TRACKING THE SKIES: AN AIRLINE-BASED SYSTEM FOR LIMITING GREENHOUSE GAS EMISSIONS FROM INTERNATIONAL CIVIL AVIATION

by

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In the past decade, two major international agreements have been reached to curb emissions of greenhouse gases ("GHGs"). One substantial source of GHG emissions, however, has not yet been subject to limits: the international civil aviation sector. In June 1999, a Special Report of the Intergovernmental Panel on Climate Change described emissions of GHGs and other gases from the aviation sector and reviewed scenarios for growth in air transport and emissions. While the report spurred an intense dialogue among scientists, industry, governments, and environmentalists about the nature and extent of measures needed to limit emissions from international civil aviation, no plan has been established yet to limit these emissions.

Action is needed. Rapid growth in air travel is likely to increase significantly the GHG burden civil aviation places on the atmosphere. This Article examines options for controlling GHG emissions from civil aviation; specifically, it explores methods for tracking, reporting, and limiting GHG emissions from international civil aviation. It recommends a system that establishes legally binding limits on total international civil aviation emissions from industrialized nations; sets those emissions caps at levels comparable to those already agreed upon by industrialized nations for other GHG emissions under the Kyoto Protocol; allocates GHG emissions allowances to air carriers for this time period; and affords carriers the flexibility to undertake emissions trading, providing market-based incentives for cost-effectively limiting and reducing GHG emissions in this important economic sector. The Article urges that the system be devised and adopted by 2001. In the event nations do not reach an agreement, they may impose a potentially disparate system of emissions charges and aviation fuel taxes.

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I. INTRODUCTION

In 1995, scientists found that the balance of evidence suggests that human activities are having a "discernible influence on global climate."[1] Greenhouse gases ("GHGs")—carbon dioxide (CO_2), methane (CH_4), and other compounds—released by burning coal and oil to produce electricity, drive cars, fly airplanes, power ships, and grow food, are building up in the atmosphere, where they warm Earth by trapping heat that would otherwise radiate into space.[2] GHGs emitted today will affect Earth's climate for centuries. CO_2, for example, remains in the atmosphere for one hundred years or more.[3] In the past century, the Earth already has warmed about 0.5 degrees Celsius (°C).[4] Sea levels are rising, glaciers are retreating, and much of the United States and other nations have experienced above-normal temperatures and more intense rain and snow storms.[5] Scientists link these changes at least in part to anthropogenic GHG emissions.[6]

Unchecked, these GHG emissions will subject societies to a vast and potentially dangerous experiment: a world warmer, and warming faster, than at any time in the past ten thousand years. Continued climate change could expand the extent of tropical diseases, cause more severe storms and coastal flooding, reduce agricultural productivity in vulnerable regions, and threaten the survival of many plants and animals.[7] In drought-prone regions, economically critical water supplies will be altered.[8] In other regions, coastal real estate and treasured forests will be damaged.[9] If emissions curbs do not begin to take effect

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[1] Intergovernmental Panel on Climate Change (IPCC), *IPCC Second Assessment Report: Climate Change 1995, Summary for Policymakers* 22 (1995) (visited June 1, 2000) <http://www.ipcc.ch/pub/reports.htm>.

[2] *See* IPCC, WORKING GROUP I, CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE 3 (SECOND ASSESSMENT REPORT) (J.T. Houghton et al. eds., 1995) [hereinafter IPCC SAR WORKING GROUP 1 REPORT].

[3] *See id*. at 15–16.

[4] *See id*. at 13.

[5] *See id*. at 4–6.

[6] *See id*. at 5.

[7] *See id*. at 7.

[8] *See* IPCC, WORKING GROUP II, CLIMATE CHANGE 1995: IMPACTS, ADAPTATIONS AND MITIGATION OF CLIMATE CHANGE: SCIENTIFIC-TECHNICAL ANALYSES 155–56 (Robert T. Watson, et al. eds., 1996) [hereinafter IPCC SAR WORKING GROUP 2 REPORT].

[9] *See id*. at 97–98.

soon, it may not be possible to prevent what many scientists believe will be a dangerous climate change.[10]

While steps have been taken, certain GHG-emitting sectors have been overlooked. Although the 1992 United Nations Framework Convention on Climate Change[11] ("UNFCCC," "Framework Convention," or "Rio Treaty") requires governments to report national GHG emissions,[12] the Framework Convention does not specify any requirements for reporting international emissions from aviation and maritime transport. The 1997 Kyoto Protocol on Climate Change[13] contains legally binding obligations for certain industrialized nations to reduce GHG emissions for the 2008 to 2012 period to approximately five percent below reported 1990 levels.[14] Although the Kyoto Protocol has been adopted, it has yet to be ratified, and participating governments have not yet agreed on whether and how these emissions limits will apply to international aviation and maritime transport emissions.[15]

Currently, governments report GHG emissions from international civil aviation[16] separately,[17] and no agreed formula for allocating responsibility for these emissions exists.[18] If this situation is not addressed effectively, the result will be that after an aircraft or ship has

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[10] *See* Letter from Harold Mooney, Professor, Stanford University, et al., to President William Clinton (May 21, 1997) (warning the President that warming of greater than one degree Celsius over the next 100 years could trigger dangerous interference in the climate system) (copy on file with *The Environmental Lawyer*) [hereinafter Harold Mooney Letter].

[11] Framework Convention on Climate Change, U.N. Conference on Environment and Development, May 9, 1992, 31 I.L.M. 849 [hereinafter UNFCCC, Framework Convention, or "Rio Treaty"].

[12] *See id*. art. 4.

[13] *See* Conference of the Parties (COP) to the UNFCCC: Kyoto Protocol, Dec. 10, 1997, 37 I.L.M. 22 (1997) [hereinafter Kyoto Protocol].

[14] *See id*. art. 3.1.

[15] *See* IPCC, AVIATION AND THE GLOBAL ATMOSPHERE 338 (Joyce E. Penner et al., eds., 1999) [hereinafter IPCC SPECIAL REPORT].

[16] In this paper, the term "international civil aviation" is used to refer to all non-domestic aviation emissions associated with parties listed in Annex 1 of the UNFCCC; that is, to all emissions from the transport of passengers, mail, or property by aircraft for compensation between a place in the sovereign territory of an Annex 1 Party and a place outside that Party's sovereign territory, plus all emissions from the transport of passengers, mail, or property for compensation by aircraft registered in an Annex 1 Party; *cf*. 49 U.S.C. § 40102(a)(22)–(23) (defining foreign air commerce and transportation).

[17] *See Methodological Issues: Emissions Resulting From Fuel Used for International Transportation, Note by the Secretariat*, UNFCCC Subsidiary Body for Scientific and Technological Advice, 10th Sess., Provisional Agenda Item 5(b), at 4–5, U.N. Doc. FCCC/SBSTA/1999/INF.4 (1999) [hereinafter *Methodological Issues*].

[18] *See* IPCC SPECIAL REPORT, *supra* note 15, at 338.

embarked from a nation's sovereign territory, the GHG emissions of that vessel will no longer be subject to internationally agreed-upon controls.[19] These potentially "orphan" emissions are projected to grow significantly, increasing anthropogenic climate change.[20]

This Article first examines whether emissions from international civil aviation contribute to atmospheric concentrations of GHGs such that they should be limited in order to meet the objective of the UNFCCC and the Kyoto Protocol. Finding that such limits are needed, the Article suggests how the nations of the world, acting under the auspices of the International Civil Aviation Organization ("ICAO") and with oversight by the Conference of the Parties ("COP") of the UNFCCC, may develop, agree on, and implement a cap-and-trade system for the international civil aviation sector's GHG emissions, beginning with CO_2. While the structure proposed in this Article could be expanded to cover other aircraft emissions—as well as maritime emissions—they are beyond the scope of the current Article.

II. AVIATION AND GLOBAL WARMING

This section explains the urgency of global warming for all nations. It then focuses on the significant impact of the international civil aviation sector on global warming, explaining why action must be taken promptly to control emissions from this overlooked and rapidly growing sector.

A. Why Nations Must Act

Every region of the world consumes fossil fuels, emits GHGs, and will be affected by climate change, with many regions likely to experience adverse—and potentially irreversible—effects.[21] No one country can significantly slow global warming. Recognizing the global scale of the problem, in 1992, 160 nations adopted the Rio Treaty,[22] which established non-binding emissions limitation goals for industrialized nations. The Rio Treaty's objective is to stabilize atmospheric concentrations of GHGs at levels that would prevent

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[19] *See id.*

[20] *See id.*

[21] *See* IPCC SAR WORKING GROUP 2 REPORT, *supra* note 8, at 4, 85–86.

[22] *See* UNFCCC, *supra* note 11, art. 4.2.

dangerous anthropogenic interference in the world's climate system.[23]

Although the Rio Treaty represented an important first step in reducing GHG emissions, its voluntary emissions limitations have not proved sufficient to meet the treaty's objective.[24] Most nations' emissions are projected to increase significantly in the coming years.[25] Atmospheric concentrations of GHGs continue to rise,[26] while GHG emissions from both industrialized and developing countries continue to increase rapidly.[27]

B. The Intergovernmental Panel on Climate Change Special Report on Aviation and the Global Atmosphere

In the early 1990s, published reports began to indicate that emissions of CO_2, nitrogen oxides (NO_x), and possibly other gases and particles emitted from aircraft engines were contributing to global warming.[28] While airline energy efficiency in terms of fuel use per seat-kilometer or ton-mile had improved fairly consistently since the 1970s, total aviation fuel use has steadily increased because of the demand for air travel.[29] Scientists have realized the projected sharp increases in these emissions due to the expected future growth in air travel will increase the contribution of the aviation sector relative to a number of other emission sectors.[30]

Historically, environmental attention to emissions in the civil

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[23] *See id*. art. 4.2.

[24] *See, e.g.*, *Background Material on President Clinton's Climate Change Proposal* (Oct. 22, 1997) (visited June 1, 2000) <http://www.state.gov/www/global/global_issues/climate/background.html> (providing key elements of the climate change planning proposed by the Clinton administration).

[25] *See* IPCC, RADIATIVE FORCING OF CLIMATE CHANGE: THE 1994 REPORT OF THE SCIENTIFIC ASSESSMENT WORKING GROUP OF IPCC 14 (1994) [hereinafter RADIATIVE FORCING]; IPCC SAR WORKING GROUP 1 REPORT, *supra* note 2, at 23–25.

[26] *See* IPCC SAR WORKING GROUP 1 REPORT, *supra* note 2, at 13–23.

[27] *See* IPCC SAR WORKING GROUP 2 REPORT, *supra* note 8, at 84.

[28] *See* ANU VEDANTHAM & MICHAEL OPPENHEIMER, ENVIRONMENTAL DEFENSE FUND, AIRCRAFT EMISSIONS AND THE GLOBAL ATMOSPHERE: LONG-TERM SCENARIOS 9, 11–12 (1994) (citing *Scientific Assessment of Ozone Depletion*, WORLD METEOROLOGICAL ORGANIZATION (WMO), GLOBAL OZONE RESEARCH AND MONITORING REPORT PROJECT, Report No. 25 (1991)).

[29] IPCC SPECIAL REPORT, *supra* note 15, at 296–97. "Seat-kilometers" or "revenue passenger-kilometers" represent "the traffic carried by commercial aviation" measured as "one revenue-paying passenger carried" per one kilometer. *Id*. at 3 nn.2–3. This also can be expressed in "emissions per unit of traffic carried." *Id*. at n.3.

