203 above.

[240] See L.B. de Chazournes, 'Unilateralism and Environmental Protection: Issues of Perception and Reality of Issues' (2000) 11(2) *European Journal of International Law*, pp. 315–38, at 315.

[241] See generally D. Bodansky, 'What's so Bad about Unilateral Action to Protect the Environment?' (2000) 11(2) *European Journal of International Law*, pp. 339–47.

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measures advance a global objective – climate change mitigation – which every ICAO member state has agreed to pursue.[242]

While there are legal constraints on the measures that states may impose, states retain significant regulatory space to implement measures aimed at addressing the climate impact of the aviation sector. The larger jurisdictions, in particular, have considerable market power to set de facto global standards, for instance, on aircraft efficiency,[243] and they could even implement carbon-pricing mechanisms in cooperation with other parties interested in exercising global leadership. They also have diplomatic leverage to facilitate the adoption of a new generation of bilateral air service agreements allowing a systematic phase-out of tax exemptions. States would be able to give a clear signal to the ICAO and the aviation industry that, if no effective long-term strategy is formulated for the decarbonization of aviation, the world will have to find a long-term strategy without air transportation.

6. CONCLUSION

This article has shown the existence of two distinct streams of mitigation initiatives in the aviation sector. While the ICAO has claimed exclusive competence on the regulation of international civil aviation, neither climate nor aviation law prevents national initiatives aimed at reducing the impacts of aviation, including international civil aviation, on the climate system. In fact, while the ICAO is yet to achieve any significant mitigation outcomes, national initiatives have long resulted in the implementation of effective measures, including direct and indirect carbon pricing, infrastructure development, biofuel-content requirements, and air traffic management.

Overall, our analysis has shed critical light on ICAO initiatives on climate change, which too often have been aimed at forestalling the implementation of more effective national measures. CORSIA should be saluted as the first global market-based mechanism, but one must also keep in mind its limited aim (to offset increases in the sector's CO_2 emissions, without addressing pre-existing emission levels and non-CO_2 impacts) and the foreseeable difficulties of ensuring the environmental integrity of offsetting units. There is a risk that, like previous ICAO initiatives,[244] CORSIA could constitute a red herring, distracting the attention of regulators from the need for far more effective action – the type of action that, so far, has been undertaken only through national initiatives. As the ICAO has proved unable to exercise true leadership over the last three decades, it is in the national stream that lies the best hopes for the implementation of effective mitigation action and the definition of a long-term decarbonization strategy for the aviation sector.

[242] Every ICAO member state is a party to the UNFCCC; see S. Truxal, *Economic and Environmental Regulation of International Aviation* (Routledge, 2018), pp. 151–5.

[243] A. Bradford, 'The Brussels Effect' (2012) 107(1) *Northwestern University Law Review*, pp. 1–68.

[244] See Section 3.2 above.

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