[30] *See* VEDANTHAM & OPPENHEIMER, *supra* note 28, at 58–59.

aviation sector focused on local air quality concerns, specifically the landing and take-off ("LTO") cycle.[31] Moreover, while early reports indicated concern about NO_x emissions from supersonic aircraft on the ozone layer,[32] only recently has a broad-based call for scientific and technological analyses to address the full-flight atmospheric implications of aircraft emissions arisen.[33]

In June 1999, the Intergovernmental Panel on Climate Change ("IPCC")[34] published a Special Report on Aviation and the Global Atmosphere ("IPCC Special Report" or the "Report").[35] The IPCC Special Report represents "the most comprehensive assessment available of the effects of aviation on the global atmosphere."[36] The Report considered how potential changes in aircraft technology, air transport operations, and the institutional, regulatory and economic framework of air travel might affect emissions in the future.[37] The Report recognized the complexities of the science of aviation emissions; the range of airframe and engine technologies currently available and projected to be available;[38] the range of emissions from aircraft engines at ground, climb, and cruise altitudes;[39] the long-time horizon for capital stock development and turnover in the aviation sector; the technology-rich and highly competitive nature of the industry; the relationships among air traffic control systems,[40] operational systems, ground systems; and other factors such as weather uncertainties.[41] The Report also examined various emissions scenarios for growth in the civil

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[31] JENNIFER STENZEL ET AL., NATURAL RESOURCES DEFENSE COUNCIL, FLYING OFF COURSE: ENVIRONMENTAL IMPACTS OF AMERICA'S AIRPORTS 36–55 (1996).

[32] *See, e.g.,* IPCC SPECIAL REPORT, *supra* note 15, at 33 (noting that concerns about NO_x emissions "from present-generation subsonic and supersonic aircraft operating in the upper troposphere (UT) and lower stratosphere (LS) were raised by Hidalgo and Crutzen" in 1977).

[33] *See, e.g.*, VEDANTHAM & OPPENHEIMER, *supra* note 28, at 1, 3; STENZEL ET AL., *supra* note 31, at 78.

[34] The IPCC was established in 1988 under the United Nations Environment Programme and the WMO to "(i) assess available information on the science, the impacts, and the economics of, and the options for mitigating and/or adapting to, climate change and (ii) to provide, on request, scientific/technical/socio-economic advice" to the UNFCCC COP. *See* IPCC SPECIAL REPORT, *supra* note 15, at Foreword.

[35] *See* IPCC SPECIAL REPORT, *supra* note 15.

[36] *Id.*

[37] *See id.*

[38] *See id.* at 221–47.

[39] *See id.* at 31–63.

[40] *See id.* at 273–88.

[41] *See id.* at 273–87.

aviation sector.[42] It concluded that radiative forcing (a measure of warming)[43] due to subsonic aviation emissions could grow from 3.5 percent of the amount of total anthropogenic radiative forcing in 1992 to as much as eleven times that by 2050.[44] In addition, the Report looked at the possible significant atmospheric disturbance that might result if fleets of supersonic aircraft were deployed.[45]

The IPCC Special Report identified the following direct emissions from aviation that perturb the atmosphere: CO_2, NO_x, water vapor, sulfate aerosols, and soot.[46] The Report also indicated that some of these emissions, such as CO_2, contribute to global warming directly by trapping heat in the atmosphere.[47] The Report noted that other emissions operate indirectly. For example, NO_x undergoes chemical reactions in the atmosphere that can change concentrations of ozone (O_3), which in turn traps heat.[48] Soot particles emitted from jet engines can, through physical processes, trigger the formation of clouds that trap heat.[49] Moreover, water vapor emissions from aircraft engines can lead both to chemical and physical processes that increase the heat-trapping constituents in the atmosphere.[50]

As the aviation sector grows over the next several decades, its impact on the global climate will increase significantly. The IPCC Special Report described the radiative forcing associated with each constituent of aviation emissions.[51] In some cases, e.g., sulfate aerosols, this radiative forcing may be negative, but overall, the radiative forcing from aviation emissions is positive, meaning that aviation emissions contribute to global warming.[52] For example, even though the sulfur dioxide component of engine emissions has a cooling effect, other engine emissions constituents more than cancel out that cooling effect.

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[42] *See id*. at 309–29.

[43] *See* RADIATIVE FORCING, *supra* note 25, at 8. Radiative forcing "is a measure of the importance of a potential climate change mechanism." IPCC SPECIAL REPORT, *supra* note 15, at 3 n.4. Radiative forcing "expresses the perturbation or change to the energy balance of the Earth-atmosphere system in watts per square meter (Wm^{-2})." *Id*. Positive values indicate a warming effect, while values that are negative indicate a net cooling. *Id*.

[44] *See* IPCC SPECIAL REPORT, *supra* note 15, at 8.

[45] *See id*. at 123–60.

[46] *See id*. at 21.

[47] *See id*. at 21–22.

[48] *See id*. at 23.

[49] *See id*. at 67.

[50] *See id*. at 189 (figure 6-1).

[51] *See id*. at 187–213.

[52] *See id* at 213; *see also supra* note 43 and accompanying text.

The Report described the chemical and physical processes by which radiative forcing occurs and noted that "the aircraft contribution to overall climate change may have a particular signature" because aircraft emissions occur at high altitudes in the upper troposphere and lower stratosphere.[53]

In conjunction with the publication of the IPCC Special Report, governments, industry, and environmental nongovernmental organizations (NGOs) increased their consideration of mechanisms for responding to the challenge of increased GHG contributions from the international civil aviation sector.[54] They have proposed a range of options for controlling aviation emissions, from engine and airframe technology mandates to commitments to limit emissions per seat-kilometer, to air traffic control system and operational measures improvements,[55] to emissions charges.[56]

Recently, some air carriers and NGOs have advocated development of an emissions permit system, possibly including emissions trading, tailored to the aviation sector.[57] In proposing an emissions trading or "cap-and-trade" system[58] for the international civil aviation sector, these

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[53] *See* IPCC SPECIAL REPORT, *supra* note 15, at 191.

[54] *See* U.S. GENERAL ACCOUNTING OFFICE (GAO), AVIATION AND THE ENVIRONMENT: AVIATION'S EFFECTS ON THE GLOBAL ATMOSPHERE ARE POTENTIALLY SIGNIFICANT AND EXPECTED TO GROW, GAO/RCED-00-57 (2000) [hereinafter GAO REPORT]; *see also* L. Mullin, *Efficiency and Our Environment: Finding Ways to Improve Both*, DELTA SKY MAGAZINE, Oct. 1999, at 10 (identifying Delta's partnerships with local groups to support communities planting trees that help absorb GHGs).

[55] *See generally* IPCC SPECIAL REPORT, *supra* note 15, at 341–48 (describing regulatory and market-based measures to mitigate aircraft emissions); NASA's Aerospace Technology Enterprise, *Industry Roundtable* (visited June 1, 2000) <http://www.aerospace.nasa.gov/library/showcase/environ.htm> (describing the "Ultra Efficient Engine Technology Program" for the development of technologies to improve engine performance to reduce aircraft emissions); *see also* IPCC SPECIAL REPORT, *supra* note 15, at 217–87, 335–48 (discussing aircraft technology, operation, and regulatory and market -based mitigation measures).

[56] *See generally* MARK BARRETT, WORLDWIDE FUND FOR NATURE, ENVIRONMENTAL CHARGES FOR CONTROLLING GREENHOUSE GAS EMISSIONS FROM CIVIL AVIATION, DRAFT DISCUSSION PAPER (1996) (describing charges).

[57] *See, e.g.,* HUGH SOMERVILLE & ANDREW SENTANCE, WHY AIRLINES MUST DO THEIR BIT TO CURB GLOBAL WARMING, BRITISH AIRWAYS NEWS (2000) ("If airlines are to avoid taxes on aviation fuel, we need to come forward with constructive and workable proposals for voluntary agreements and emissions trading."); *see also* Sue Gander & Ned Helme, *Emissions Trading is an Effective, Proven Policy Tool for Solving Air Pollution Problems*, 54 ICAO J. 12, 12 (1999) (noting opportunities for the aviation sector to draw on lessons learned from the U.S. sulfur dioxide emissions trading program).

[58] *See* A. DENNY ELLERMAN, ET AL., CENTER FOR ENERGY AND ENVIRONMENTAL POLICY RESEARCH, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, EMISSIONS TRADING

advocates note the success of emissions trading systems in providing powerful incentives for industry to reduce emissions cost-effectively, spurring technology and process innovation, and affording regulated entities flexibility in choosing how to reduce emissions. Because cap-and-trade systems have succeeded in creating new assets by valuing environmental protection,[59] they have the potential to attract the voluntary participation of sovereign nations. Moreover, some NGOs note that only a system that places a cap on total aviation emissions provides the assurance that the aviation sector will do its share to help meet the objective of the UNFCCC.[60] Proposed technological measures, on the other hand, do not provide an overall limit on aviation GHG emissions. They may prompt greater efficiency in the sector, but they potentially allow unlimited emissions growth.

Interest in a cap-and-trade system has grown as carriers face increasing fuel consumption directly associated with air traffic control delays at crowded airports. According to the German airline Lufthansa, modernization of air traffic control in Europe could cut fuel consumption by seven percent.[61] The Scandinavian airline SAS also has noted the adverse environmental consequences of air traffic delays in Europe and has said that in light of the IPCC Special Report, "an environmentally conscious airline should reduce its environmental impact by [two percent] per year at the very least."[62]

UNDER THE U.S. ACID RAIN PROGRAM 5 (1997) (stating that the " 'cap and trade' approach to emissions control establishes an aggregate emissions limit, distributes to individual sources a number of permits equal to this limit according to certain criteria, and allows individual sources to trade permits with other parties or to bank unused permits for later use").

[59] *See id.* at 1.

[60] *See* VEDANTHAM & OPPENHEIMER, *supra* note 28, at 61.

[61] *See* Simon Warburton, *Lufthansa Blames ATC For High Fuel Burn*, AIR TRANSPORT INTELLIGENCE, Aug. 4, 1999, *available in* LEXIS, News Group File.

[62] *See* Jan Stenberg, *Message From the CEO: A Proactive, Transparent Policy on Environmental Issues*, SCANORAMA, Apr. 2000, at 108.

III. THE INTERNATIONAL LAW CONTEXT

The international legal context for controlling GHG emissions from the international civil aviation sector includes the 1992 Framework Convention;[63] the 1997 Kyoto Protocol on Climate Change;[64] and the 1944 Chicago Convention on International Civil Aviation ("Chicago Convention"), which established the International Civil Aviation Organization (ICAO),[65] the Act to Incorporate the International Air Transport Association (IATA),[66] and the legal authorities exercised by airports. The IPCC was established under the joint auspices of the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP).[67] This section will outline these agreements, organizations and entities. The next section will explain the legal framework within which an international civil aviation emissions cap-and-trade system can successfully operate.

A. Agreements, Organizations, and Entities Involved in International Civil Aviation

The agreements, organizations, and entities affecting GHG emissions from the international civil aviation sector are described below.

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[63] UNFCCC, *supra* note 11.

[64] The Kyoto Protocol, *supra* note 13.

[65] The Convention on International Civil Aviation, Dec. 7, 1944, 61 Stat. 1180, 3178, 15 U.N.T.S. 295, 324 [hereinafter Chicago Convention].

[66] *See* Articles of Association to Regulate the Activities and Affairs of an Association Known as the International Air Transport Association ("IATA") [hereinafter "IATA Articles], art. 4. *See also* An Act to Incorporate the International Air Transport Association, Statutes of Canada, 1945, ch. 51 (assented to December 18, 1945) as amended and cited in IATA Articles, art. 2.

[67] The Montreal Protocol on Substances that Deplete the Ozone Layer, *see id*., Sept. 16, 1987, 26 I.L.M. 1550, and the United Nations Economic Commission for Europe Long-Range Transboundary Air Pollution Convention both provide a legal framework that potentially could be used to control aviation emissions of ozone-depleting high-altitude NO_x. To date, neither have been used to address reducing aviation NO_x.

1. The 1992 United Nations Framework Convention on Climate Change

In 1992, 160 nations adopted the UNFCCC;[68] as of June 1, 2000, the Framework Convention has received 184 instruments of ratification.[69] Article 2 of the Framework Convention establishes the ultimate objective of the treaty "and of any related legal instruments that the Conference of the Parties may adopt" is the stabilization of GHG concentrations in the atmosphere "at a level that would prevent dangerous anthropogenic interference with the climate system."[70] The treaty requires each party to track its greenhouse pollution and asks industrialized countries, which have emitted the most gases, to take the first step in controlling the problem by voluntarily limiting their GHG emissions.[71]

The Conference of the Parties (COP) to the UNFCCC has indicated that:

> [U]nder the Revised 1996 Guidelines for National Greenhouse Gas Inventories of the [IPCC], emissions based upon fuel sold to ships or aircraft engaged in international transport should not be included in national totals, but reported separately; and [the COP] urges the Subsidiary Body for Scientific and Technological Advice [of the UNFCCC] to further elaborate on the inclusion of these emissions in the overall greenhouse gas inventories of Parties.[72]

2. The Kyoto Protocol on Climate Change

In 1997, at the third COP to the UNFCCC, the Rio Treaty Parties adopted the Kyoto Protocol on Climate Change.[73] The Kyoto Protocol,

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[68] UNFCCC, *supra* note 11, art. 4.2.

[69] *See The Convention and Kyoto Protocol*, UNFCC (May 17, 2000) (visited June 1, 2000) <http://www.unfccc.de/resource/convkp.html>.

[70] *See* UNFCCC, *supra* note 11, art. 2.

[71] *See id.*, art. 4.

[72] *Report of the Conference of the Parties on its Third Session, Held at Kyoto From 1 to 11 December 1997*, UNFCCC, 3d Sess., addendum pt. 2, Decision 2/CP.3, at 31, U.N. Doc. FCCC/CP/1997/7/ Add.1 (1998) [hereinafter *COP Decisions*].

[73] *See* Kyoto Protocol, *supra* note 13, pmbl.

as a legal instrument related to the 1992 Framework Convention and adopted by the Convention's COP, shares the same objective as the UNFCCC, namely, stabilizing atmospheric concentrations of GHGs at a level that would prevent dangerous anthropogenic interference with the climate system.[74] The Kyoto Protocol requires Parties included in Annex 1 of the UNFCCC ("Annex 1 Parties") to limit their emissions of six GHGs[75] to, on average, approximately five percent below 1990 levels for the period between 2008 and 2012.[76]

Under the Kyoto Protocol Emissions Trading Framework, Annex 1 Parties may accomplish emissions reductions individually or jointly.[77] Parties' emissions limitation and reduction obligations are defined expressly in terms of five-year total cumulative legally binding limits on GHG emissions, expressed in terms of "assigned amounts" of emissions.[78] Parties with such legally binding obligations may meet their obligations under Article 3 of the Kyoto Protocol through four flexible mechanisms:[79]

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[74] *See* UNFCCC, *supra* note 11, art. 2.

[75] The six GHGs controlled by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). *See* Kyoto Protocol, *supra* note 13, annex A.

[76] *See id*. art. 3.1. Annex 1 Parties "shall, individually or jointly, ensure that their aggregate anthropogenic [CO_2] equivalent emissions of the [GHGs] listed in Annex A do not exceed their assigned amounts . . . with a view to reducing their overall emissions of such gases by at least [five percent] below 1990 levels in the commitment period 2008 to 2012." *Id*. The Annex 1 Parties are the countries included in the original UNFCCC document regarding emissions controls, whereas Annex B Parties are a similar list in the Kyoto Protocol that specify emissions limits. *See* UNFCCC, *supra* note 11, annex 1; Kyoto Protocol, *supra* note 13, annex B. The protocol uses the concept of "carbon dioxide equivalent emissions," based on the global warming potential ("GWP") of each GHG, to compare the six gases. *Id*. art. 4.1. GWP is a measure of the overall climate impact of emissions of particular GHGs in relation to the warming effect of an equivalent mass of CO_2 that is resident in the atmosphere during a specified time period, e.g., one hundred years. *See* IPCC SPECIAL REPORT, *supra* note 15, at 199. These limits apply to the industrialized countries included in Annex B of the Kyoto Protocol ("Annex B Parties"). Kyoto Protocol, *supra* note 13, Annex B. Annex B is similar to the list of countries in Annex 1, but lists specific emissions limits. If the Annex B Parties meet their emissions limitation commitments, their overall anthropogenic GHG emissions for the commitment period, on average, will be approximately five percent lower than these nations' 1990 GHG emissions. *Id*. art. 3.1. The Protocol allows Annex B Parties to undertake emissions trading.

[77] *See* Kyoto Protocol, *supra* note 13, art. 3.1.

[78] *See id*. art 3.1.

[79] *See id*. art. 3.

- Emissions Trading Among Nations With Legally Binding GHG Limitations—Trading in Parts of Assigned Amounts;[80]
- Joint Implementation Between Nations With Legally Binding GHG Limitations—Trading in Parts of Assigned Amounts Expressed As Project-Based Emissions Reduction Units;[81]
- "Clean Development Mechanism" (CDM) Between Industrialized and Developing Nations—Trading in Certified Emissions Reductions; and,[82]
- Agreements Among Groups of Parties to Fulfill their Commitments Jointly.[83]

These flexible mechanisms comprise two types of emissions trading:

- Between and Among Nations With Legally Binding Limits on Emissions;[84] and,
- Between Nations with Legally Binding Limits and Those Without Limits.[85]

All Annex 1 Parties must report their GHG emissions from sources and removals by sinks annually, in a transparent and verifiable manner.[86] The rigorous double-entry bookkeeping system established under Articles 3.10, 3.11, and 3.12 provides a solid foundation for transparent accounting for compliance as well as tracking of emissions trades.[87]

With regard to aviation sector emissions in particular, Article 2.2 of the Kyoto Protocol provides:

> The Parties included in Annex 1 [of the UNFCCC] shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol [on Substances That Deplete the Ozone Layer] from aviation and marine bunker fuels, working through the International Civil Aviation

[80] *See id.* art. 17.
[81] *See id.* art. 6.
[82] *See id.* art. 12.
[83] *See id.* art. 4.
[84] *See id.* arts. 4, 6, 17.
[85] *See id.* art. 12.
[86] *See id.* arts. 3, 7.
[87] *Id.* art. 3.10–3.12.

Organization [ICAO] and the International Maritime Organization [IMO], respectively.[88]

3. The Chicago Convention and the International Civil Aviation Organization

The 1944 Chicago Convention on International Civil Aviation established ICAO.[89] ICAO is a specialized agency of the United Nations (U.N.), linked to the U.N. Economic and Social Council, that "develop[s] the principles and techniques of international air navigation" and "foster[s] the planning and development of international air transport"[90] by, among other things, establishing standards and procedures for international civil aviation.[91] As of June 1997, 185 nations had ratified the Chicago Convention and its subsequent amendments.[92] ICAO undertakes its tasks through an Assembly, which consists of all its contracting states and which has authority to amend the Chicago Convention, and its Council.[93] ICAO develops new standards, in the form of legally binding annexes to the Chicago Convention.[94] Adoption of the annexes requires a two-thirds majority vote of the ICAO Council, which has thirty-three members elected for three-year terms.[95]

Annex 16 to the Chicago Convention addresses aircraft noise.[96] Volume 1 of Annex 16 sets aircraft noise limitations, and Volume 2 imposes standards on certain aircraft engine emissions.[97] In 1993, the ICAO Council reduced the original emissions limits for NO_x by twenty percent, and, in February 1999, further reduced the NO_x limits for engines first certificated after 2003 by sixteen percent.[98]

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[88] *See id*. art. 2.2.

[89] *See* Chicago Convention, *supra* note 65, art. 4.3.

[90] *Id*. art. 44. The Chicago Convention states: "The Organization shall enjoy in the territory of each contracting State such legal capacity as may be necessary for the performance of its functions." *Id*. art. 47.

[91] *See id*. arts. 37–42.

[92] *See* ICAO, *ICAO Contracting States*, (visited June 1, 2000) <http://www.icao.org/icao/en/members.htm >.

[93] *See* Chicago Convention, *supra* note 65, arts. 48(b), 49(j), 50(a); 54 ICAO J. 1 (1999) (listing the 33 member states).

[94] *See* Chicago Convention, *supra* note 65, art. 54.1.

[95] *See id*. art. 90(a).

[96] *See id*. annex 16.

[97] *See id*. annex 16; *see also* IPCC SPECIAL REPORT, *supra* note 15, at 248.

[98] *See* ICAO, *Statement to the UNFCCC Subsidiary Body for Scientific and*

At its thirty-second session, the ICAO Assembly adopted a resolution requesting the ICAO Council to study policy options to limit or reduce the GHG emissions from civil aviation, taking into account the findings of the IPCC Special Report and the requirements of the Kyoto Protocol, and to report its findings to the following ordinary session of the ICAO Assembly between September and October 2001.[99] In its statement to the tenth session of the UNFCCC Subsidiary Body for Scientific and Technological Advice ("SBSTA") made in Bonn in June 1999, ICAO stated its full commitment "to respond[] to this challenge in an effective and timely manner."[100]

ICAO's Committee on Aviation Environmental Protection ("CAEP") has formed five working groups to undertake specific studies, as approved by the ICAO Council, related to control of aircraft noise and gaseous emissions from aircraft engines.[101] Working Group 1 will address noise certification; Working Group 2 has been assigned noise operations; Working Group 3 will concentrate on emissions certification; Working Group 4 will handle emissions operations; and Working Group 5 will address market-based options for limiting emissions.[102]

The CAEP Working Groups' current deadline is the final quarter of 2000 or the first quarter of 2001, when CAEP will conduct its next full meeting.[103] CAEP will present its findings to the ICAO Council, which, in accordance with the ICAO Assembly Resolution of 1998,[104] will report to the ICAO Assembly at the Assembly's September-October 2001 session.[105]

Technological Advice ("SBSTA"), 10th Sess. [hereinafter "ICAO Statement"] (visited June 1, 1999) <http://www.icao.org/icao/en/env/sbsta99.htm>.

[99] *See id*.

[100] *Id*.

[101] *See* Overheads: The Challenge for ICAO (Dept. of Env't, Trans. & Regions, United Kingdom 1999) (copy on file with author and *The Environmental Lawyer*).

[102] *See id*.

[103] *See id*.

[104] *See id*.

[105] *See id*.

4. The International Air Transport Association

The 1945 Act to Incorporate the International Air Transport Association established IATA as a vehicle for cooperation among its member air service companies.[106] IATA was established under Canadian law with its headquarters in Montreal.[107] IATA includes active and passive members. An active member is "any airline operating an international air service," while a passive member includes "any airline operating an air service other than an international air service."[108] IATA members' experience with negotiating and trading

[106] *See* IATA Articles, *supra* note 66, art. 4. IATA has three main objectives: first, to "promote safe, reliable and secure air services for the benefit of the peoples of the world"; second, to "provide means of collaboration among airlines engaged directly or indirectly in international air transport"; and, third, to "cooperate with the International Civil Aviation Organization and other relevant international organizations." *Id.* According to Article 12 of IATA's Articles of Association, the association itself has the legal authority to carry out any or all of the association's objectives and act alone or in conjunction with others to: (1) acquire and manage rights and property; (2) borrow money; and (3) make investments. IATA conducts much of its business during its annual general meetings. *Id.* art. 9.

[107] *See id.* arts. 2, 3. Much of IATA's work is done through its Tariff Coordination Conferences, in which members decide on fares and tariff conditions. *See id.* When it conducts these conferences, IATA enjoys limited immunity from antitrust prosecution under the laws of the United States and other nations. *See* Aviation Proceeding, IATA, 55 Fed. Reg. 20,235, 20,235 (1990). The U.S. Department of Transportation (DOT) recognizes the tariff conferences as anticompetitive because it understands that transportation needs based on foreign policy and comity cannot be satisfied by other reasonable alternatives. *See id.* Thus, the U.S. government has granted the IATA Tariff Coordination Conferences limited antitrust immunity under DOT Order 85-5-32. *See id.* IATA classifies international air traffic as either passenger or cargo and each category has its own Tariff Coordination Conference. IATA, IATA 1-2-3 GUIDE 35–36 (2000). The Passenger Tariff Coordination Conference is led by a steering group composed of representatives of nineteen IATA active members. *See id.* at 35. The Resolution Advisory Panel, consisting of twenty-five industry experts, is responsible for establishing industry-wide standards for the Passenger Tariff Coordination Conference. *See id.* While the Steering Group and the Advisory Panel meet several times a year, the Passenger Tariff Conference usually meets only annually. *See id.* The Cargo Tariff Coordination Conference has a similar structure, but usually meets biennially. *See id.* at 36. In these conferences, the world is divided into fifty-seven geographic conference areas; members can participate in any of these regional conferences as well as in the worldwide Tariff Composite Conference. *See id.* IATA also has a Special Environment Task Force ("Task Force"). *See id.* at 21. The Task Force holds periodic discussions of environmental issues of concern to members and compiles environmental data provided to it by members. *See id.*

[108] *See* IATA Articles, *supra* note 66, art. 5.1.a. Only active members have the right to vote at IATA general meetings. *See id.* art. 5.

landing slots, as well as the organization's existing clearinghouse for tracking inter-airline transactions and debts, might naturally lend themselves to the development of an air carrier-based emissions trading system.[109]

5. Airports

In addition to the international legal systems described above, airports exercise considerable legal authority at the local or municipal level. This authority is relevant to emissions limitation efforts. The Airports Council International ("ACI"), headquartered in Geneva, Switzerland, represents the majority of the world's airports.[110] It currently includes members from approximately 530 airport and airport authorities operating more than 1400 airports in 165 countries. [111] The ACI's Environment Standing Committee is responsible for evaluating engine emissions and air pollution.[112] The ACI has observer status in ICAO.[113]

Recently, some airports in the ACI have established emissions charges or levies based on the amount of pollutants various aircraft emit.[114] Other airports in the United States are exploring the possibility of setting up cap-and-trade systems.[115] These airports would establish

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[109] IATA holds informal landing-slot conferences at which members can trade and negotiate landing slots with other members and airports. In these conferences, if an airline wants to obtain landing slots at an airport, the delegate of that airline first submits a request to the coordinator of the airport authority that represents that airport. If landing slots are available from the shifts of other airlines or from additional landing slots at that airport, then the airline will be granted the landing slots. If not, then the airline must negotiate with other airlines that have the particular landing slots it desires and attempt to trade or buy them. In addition, for easing passengers' inter-airline connections, IATA has established a clearinghouse that keeps track of and offsets the debts among members of the association. *See* IATA, *History: Early Days* (visited June 1, 2000) <http://www.iata.org/history1.htm>. As of 1994, the clearinghouse had facilitated transactions among 380 different entities, including non-airline organizations. *See id*.

[110] *See* Airport Council International (ACI), *About ACI: The Voice of the World's Airports* (visited June 1, 2000) <http://www.airports.org/about/voice.html>.

[111] *See id*.

[112] *See* ACI, *About ACI: World Standing Committees* (visited June 1, 2000) <http://www.airports.org/about/committees.html>.

[113] *See* discussion *infra* Part III.B.3.

[114] *See, e.g.*, ZURICH AIRPORT AUTHORITY, AIRCRAFT ENGINE EMISSION CHARGES 6-9 (2000) (describing levies assessed on airlines based on the amount of NO_x and hydrocarbons emitted).

[115] *See* Sonia Hamel, Director of Air Policy and Planning, Massachusetts Executive

airport-wide emissions "bubbles," in which different departments of the airport, and various service operators, would receive emissions allowances under an airport-wide emissions cap, and would be allowed to trade surplus allowances.[116]

B. The Legal Context

The Kyoto Protocol shares the Framework Convention's objective of preventing dangerous interference with the climate system. Thus, a logical, although not necessarily exclusive, implication is that the COP decided in Kyoto Protocol Article 2.2 and Decision 2/CP.3 to work through ICAO to make effective the 1992 Framework Convention's objective, taking into account any elaboration by the UNFCCC's SBSTA on how to include GHG emissions from Annex 1 Parties in overall national greenhouse gas inventories. Arguably, any system that is developed to limit the emissions of international aviation, and any agreements that ICAO adopts in this area, will—in accordance with the COP mandate in Article 2.2—have to share the same objective as the Kyoto Protocol and the UNFCCC. Moreover, even though the UNFCCC COP has referred the international aviation emissions issue to an international organization with independent legal competency in the areas of aviation and emissions,[117] the COP—as the supreme body of the U.N. treaty established to protect the Earth against dangerous interference with the climate system[118]—retains legal competence to review the work that ICAO and IMO undertake pursuant to Article 2.2 of the Kyoto Protocol,[119] and to take further steps as needed to

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Office of Environmental Affairs, Presentation at the "Dialogue on Aviation and the Environment" (Feb. 10, 2000) [hereinafter "Hamel Presentation"]; personal communication between Hamel and Ram Uppuluri, Climate Change Attorney, Environmental Defense (describing proposed emissions trading system for Boston's airport).

[116] *See* Hamel Presentation, *supra* note 115.

[117] *See* Chicago Convention, *supra* note 65, annex 16.

[118] *See COP Decisions*, Decision 2/CP.3, *supra* note 72, at 31.

[119] *See* UNFCCC, *supra* note 11, art. 7.2 ("The Conference of the Parties, as the supreme body of this Convention, shall keep under regular review the implementation of the Convention and any related legal instruments that the Conference of the Parties may adopt."). Because the Kyoto Protocol is a "related legal instrument" adopted by the COP and Article 2.2 of the Protocol specifies that the "Parties included in Annex 1 shall pursue limitation or reduction of emissions of greenhouse gases . . . from aviation and marine bunker fuels, working through [ICAO] and [IMO] respectively," the COP has the legal capacity to review the progress of ICAO and IMO in this field. *See id*. art. 2.2.

meet the 1992 Framework Convention's objective.[120]

IV. PROPOSED SYSTEM TO LIMIT EMISSIONS FROM THE INTERNATIONAL CIVIL AVIATION SECTOR

Given the technological, economic, scientific, legal, and institutional complexities of international civil aviation, it is not surprising that a detailed plan for controlling civil aviation GHG emissions has yet to be developed. This section outlines such a plan. It addresses the types of GHGs to be covered by the system; the emissions sources to be covered, including the question of what constitutes "international civil aviation"; the choice of policy instrument and its point of application; the legal structure and steps to establish it; verification and compliance; incentives for broad participation; the relationship of an aviation trading system to other trading systems; and alternatives in the event that ICAO or the airlines fail to agree on an effective system by 2001.

This Article's proposal for an emissions cap-and-trade system for the international civil aviation sector is premised upon a market-based environmental policy approach. To be successful, a market-based approach must include certain core elements, listed as follows:[121]

- A *cap* on total emissions, i.e., an "absolute" target, as contrasted with a "specific" target measured in terms of emissions per unit of product produced;
- A system for *measuring* actual emissions with reasonable certainty;
- A requirement for *reporting* actual emissions as well as allowance transactions;
- *Fungibility*, that is, tradability or exchangeability of allowances;
- *Accountability*, i.e., a mechanism for holding participants accountable to ensure that emissions do not exceed allowable levels; and,

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[120] *See id.*

[121] *See* ANNIE PETSONK ET AL., ENVIRONMENTAL DEFENSE FUND & PEW CENTER ON GLOBAL CLIMATE CHANGE, MARKET MECHANISMS AND GLOBAL CLIMATE CHANGE: AN ANALYSIS OF POLICY INSTRUMENTS 5 (1998) [hereinafter MARKET MECHANISMS].

- *Transparency* so that the public can see and understand the system, its operation, and its results.

These minimum elements can be applied to the design of a cap-and-trade system for the international civil aviation sector.

With regard to the type of pollutant, the proposal below focuses on CO_2, as it is the major anthropogenic GHG. In addition, much is known about its behavior. In applying the market-based elements to a cap-and-trade system, it will be important to take care that by focusing on one environmental concern, the policy does not inadvertently encourage economic activity to shift to other less regulated pollutants, or to migrate to other less regulated locations. In implementing this proposal, however, regulators need to avoid inadvertently encouraging shifts that generate more of other, less regulated pollutants.[122] The proposal is designed so that the program can be expanded readily as more information becomes available about the role and behavior of non-CO_2 aviation emissions. Similarly, with regard to the geographic scope of regulation, the system outlined below proposes to follow the Kyoto Protocol approach of beginning with limits on the emissions of industrialized nations; however, the proposal is designed so as to reduce the likelihood that carriers would simply reflag or relocate as a means of avoiding regulation. The proposal is designed to invite geographically broad participation.

A. Emissions Covered and Level of Commitment

Table 1 compares the aviation emissions of concern to global warming with the GHGs covered by the Kyoto Protocol. The table shows that of the GHGs emitted by aviation, the Kyoto Protocol's legally binding emissions caps only include CO_2. Hence, to be fully effective in addressing aviation contributions to global warming, a system for limiting aviation emissions ultimately should cover gases not

[122] In principle, there is no legal objection to expanding the coverage of legal instruments for controlling GHGs to GHGs not currently controlled under the Kyoto Protocol. The UNFCCC COP's charge to ICAO, stated in Kyoto Protocol Article 2.2, is not limited to the gases listed in Annex A of the Kyoto Protocol. *See* Kyoto Protocol, supra note 13, art. 2.2. Rather, Article 2.2 directs Annex 1 Parties to pursue, through ICAO, the "limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol [on the Ozone Layer]." *Id.* Accordingly, ICAO should examine all the GHGs identified by the IPCC Special Report as contributing to aviation's global warming effect, and should focus its limitation and reduction efforts on GHGs not controlled by the Montreal Protocol.

currently covered by the Kyoto Protocol. However, because CO_2 constitutes the principal anthropogenic GHG from aviation, and its behavior in the atmosphere has been well-characterized relative to other GHGs, it presents a logical starting point for an aviation GHG emissions limitation policy.

Table 1

GHGs Emitted from Aviation Compared with GHGs Covered by the Kyoto Protocol[123]

Emissions	From Aviation?	Covered by the Kyoto Protocol?	Global Warming Potential[124]
Carbon dioxide (CO_2)	Yes	Yes	1
Methane (CH_4)	No	Yes	24.5
Nitrous oxide (N_2O)	No	Yes	320
Hydrofluorocarbons	No	Yes	140–12,100
Perfluorocarbons (PFCs)	No	Yes	6,300–12,500
Sulfur hexafluoride (SF_6)	No	Yes	24,900
Oxides of nitrogen (NO_x)	Yes	No	*
Water vapor (H_2O)	Yes	No	*
Sulfur dioxide (SO_2)	Yes	No	*
Soot	Yes	No	*

In this context, it should be remembered that the Kyoto Protocol emissions limits are rooted in the UNFCCC objective of avoiding dangerous anthropogenic interference in the climate system.[125] Meeting

[123] *See* Kyoto Protocol, *supra* note 13, annex A; IPCC SPECIAL REPORT, *supra* note 15, at 189; RADIATIVE FORCING, *supra* note 25, at Table 1.

[124] GWP One Year Time Horizon. *See* IPCC SPECIAL REPORT, *supra* note 15, at 199.

[125] *See* UNFCCC, *supra* note 11, art. 2.

this objective requires, according to leading U.S. scientists, limiting or at least preserving the option to limit, the rate and amount of global warming to one degree Celsius over the next one hundred years.[126] Accordingly, at a minimum, the limitation on CO_2 emissions recommended by ICAO ought to be no less stringent than that previously agreed for Annex 1 Parties.

B. Institutions for Implementing a Cap-and-Trade System for the International Civil Aviation Sector

ICAO is best equipped to devise a plan to limit aviation emissions. ICAO has legal powers as an intergovernmental body with competence in the field of civil aviation,[127] IATA's commitment to cooperate with ICAO,[128] and the commitment of the UNFCCC Parties to limit aviation emissions through ICAO.[129] As a matter of law, however, the UNFCCC COP retains the legal competence to evaluate ICAO's work to determine whether it is adequate to serve the ultimate objective of the UNFCCC and the Kyoto Protocol.[130]

C. Sources Covered: What Constitutes "International Civil Aviation" for Annex 1 Parties?

As noted earlier, COP Decision 2/CP.3 states that "emissions based upon fuel sold to ships or aircraft engaged in international transport should not be included in national totals, but reported separately."[131] Decision 2/CP.3 thus distinguishes between, on the one hand, emissions based on fuel sold to ships or aircraft engaged in domestic transport, which should be reported in and added to national emissions inventories required of all nations under Article 4.1(a) of the UNFCCC, and, on the other hand, emissions from international aviation and marine transport, which should be reported separately.[132] Moreover, under Article 2.2 of the Kyoto Protocol, each Annex 1 Party has an obligation, working

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[126] *See* Harold Mooney Letter, *supra* note 10 (cautioning the President that warming of greater than one degree Celsius over the next 100 years could trigger dangerous interference in the climate system).

[127] *See* Chicago Convention, *supra* note 65.

[128] *See* IATA History, *supra* note 109.

[129] *See* Kyoto Protocol, *supra* note 13, art. 2.2.

[130] *See* Hamel Presentation, *supra* note 115.

[131] *COP Decisions*, Decision 2/CP.3, *supra* note 72, at 31.

[132] *Id.*

through ICAO, to limit and reduce GHG emissions from aviation.[133]

Every nation has sovereign authority to limit or reduce its *domestic* aviation emissions—that is, emissions from flights that occur within its sovereign territory—through domestic policies and measures. It is the remaining emissions that pose the problem, because, if no system exists to deal with them, nations will have little incentive to act individually to limit the "orphan" emissions from ships and aircraft once those vessels have departed the nations' sovereign territories. In addition, while some nations may act individually to limit emissions of aircraft and ships flying their flags, they will not wish to put their fleets at a competitive disadvantage relative to other nations that have not taken such steps. Hence, international agreement becomes essential.

A crucial element in reaching such agreement generally will be defining "international transport" and specifically "international civil aviation" with respect to Annex 1 Parties for purposes of Article 2.2 and Decision 2/CP.3.[134] The question of what constitutes "international civil aviation" for Annex 1 Parties has two elements: "international aviation" and "Annex 1 Parties." Further, the possibility of entering into joint commitments under Article 4 of the Kyoto Protocol represents a special case.

1. "International Civil Aviation"

The international nature of air transport requires countries to work together to formulate a method for allocating international aircraft emissions.[135] Before a universal methodology for allocation and reporting can be adopted, however, the definition of international civil aviation must be established. Thus, although several different proposals have been made regarding the definition of "international aviation,"[136]

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[133] *See* Kyoto Protocol, *supra* note 13, art. 2.2.

[134] The question of what constitutes international aviation other than civil aviation is beyond the scope of this Report.

[135] MINISTRY OF HOUSING, SPATIAL PLANNING AND THE ENVIRONMENT, THE NETHERLANDS, GOVERNMENT POLICY OF THE NETHERLANDS ON AIR POLLUTION AND AVIATION 53–54 (1995).

[136] *See, e.g.*, *Methodological Issues*, *supra* note 17, at 5. "According to the [current] IPCC Guidelines, emissions from these fuels should be estimated on the basis of fuels *sold*, that is, fuel taken on board by each departing aircraft or vessel. It should be distinct from emissions resulting from fuel *consumed* during a journey. The fuel intake of an aircraft, for example, does not necessarily take place in the country of departure. Since carrying excess fuel increases the weight of the aircraft and hence the amount of fuel required to reach the next airport, aircraft on long-haul flights usually only take on the amount of fuel required to

as well as methodologies for allocating and reporting GHG emissions from international civil aviation,[137] governments should settle on one definition.

The distinction between international and domestic civil aviation is well established throughout the aviation industry by the IATA's categorization of "active" (international) and "passive" (domestic) member airlines[138] and by the distinctions, in both domestic and international aviation law, between international and domestic flights. For example, according to national legislation in the United States, " 'foreign air transportation' means the transportation of passengers or property by aircraft as a common carrier for compensation, or the transportation of mail by aircraft, between a place in the United States and a place outside the United States when any part of the transportation is by aircraft."[139] Similarly, in many nations, the process for allocating landing slots among carriers already distinguishes between foreign and domestic air transportation.[140] Thus, a reasonable definition for "international aviation" would cover civil transport between one nation and any place outside that nation.

2. Annex 1 Parties

Because Article 2.2 of the Kyoto Protocol directs Annex 1 Parties to limit and reduce their GHG emissions through ICAO,[141] the second question to address is which GHG emissions are associated closely enough with the Annex 1 Parties to require their inclusion in Annex 1 Parties' obligations for limiting emissions. In answering this question, it would be reasonable to establish international aviation emissions by

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reach the next airport. On shorter flights, aircraft may carry sufficient fuel for several stops, depending upon fuel prices, availability and other considerations." *Id*. In addition, "complex relationships may exist in the shipping as well as in the aviation sector. These may affect data on fuel use. A ship, for example, may be owned by a company in one country, which itself is owned by other companies in another country, registered in a third country, operated by a ship-management company in a fourth country and crewed from a manning agency in a fifth country with nationals from other countries. Furthermore, carriage may be paid for by charterers, and in some cases a number of sub-charterers, based in other countries." *Id*.

[137] *See id*., at 8–10.

[138] *See* discussion *supra* note 107 (identifying IATA categories of membership).

[139] *See, e.g.*, 49 U.S.C. § 40102(a)(23) (1994).

[140] *See, e.g.*, *id*. § 41714(b). In the European Union, slot transfers are routinely discussed in the context of airport congestion and merger approvals. *See, e.g.*, EUROPEAN COMMISSION, XVIII REPORT ON COMPETITION POLICY 27 (1998).

[141] *See* Kyoto Protocol, *supra* note 13, art. 2.2.

Annex 1 Parties as emissions from flights between a place in any Annex 1 Party and any place outside that Party.

With respect to emissions of aircraft in international aviation registered under the flag of an Annex 1 Party, or owned or leased by a company registered in an Annex 1 Party, the long-standing principle of customary public international law is to give a state jurisdiction over vessels flying its flag.[142] The Chicago Convention embodies this principle, as it states, with respect to "Nationality of Aircraft" that "[a]ircraft have the nationality of the State in which they are registered."[143] Accordingly, Article 2.2 of the Kyoto Protocol should be read in the context of long-standing customary public international law and the plain language of the Chicago Convention to require that international aviation emissions from any vessel registered in any Annex 1 Party be subject to the emissions limitations that, as specified in Article 2.2, are to be pursued through ICAO—regardless of whether these aircraft actually enter the territory of any Annex 1 Party. To omit these would be to omit emissions from aircraft having the nationality of Annex 1 Parties.[144]

In terms of geography, this approach would mean that all of the emissions resulting from flights between two nations, at least one of which is an Annex 1 Party, would be covered. With respect to flights between two non-Annex Parties, emissions of Annex 1 carriers and aircraft would be included in the trading system.

3. Article 4 Agreements: A Special Case

Article 4 of the Kyoto Protocol allows Parties to establish agreements to fulfill their emissions limitations jointly.[145] With respect to international civil aviation, this raises the question of whether, when two or more Parties to the Kyoto Protocol decide to fulfill their emissions limitation commitments jointly under Article 4, the flights between countries of the same Article 4 agreement—often referred to as a "bubble" or "umbrella" agreement—still constitute "international transport" pursuant to Decision 2/CP.3.

Article 4.1 of the Kyoto Protocol states that:

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[142] *See, e.g.*, S.S. Lotus (France v. Turkey), 1927 P.C.I.J. (ser. A) No. 10, at 22.

[143] *See* Chicago Convention, *supra* note 65, art. 17.

[144] Arguably, similar reasoning may be applied to aircraft owned or operated by leasing companies or airlines registered in an Annex 1 Party.

[145] Kyoto Protocol, *supra* note 13, art. 4.

> [A]ny Parties included in Annex 1 that have reached an agreement to fulfill their commitments under Article 3 jointly, shall be deemed to have met those commitments provided that their total combined aggregate anthropogenic carbon dioxide equivalent emissions of the greenhouse gases listed in Annex A do not exceed their assigned amount calculated pursuant to their quantified emission limitation and reduction commitments inscribed in Annex B and in accordance with the provisions of Article 3.[146]

The words "total combined aggregate" describe the extent of an Article 4 group's emissions limitation responsibility. In particular, "*combined*. . . . anthropogenic . . . emissions" specifies that the emissions for which an Article 4 group is responsible should be the sum of all the emissions from the group's member nations.[147] Under Article 4, if the sum of the emissions of the participating Parties is, effectively, to be treated as if from a single entity, then, arguably, after several Parties reach an Article 4 agreement, flights among the Parties in the group must be counted by those Parties as domestic emissions. That is, the bubble must take ownership of the emissions from these flights and include this quantity in its "total combined aggregate anthropogenic" emissions under Article 4.1.

In the case of a regional economic integration organization acting under Article 4.6 of the Protocol,[148] the organization must limit emissions over which it has legal authority. The organization must count emissions from flights between and among its members in the totals that it, as a party, reports to the UNFCCC and the Protocol, unless, in accordance with Article 24.3 of the Kyoto Protocol,[149] it

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[146] *Id*. art. 4.1.

[147] *Id*.

[148] Article 4.6 of the Kyoto Protocol states that "[i]f parties acting jointly do so in the framework of, and together with, a regional economic integration organization which is itself a Party to this Protocol, each member State of that regional economic integration organization individually, and together with the regional economic integration organization acting in accordance with Article 24, shall, in the event of failure to achieve the total combined level of emissions reductions, be responsible for its level of emissions as notified in accordance with this Article." *Id*. art. 4.6.

[149] Article 24.3 of the Kyoto Protocol provides that "[i]n their instruments of ratification, acceptance, approval or accession, regional economic integration organizations shall declare the extent of their competence with respect to the matters governed by this Protocol. These organizations shall also inform the Depositary, who shall in turn inform the Parties, of any substantial modification in the extent of their competence." *Id*. art. 24.3.

declares at the time it ratifies the UNFCCC and the Protocol that it lacks competence over the activities, i.e., flights that produce these emissions. In that case, the organization and its members would need to ensure that they would bring those emissions—which would, under the definition proposed above, be considered as "international" aviation emissions—within the emissions limitation and reduction framework proposed here.

Currently, the 1990 national emissions totals submitted by the UNFCCC Parties, which serve as the baseline for calculating the assigned emissions limit for each Annex 1 Party to the Kyoto Protocol,[150] include only those emissions from flights occurring entirely within each party's national boundaries. Accordingly, Parties that wish to form Article 4 groups arguably would need to amend their 1990 emissions data to include the 1990 emissions of flights among the Parties to be included in the group, and their emissions reduction commitments stated in Annex B of the Kyoto Protocol accordingly would apply to this adjusted baseline.

D. Choice of Policy Instrument and Point of Application

Having identified the emissions to be covered, the level of the emissions limitations obligation, and the relevant international organizations, the next step in creating a system to limit the international aviation emissions of GHGs is to find both a policy instrument that could achieve the emissions limitation objective and the point at which that policy instrument could be applied. Particularly with regard to emissions from international aviation, the choice of policy instrument and the point at which it should be applied are intertwined.

1. Choice of Policy Instrument

Several policy instruments for limiting international civil aviation emissions currently are being considered by several governments.[151] Possible instruments include, but are not limited to: fuel taxes; en route charges; emissions charges levied by airports upon landing or departure; technology mandates for engines and airframes; operational mandates for aircraft; air traffic control system modernization and other improved technologies for reducing airport congestion; and emissions cap-and-

[150] *See id.* art. 3.7.

[151] *See* IPCC SPECIAL REPORT, *supra* note 15, at 337.

trade systems.[152] In general, the selection of any particular policy instrument will depend on the particular policy arena.[153]

In the policy arena of international aviation, several factors favor a GHG emissions cap-and-trade approach. First, as environmental policymakers around the world have realized, an emissions cap-and-trade approach can achieve readily measurable improvements in environmental quality in a highly transparent manner.[154] This approach also can promote the development and deployment of new, cost-effective technologies and processes for enhancing environmental performance.[155] As regulation has evolved from command-and-control to technology mandates to market-based systems, and as the attainment of environmental goals occurs in an increasingly competitive economic context, policymakers more and more favor approaches that give emitters an incentive to seek better, cheaper, and faster ways of reducing emissions.[156]

With regard to policies aimed at meeting global cumulative GHG emissions targets, cap-and-trade systems offer performance as well as cost and innovation advantages,[157] factors that the highly competitive, technology-intensive international civil aviation sector considers particularly important. In fact, with respect to emissions of GHGs from the aviation sector in particular, the IPCC has stated that "an emissions trading regime would be likely to meet environmental objectives at the lowest cost because it sets overall environmental goals, provides geographic and temporal flexibility, would allow for flexible trading across industry boundaries, and would offer incentives for meeting the goals."[158]

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[152] *See id*. at 337–48.

[153] *See* Annie Petsonk, *Taxes and Trading: The Context for Climate Policy Instruments*, *in* ECONOMIC INSTRUMENTS FOR CLIMATE PROTECTION: A U.S.-GERMAN DIALOGUE 13 (The Heinrich Böll Found. 1999).

[154] *See Overview and Issues on Emissions Allowance Trading Programs: Hearings before the Joint Economic Committee*, 105th Cong. (1997) (statement of Peter F. Guerrero, Director, Environmental Protection Issues, Resources, Community and Economic Development Division, U.S. General Accounting Office).

[155] *See* ELLERMAN ET AL., *supra* note 58; *see also* MARKET MECHANISMS, *supra* note 121, at 15.

[156] *See* IPCC SPECIAL REPORT, *supra* note 15, at 337; *see also* Bruce Ackerman & Richard Stewart, *Reforming Environmental Law: The Democratic Case for Market Incentives*, 13 COLUM. J. ENVTL. L. 171, 172–80 (1988).

[157] *See* Jonathan Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L. J. 677, 765–66 (1999).

[158] MARKET MECHANISMS, *supra* note 121, at 347.

Second, in the case of GHG emissions, policy instruments such as technology mandates, taxes, charges, and voluntary agreements to limit emissions to specific rates per unit of product output all measure compliance in metrics that differ from the overall environmental performance goal, namely, emissions reductions. By contrast, in emissions cap-and-trade systems, the "currency" of compliance is total emissions.[159] By creating financial incentives for improved environmental performance, the link between compliance and successful environmental performance enables emissions trading markets to become more environmentally effective at the same time that they reduce compliance costs, which may be achieved by new technologies and processes.[160]

Third, cap-and-trade systems provide greater flexibility for the regulated community across airline operations, avoiding problems associated with different regulations on an airport-by-airport, flight-by-flight, or aircraft-by-aircraft basis.[161] While differential regulation may be needed to address pollutants that create local health hazards such as ground level NO_x, the flexibility of cap-and-trade can be highly effective in controlling emissions such as CO_2 that mix uniformly in the atmosphere and exert a global effect.[162]

Finally, the Kyoto Protocol itself establishes an emissions trading framework.[163] If governments were to develop an emissions trading system for the aviation sector as proposed above, allowances under that system could be designed so as to be fungible with allowances under the Protocol's emissions trading framework, enabling the aviation sector to participate in the most comprehensive global legal framework for limiting and reducing GHG emissions.

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[159] *See* MARKET MECHANISMS, *supra* note 121, at 3.

[160] *See Green Paper on Greenhouse Gas Emissions Trading Within the European Union*, European Commission, at 4, COM(00)87 (discussing the advantages of emissions trading systems for controlling GHG emissions in a trans-boundary context) [hereinafter EU Green Paper].

[161] *See* Wiener, *supra* note 157, at 765–66.

[162] *See* EU Green Paper, *supra* note 160, at 7–9.

[163] *See* Kyoto Protocol, *supra* note 13, art. 17.

2. Point of Application

The point of application of the policy instrument also represents an important aspect of an emissions trading program. For example, possible levy points for aviation emissions charges include the points of landing, the points of departure, the individual airline companies, the nation in which the vessel is registered, and the individual passengers.[164] The methodology for calculating the relevant emissions at any of these points needs to be considered. In addition, each approach raises both methodological and transaction cost issues. For example, a policy instrument that applies emissions charges to passenger tickets would need to calculate each passenger's share of emissions from that particular flight. A policy instrument that taxes aviation fuels at the point of sale by contrast, would need to guard against the potentially environmentally damaging consequences of such a policy inadvertently encouraging planes to travel farther in order to refuel in places where the fuel tax did not apply, or set taxes at a level sufficiently high to achieve the desired emissions reductions.[165]

The IPCC Special Report recognized the advantages of applying an emissions cap-and-trade policy to international civil aviation but noted the difficulty of deciding on the point at which the policy would be applied, i.e., in effect, the emissions allowance allocation issue, noting that:

> International aviation emissions are not covered by the emissions-related targets in the Kyoto Protocol. The prerequisite for emissions trading is adoption of emissions reduction targets or caps. In principle, the aviation sector could be included in the emissions targets agreed in the Kyoto Protocol, *but the feasibility of applying an emissions trading regime depends on establishing a method to allocate*

[164] *See* A. N. BLEIJENBERG & R. C. N. WITT, CENTRE FOR ENERGY CONSERVATION AND ENVIRONMENTAL TECHNOLOGY, A EUROPEAN ENVIRONMENTAL AVIATION CHARGE: FEASIBILITY STUDY 24–25 (1996).

[165] One reason that it is difficult to set a tax at a high enough level is that different airlines face different marginal costs of emissions control, so what is high enough to affect one company's behavior may not be high enough to affect another's. In addition, every company faced with the prospect of a future tax will consider the time value of money—that is, of investing money in revenue-producing activities rather than in emissions reductions, and, having invested in revenue-producing activities, will pay the tax in future, cheaper dollars, euros, or yen. *See* Wiener, *supra* note 157.

> *international aviation bunker fuels*. Emissions trading would likely be available across all industries, allowing progress in emissions reduction at the lowest cost. High-cost compliance industries with limited compliance options could purchase rights from lower-cost producers of other commodities.[166]

Basic principles of sound environmental policy can resolve the dilemma posed by the IPCC. One sensible starting point is that an environmental policy should be established to provide the greatest incentives for those with the most control over the outcomes to achieve the environmentally desired compliance outcome. In addition, the approach to measuring compliance should be designed so as to require the fewest assumptions about intermediate variables between regulatory compliance and environmental effectiveness.[167] Accordingly, a logical way to apply an aviation emissions limitation policy would be to allocate emissions limits to air carriers, because carriers have both the most information about their emissions and the greatest ability to respond to incentives to reduce emissions. Moreover, carriers' compliance and environmental effectiveness can be measured readily, as carriers keep close track of their fuel consumption.[168]

Governments, of course, have the sovereign right to determine not only the nature and structure of any aviation emissions limitation system, but also the legal entities to whom they will devolve such responsibilities. This means that governments could devolve inter-governmentally-established emissions limits to carriers operating in their territories, flying their flags, or flying aircraft registered in their territories. A carrier-based cap-and-trade system for international aviation emissions would be advantageous because it likely would have lower transaction costs than other policies as a carrier-based system. Specifically, a carrier-based system could mesh easily with the existing domestic and international institutions for multilateral aviation transactions and with the emerging market-based GHG emissions reduction approach of the Kyoto Protocol. Governments also could readily enforce compliance with such a system, as governments retain

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[166] IPCC SPECIAL REPORT, *supra* note 15, at 347 (emphasis added).

[167] See MARKET MECHANISMS, *supra* note 121, at 4–5, for a comparison of regulatory instruments based on the number of assumptions that need to be made to ascertain levels of compliance.

[168] *See, e.g.*, AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC., AEROSPACE FACTS AND FIGURES 1994-1995, at 92 (1994) (describing jet fuel consumption by U.S. air carriers).

authority to allow aircraft to operate within their territories and jurisdiction. Accordingly, this Article recommends that a GHG emissions cap-and-trade system for limiting and reducing total emissions from the international aviation sector be applied at the level of the air carriers, by devolution from governments.

E. Establishing a Legal Structure for a Carrier-Based System

As soon as possible, CAEP Working Group 5 should examine options for designing a carrier-based emissions cap-and-trade system. Applying the minimum elements noted above,[169] the steps CAEP Working Group 5 should take include:

(1) propose that governments listed in Annex 1 of the UNFCCC adopt a group-wide absolute limit on total allowable CO_2 emissions from the international civil aviation sector for the period 2008 to 2012;
(2) recommend that participating governments require covered carriers to *measure* and *report* to ICAO their 1990 base year international civil aviation CO_2 emissions and annually measure and report those emissions for each year from 2008 to 2012, which reports ICAO should promptly make available to the UNFCCC COP;
(3) recommend that ICAO invite governments to allocate the allowable emissions for the 2008-2012 period among themselves, in consultation with the covered carriers, with a view to devolving the allowances to the carriers and requiring the carriers to measure and report annually, to their governments and ICAO, their covered CO_2 emissions, as well as all transactions in allowances, which reports ICAO also should promptly make available to the UNFCCC COP;
(4) recommend that ICAO and its member governments agree that ICAO contracting Parties should not provide airport services to covered carriers that do not hold sufficient allowances to cover the emissions of their flights;[170] and

[169] *See supra* note 121 and accompanying text.

[170] While this requirement, in theory, could be applied on a flight-by-flight basis, it might

> (5) further recommend that the international civil aviation trading system enter into force when a specified number of Annex 1 Parties representing a specified majority of international civil aviation CO_2 emissions in 1990 have ratified the agreement creating the system.[171]

The CAEP also should agree that the cap on total CO_2 emissions for the international civil aviation sector for Annex 1 Parties should be set at the same level as the Kyoto Protocol emissions cap, namely 5.2 percent below 1990 levels.

CAEP Working Group 5 would need to work with governments and IATA to establish 1990 baselines for covered emissions. In this fashion, the CAEP could help governments identify the overarching governmental commitments that would then be devolved, through parallel negotiations involving IATA members, to carriers. In this way, governments working through ICAO would adopt commitments, accountable in both the ICAO and UNFCCC contexts, and could hold carriers accountable to them as well.[172]

To the maximum extent consistent with the science of aviation

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be more pragmatic to apply it as an end-of-commitment-period consequence.

[171] *See* Kyoto Protocol, *supra* note 13, art. 25 (indicating that the Protocol enters into force on the 90th day after the date on which 55 Parties to the UNFCCC, accounting for at least 55% of total CO_2 emissions for 1990 of Parties included in Annex 1, have ratified). Such "entry into force" provisions are essential to address the coverage and competitiveness concerns described *supra* Part IV.

[172] After IATA's active members agree on the airlines' emission targets, IATA would then forward to the CAEP the list of emission limits allocated to different airlines. In conjunction with these negotiations, IATA might wish to facilitate the development of pools for smaller airlines to participate in emissions trading. Alternatively, the airlines might wish to utilize their existing alliances, e.g., code-sharing, and interlocking frequent flyer programs, to provide emissions trading-related services to members. Also, for purposes of these negotiations, CAEP and IATA should seek to obtain from national governments an indication of which governments plan to enter into Kyoto Protocol Article 4 agreements, as airlines flying between and among those nations might need to denominate such flights as domestic flights that would not be included in the international emissions trading system, but would be reported by the parties in their national totals under the Kyoto Protocol, with a proportionate share of emissions from each nation. Further, for purposes of the airline-allocation negotiation and if necessary, governments could agree that IATA emissions allowance allocation negotiations might receive limited antitrust immunity. Like tariff conferences, emissions allowance allocation negotiation in the IATA could produce beneficial results that would outweigh any small anti-competitive effects. The participants in the trading system, however, would, of course, remain subject to antitrust law if they undertook anti-competitive, predatory, or monopolistic practices in their emissions trading. *See* Aviation Proceeding, IATA, 55 Fed. Reg. 20,235, 20,235 (1990).

emissions and the global atmosphere, the CAEP Working Group 5 proposal should seek to ensure that aviation allowances are fungible with emissions allowances under the larger Kyoto Protocol system. This cross-sector fungibility can spur cross-sector technology transfer, as the aviation sector represents a technology-intensive sector in which innovation can be transferred to other sectors. Moreover, cross-sector fungibility can reduce the overall costs of compliance, as emissions reductions in the aviation sector will have to compete with emissions reduction opportunities available in other sectors.

Further, CAEP should recommend a requirement that, if governments devolve their allocations to carriers, they would do so by issuing to carriers standardized, serialized allowances denominated by carrier and year of issuance. Such an approach would enhance greatly the transparency, fungibility, and accountability of the aviation emissions trading system. CAEP Working Group 5 also should develop recommendations for establishing a reporting system for actual emissions and a registry for allowance accounts and transactions. Kyoto Protocol Articles 5, 7, 3.10, 3.11, and 3.12 provide important guidance;[173] in fact, the aviation system reporting and registration framework should be created so as to interface with and be transparent within the general Kyoto Protocol trading system**.**

CAEP Working Group 5 should submit its full emissions trading proposal at the CAEP's next meeting in the last quarter of 2000 or the first quarter of 2001. There, the full CAEP could complete the details of the group's draft on aviation emissions trading and forward the package to the next ICAO Council meeting. Because the proposed international aviation cap-and-trade system would, in effect, establish a series of standards and procedures, it could be adopted as an annex to the Chicago Convention. Alternatively, it could be done by the UNFCCC COP as a protocol to the UNFCCC.[174]

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[173] Kyoto Protocol, *supra* note 13, art. 5 (establishing guidelines for a "national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol"); art. 7 (requiring supplemental information necessary to ensure and demonstrate compliance with commitments under the Montreal Protocol); art. 3.10 (stating that "emission reduction units .. . which a Party acquires from another Party .. . shall be added to the assigned amount for the acquiring Party"), art. 3.11 (establishing that "emission reductions units . . . which a Party transfers to another Party . . . shall be subtracted from the assigned amount for the transferring Party"); art. 3.12 (holding that "certified emissions reductions which a Party acquires from another Party . . . shall be added to the assigned amount for the acquiring Party.").

[174] *See* UNFCCC, *supra* note 11, art. 17 (describing the adoption of protocols).

Adoption as an annex to the Chicago Convention represents an option that governments should consider seriously. The existence of annexes embodying other environmental standards, such as noise and engine NO_x emissions limits,[175] further demonstrates that ICAO can implement and enforce environmental regulations. If two-thirds of the ICAO Council members vote to adopt the draft, it would become an annex to the Chicago Convention and thus binding on all of ICAO's 185 contracting nations.[176] Moreover, under the ICAO framework, the cap-and-trade system could become legally binding upon carriers through the enactment of national legislation by the relevant Parties, thus requiring all carriers operating within their jurisdictions to hold allowances sufficient to cover the CO_2 emissions of their flights.[177]

F. Verification and Compliance of IATA Carriers

Because an aviation emissions trading program can serve as a test case for other international emissions trading systems, especially the Kyoto Protocol, the key components of verification and compliance should be developed. The aviation trading system would do well to consider proposals for verification and compliance currently under discussion in the Kyoto Protocol.[178] Moreover, IATA's Articles of Association should be explored as they offer some building blocks for verification and compliance, as well. [179]

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[175] *See* Chicago Convention, *supra* note 65, annex 16.

[176] *See id*. art. 90.

[177] An important precedent for this approach is the ICAO Annex 16 provisions on NO_x, which governments apply to all carriers taking off or landing within their territories, regardless of the flag of the carrier. *See id*. annex 16.

[178] For a discussion of mechanisms for maintaining the integrity of greenhouse gas emissions trading, see AUSTRALIAN BUREAU OF AGRICULTURAL AND RESOURCE ECONOMICS, INTERNATIONAL TRADING IN GREENHOUSE GAS EMISSIONS: SOME FUNDAMENTAL PRINCIPLES 46–51 (1998). For an analysis of compliance and accountability systems currently being considered by UNFCCC Parties, see Annie Petsonk & Chad Carpenter, *The Key to the Success of the Kyoto Protocol: Integrity, Accountability and Compliance*, LINKAGES J. (Int'l. Inst. for Sustainable Dev., Winnepeg, Manitoba, Can.), May 28, 1999.

[179] Article 9, for example, provides that IATA's annual general meeting shall appoint an external auditor. *See* IATA Articles, *supra* note 66, art. 9.3.i. This authority could be used to appoint an external auditor for the carrier-based emissions trading system. Furthermore, article 5.5.c provides that IATA's board of governors may terminate a carrier's membership if the member is "in breach of these Articles or any rule or regulation adopted thereunder" or "has committed any act or omission which is prejudicial to the aims of IATA." *See id*. art. 5.5.c. This article provides a means of holding carriers legally and politically accountable to

An essential verification and compliance component of the trading system will be for Annex 1 Parties to require that all air carriers landing in or taking off from their territories, registered in their territories, or operating aircraft flying their flags, hold sufficient allowances for the anticipated emissions of their flights. The Chicago Convention provides a solid basis for such a requirement. Specifically, Article 12 of the convention includes the following "Rules of the air" that establish enforcement authority over aircrafts:

> Each contracting State undertakes to adopt measures to insure that every aircraft flying over or maneuvering within its territory and that every aircraft carrying its nationality mark, wherever such aircraft may be, shall comply with the rules and regulations relating to the flight and maneuver of aircraft there in force . . . . Over the high seas, the rules in force shall be those established under this Convention . . . . Each contracting State undertakes to insure the prosecution of all persons violating the regulations applicable.[180]

While a possibility exists that some carriers might relocate, re-register, or re-flag to escape coverage by the proposed cap-and-trade system, the increasingly global nature of air travel makes it less and less likely that a major emitting carrier would have no contact with any Annex 1 Party. In addition, instituting a requirement that carriers hold allowances in accordance with Annex 1 equity ownership would limit the possibility that an Annex 1 carrier could establish an offshore affiliate simply to escape these requirements. Moreover, carriers increasingly are recognizing their obligations to deal responsibly with the atmospheric consequences of their activities.[181]

G. Making the Trading System Operational

Article 2.2 of the Kyoto Protocol states that "[t]he Parties included in Annex 1 shall pursue limitation or reduction of emissions of

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one another for failing to comply with, or for activity that would defeat the aims of, an emissions trading system adopted by IATA. *See id*. Finally, as a corporation chartered under and subject to the laws of a sovereign nation (Canada), IATA is legally and politically accountable to at least one UNFCCC Party. *See id*.arts. 2, 3.

[180] Chicago Convention, *supra* note 65, art. 12.

[181] *See, e.g.*, Stenberg, *supra* note 62, at 108.

greenhouse gases."[182] Although all 178 Parties to the UNFCCC are committed to "promote and cooperate" in limiting international aviation emissions, currently only the nations listed in Annex 1 of the UNFCCC have a legal obligation to limit these emissions.[183]

Under the proposed international aviation emissions trading program, Annex 1 Parties would devolve to each airline registered under a flag of a nation listed in Annex 1 of the UNFCCC, each airline flying aircraft registered in a nation listed in Annex 1, and each airline flying to or from a nation listed in Annex 1, allowances for CO_2 emissions from its international flights, whether or not those flights involved Annex 1 airports. Because non-Annex 1 nations are not legally obligated to "pursue" aviation emissions reductions under the Kyoto Protocol,[184] the emissions of airlines registered under the flags of these non-Annex 1 nations would not be capped, with one exception. When airlines from non-Annex 1 Parties fly to or from places located in the sovereign territory of Annex 1 nations, they would need to hold—as a condition of their carriage in those nations—allowances sufficient to cover the CO_2 emissions from those flights. Without such allowances, Annex 1 Parties would not be able to fulfill the Kyoto Protocol mandate to limit their GHG emissions.

Non-Annex 1-based airlines could obtain emissions allowances during IATA's initial allocation negotiation, or they could buy from other cap-based airlines the amount of emissions allowances they need for different routes. They also voluntarily could adopt emissions caps for all their operations and participate fully in the international aviation emissions trading system. ICAO Parties and IATA active members could agree that for the first commitment period, a non-Annex 1 airline that joined the cap-and-trade system would receive, within agreed environmental limits, emissions allowances that exceeded its actual emissions. These airlines could save the extra emissions allowances, use them to offset the emissions reductions they would have to make in later commitment periods, or sell the surplus allowances to other airlines. This approach would be particularly attractive to non-Annex 1

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[182] Kyoto Protocol, *supra* note 13, art. 2.2.

[183] *Id*. art. 3.1. The Kyoto Protocol's origins are in the 1995 Berlin Mandate, in which the first UNFCCC COP decided that the Protocol should not place emissions limitation obligations on developing country parties. *See Report of the Conference of the Parties on its Third Session, Held at Berlin from 28 March to 7 April 1995*, FCCC, 3d Sess., addendum pt. 2, Decision 1/CP.1, at 4, U.N. Doc. FCCC/CP/1995/7/Add.1 (1995); *see also COP Decisions*, Decision 1/CP.3, *supra* note 72, at 4.

[184] *See* Kyoto Protocol, *supra* note 13, art. 3 & annex B.

small island nations, many of which have great reason to be concerned about sea level rise and other impacts associated with increasing GHG emissions, and many of which are located far from mainlands, making aviation emissions a significant portion of their emissions profile.[185] The international aviation emissions cap-and-trade system would be legally binding on all ICAO contracting states.

H. Encouraging Participation in a Cap-and-Trade Civil Aviation Emissions System

The following section examines the membership of ICAO and the UNFCCC to determine how, in practice, governments might agree to adopt the emissions cap-and-trade framework proposed in this Article. Both UNFCCC and ICAO enjoy exceptionally broad membership, with most nations belonging to both. Moreover, with the exception of Liechtenstein, all of the nations listed in Annex 1 of the UNFCCC are members of ICAO. However, not all nations that belong to ICAO also belong to the UNFCCC; a few nations that belong to the UNFCCC have not yet joined ICAO; and a few carriers are from nations that have joined neither organization.

1. Members of the UNFCCC, Nonmembers of ICAO

Dominica, Liechtenstein, Niue, St. Kitts and Nevis, Tuvalu, and Yugoslavia are not members of ICAO. These nations, however, belong to the UNFCCC.[186] Airlines registered in these non-ICAO nations are members of the IATA.[187] Airlines of these non-ICAO countries would not face ICAO legal obligations to join in a cap-and-trade system, but they might face such legal obligations as a consequence of their flag nations' UNFCCC participation. Because part of the commitment to become a UNFCCC party includes a commitment to "promote and cooperate in the development, application and diffusion . . . of . . .

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[185] This approach would also be useful in minimizing any tensions with international trade rules, as participation in the international aviation emissions trading system would be open to all nations, regardless whether such nations had joined Annex 1. *See generally* Annie Petsonk, *The Kyoto Protocol and the WTO*, 11 DUKE ENVTL. LAW & POL'Y FORUM (forthcoming Winter 2000).

[186] UNFCCC, *Update on Ratification of the Convention* (visited June 1, 2000) <http://www.unfccc.de/resource/conv/ratlist.pdf>.

[187] IATA, *Members* (visited June 1, 2000) <http://www.iata.org/members/scripts/m-show.idc>.

practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the . . . transport [sector],"[188] the UNFCCC should urge all COP members to join ICAO, and both ICAO and UNFCCC members should urge all their airlines to join IATA, which would resolve membership discrepancies and render an international aviation trading system more inclusive.

Table 2

UNFCCC Nations That Do Not Belong to ICAO

Country	Member of ICAO	Member of UNFCCC
Dominica	No	Yes
Liechtenstein	No	Yes
Niue	No	Yes
St. Kitts and Nevis	No	Yes
Tuvalu	No	Yes
Yugoslavia	No	Yes

2. Members of ICAO, Nonmembers of the UNFCCC

Similarly, ICAO should urge nations that belong to ICAO, but not to the UNFCCC, to join the UNFCCC. By so doing, when their carriers participate in the international aviation system that will be established by amending the annexes to the Chicago Convention, the carriers also will be able to participate in the broader emissions trading market established by the Kyoto Protocol.

[188] UNFCCC, *supra* note 11, art. 4.1(c).

Table 3

ICAO Contracting States That Are Not UNFCCC Parties

Country	ICAO Contracting State	UNFCCC Party
Afghanistan	Yes	No
Angola	Yes	No
Belarus	Yes	No
Bosnia and Herzegovina	Yes	No
Brunei Darussalam	Yes	No
Liberia	Yes	No
Libyan Arab Jamahirya	Yes	No
Palau	Yes	No
São Tomé and Príncipe	Yes	No
Somalia	Yes	No
Turkey	Yes	No

3. Nonmembers of ICAO and the UNFCCC

The UNFCCC and ICAO should make it a priority to encourage those non-ICAO nations that also are not Parties to the UNFCCC to join both the UNFCCC and ICAO, and to urge their airlines to join IATA. It should be noted that non-ICAO nations and non-IATA airlines *will not* be allocated emissions allowances under this international aviation emissions trading system. To the extent that Annex 1 nations follow the recommendation above and require aircraft operating in their territories to hold emissions allowances, non-member airlines would need to purchase allowances to take off and land in Annex 1 nations.

Within ICAO, thirty-three nations are members of the ICAO Council.[189] A two-thirds vote in the council ratifies any proposal and adds the proposal to the convention as an annex.[190] Thus, the aviation emissions trading system needs twenty-two votes to become a legally

[189] *See* 55 ICAO J. 4 (2000) (listing the 33 member states); *see also* Chicago Convention, *supra* note 65, art. 50(a) (explaining election process of ICAO Council members).

[190] *See* Chicago Convention, *supra* note 65, art. 90(a).

binding ICAO annex. As Table 4 illustrates, of the thirty-two nations that have caps under the Kyoto Protocol, thirteen enjoy representation in the ICAO Council. Assuming that all thirteen nations vote in favor of the emissions trading system in the Council, to establish aviation emissions trading, nine of the twenty remaining nations in the Council would have to agree to this trading system.

It is important to note that the thirteen ICAO Council nations that have adopted limits under the Kyoto Protocol, and the twenty ICAO Council nations that have not, are all Parties to the UNFCCC.[191] All the ICAO Council nations thus have UNFCCC obligations to cooperate in developing a means of reducing emissions from the transport sector.[192] The emissions trading system for international civil aviation proposed above affords them a flexible, cost-effective means of implementing this obligation.

Table 4

Membership in the ICAO Council and Annex B of the Kyoto Protocol

ICAO Council Nations	Party to the UNFCCC?	Listed In Annex B of the Kyoto Protocol?
Algeria	Yes	
Argentina	Yes	
Australia	Yes	Yes
Botswana	Yes	
Brazil	Yes	
Cameroon	Yes	
Canada	Yes	Yes
China	Yes	
Colombia	Yes	
Cuba	Yes	
Egypt	Yes	
France	Yes	Yes
Germany	Yes	Yes
India	Yes	

[191] *See* UNFCCC, *Update on Ratification of the Convention, supra* note 186 (listing UNFCCC parties; IATA, *Members*, *supra* note 187 (listing IATA members).

[192] UNFCCC, *supra* note 11, art. 4.1(c).

Indonesia	Yes	
Italy	Yes	Yes
Japan	Yes	Yes
Kenya	Yes	
Lebanon	Yes	
Mexico	Yes	
Netherlands	Yes	Yes
Nigeria	Yes	
Norway	Yes	Yes
Pakistan	Yes	
Panama	Yes	
Russian Federation	Yes	Yes
Saudi Arabia	Yes	
Senegal	Yes	
Slovakia	Yes	Yes
Spain	Yes	Yes
United Kingdom	Yes	Yes
United States	Yes	Yes
Uruguay	Yes	

V. OPTIONS TO CONSIDER IF AN AGREEMENT ON A CAP-AND-TRADE SYSTEM CANNOT BE REACHED BY 2001

The foregoing analysis provides a framework for a carrier-based emissions trading system for limiting GHG emissions from international civil aviation. If, however, such a system is not adopted or is adopted at a level that fails to contribute significantly to the UNFCCC's objective, other forms of regulation may be imposed on the airlines, such as aviation fuel charges already under discussion.[193] Some Airports Council International ("ACI") member airports already have signaled their willingness to try to resolve the local emissions problem through a system of emissions charges.[194]

For example, the Zurich airport already has imposed stiff emissions charges on carriers according to each aircraft's quantity of NO_x and hydrocarbon emissions.[195] On the basis of engine emissions, the airport

[193] *Cf.* BLEIJENBER & WITT, *supra* note 164.
[194] *See* Zurich Airport Authority, *supra* note 114, at 3.
[195] *See id.* at 4–8.

separates landing aircraft into different categories.[196] Aircraft emitting the greatest pollutants must pay a surcharge of forty percent of the landing tax,[197] while those in the cleanest category are exempt.[198] Although the Chicago Convention requires the contracting states to strive for uniform regulations,[199] that provision of the convention—like the 1992 Rio Treaty's "aim" to limit GHG emissions to 1990 levels by the year 2000[200]—is hortatory, not mandatory.[201] In the event that an international system does not materialize, airport-by-airport regulation may occur, and its potential to disrupt the airlines' existing systems of aircraft deployment may be seen by the public as an inescapable cost of protecting the environment.

The carrier-based emissions cap-and-trade system described in this Article offers an alternative that would enable carriers to adopt measures that both reduce GHG emissions and meet local air quality concerns to save the "extra" allowances thus obtained, for future use or sale through the international carrier-based emissions trading system. Indeed, airports that adopt "emissions bubbles," as some ACI members are considering,[202] could design their "bubbles" to mesh with the ICAO, IATA, and Kyoto Protocol systems. Accordingly, the system proposed here offers real incentives for local air quality improvements at airports while tackling the larger problem of limiting civil aviation's contribution to global climate change.

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[196] *See id*. at 6.

[197] *See id*. at 8.

[198] *See id*. at 8.

[199] *See* Chicago Convention, *supra* note 65, art. 12.

[200] *See* UNFCCC, *supra* note 11, art. 4.2(b).

[201] Article 12 of the Chicago Convention states, "Each contracting State undertakes to keep its own regulations [relating to flight and maneuver of aircraft] . . . uniform, to the greatest possible extent, with those established from time to time under this Convention." Chicago Convention, *supra* note 11, art. 12.

[202] *See* Hamel Presentation, *supra* note 115.

VI. CONCLUSION

Increasingly, policymakers in government and industry are recognizing that environmental issues are likely to impose fundamental limitations on air transportation growth in the twenty-first century,[203] a recognition that underscores the importance of ensuring the long-term environmental capability of the aviation system. This Article has outlined a carrier-based emissions cap-and-trade system to limit and reduce emissions of CO_2 and NO_x from international civil aviation in industrialized nations.

A cap-and-trade emissions system would offer powerful incentives for technology innovation at all levels, including engine manufacture, airframe development, airport operations, and air traffic control. It also could have important local environmental benefits while at the same time providing a flexible, market-oriented, cost-effective framework for responding to the challenge of increased loading of the global atmosphere from aviation emissions. Moreover, an emissions cap-and-trade system could provide important incentives for communities and companies confronted with congested airports to work with national, regional, and local authorities to bring about innovative approaches to emissions reductions.

[203] *See*, *e.g.*, Stenberg, *supra* note 62, at 108.