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Projections for Reducing Aircraft Emissions

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PROJECTIONS FOR REDUCING AIRCRAFT EMISSIONS

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ABSTRACT

THE FEDERAL AVIATION ADMINISTRATION (FAA) reports that the commercial airline industry flew 712.6 million passengers in 2010 and is projected to increase to 1.27 billion by 2031. Per the International Air Transport Association (IATA), the airline industry’s global net profit was expected to reach $4.9 billion in 2012, accounting for 56 million jobs worldwide and between 4.7% and 5.6% of the U.S. gross domestic product. In light of these growing numbers, one of the most significant queries is what is being done to minimize the aviation industry’s impact on the environment. In an industry where growth is forecast, the potential for continued climate change is frightening. While it is clear that agencies and organizations are working toward better understanding the commercial aviation industry’s footprint on the environment and developing solutions for sustainability, the question remains whether the airline industry can drastically reduce its carbon footprint and yet continue to remain in business. To understand the impact of commercial airline emissions on the environment and the commercial future of this industry, this article offers: (1) a brief synopsis of the evolution of commercial air travel; (2) an evaluation of aircraft emissions and their effects on the environment; (3) a study of the regulatory and private sector standards currently in place for aircraft emissions; (4) a projection of the future environmental impact of the airline industry; (5) a review of the judicial system’s influence on aircraft emissions; and (6) proposals for reducing aircraft emissions in the United States in order to combat the growth of the global commercial airline industry and its effects on the environment.

I. INTRODUCTION

In 2011, the FAA reported that the commercial airline industry flew 712.6 million passengers in 2010 with an anticipated increase of 2.8% annually over the next twenty years to a projected
1.27 billion annual fliers by 2031. The airline industry's global net profit is expected to be around $4.9 billion in 2012. This profit accounts for approximately 56 million jobs worldwide and between 4.7% and 5.6% of the U.S. gross domestic product since 2000. Further, the total number of airline passengers traveling to and from the United States is projected to increase at an annual growth rate of 4.5% between 2010 and 2031, with passenger numbers increasing from 149.6 million in 2010 to 373.9 million in 2031.

In light of the above numbers generated from the commercial airline industry, one of the most important questions for its future is what is being done to minimize the aviation sector's impact on the environment. In an industry where growth is forecast, the potential for continued climate change due to aircraft emissions is frightening. However, amidst the current growing concerns pertaining to aircraft-generated pollution, it is clear that national and international agencies and organizations are working together to better understand the airline industry's footprint on the environment and are working toward developing solutions for sustainability.

Between the implementation of rigorous commercial aircraft regulations and the aviation sector's commitment to reaching noble environmental goals, the impact that the commercial aviation industry has on the environment seems to be the cornerstone of this industry's commitment to reduce aircraft emissions in our skies. However, the question remains: Are the standards and goals currently in place enough to curb the impact of commercial aviation emissions as compared to the expected increase in flight demand? Our aim is to present an understanding of the national and international efforts in place to curb commercial aviation emissions and to offer proposals that the United States may utilize to proactively lower aviation emissions domestically in order to offset the catastrophic increase in global greenhouse emissions currently ailing planet Earth. To better

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4 FAA Forecast Fact Sheet, supra note 1.

5 Id.
understand the impact of commercial airline emissions on the environment and the commercial future of this industry, this article offers: (1) a brief synopsis of the evolution of commercial air travel; (2) an evaluation of aircraft emissions and their effects on the environment; (3) a study of the regulatory and private sector standards currently in place for aircraft emissions; (4) a projection of the future environmental impact of the airline industry; (5) a review of the judicial system's influence on aircraft emissions; and (6) proposals for reducing aircraft emissions in the United States in order to combat the growth of the global commercial airline industry and its effects on the environment.

II. EVOLUTION OF COMMERCIAL AIRCRAFT

While mankind entered unchartered airspace in the eighteenth century with the launch of the hot air balloon in Paris, commercial air transportation did not begin until Germany launched the first official passenger service airline in 1919. The earliest U.S. airlines included Northwest Airways, Inc. (NWA), Eastern Airways, Pan American Airways (Pan Am), the Boeing Air Transport Company (Boeing), Delta Air Service (Delta), American Airways, Inc. (American), and Trans World Airlines (TWA). By 1931, passengers could travel via commercial aircraft between all major American cities. While few, if any, of the commercial airline companies made profits in

6 R.G. Grant, Flight: 100 Years of Aviation 134 (Dominick A. Pisano et al. eds., 2002).
13 Joe Christy, American Aviation: An Illustrated History 129 (Joanne Slike et al. eds., 2d ed. 1994).
14 Id. at 129.
the early days of commercial flight. By the end of the decade, "U.S. airliners were carrying \[3\] million passengers a year." The 1940s, the end of World War II, and the 1950s welcomed the new era of commercial air travel, particularly non-stop air travel on a domestic and international scale. The post-World War II era in commercial aviation brought with it another generation of evolutionary design—specifically to the aircraft engine. Early jet engines "used up enormous quantities of fuel and made heavy demands on maintenance staff." The advent of the turboprop engine offered far better fuel economy than the original turbojet engines. Then, the 1950s turbojet engine design, followed by the turbo-fan engine of the 1960s, became standard models in jet aircraft due to their fuel-efficiency and long-distance travel range. "The growth of passenger miles flown on long-distance routes in the first decade of jet travel was astonishing—for TWA, for example, the figure rose from 4.6 billion in 1958 to 19.1 billion in 1969 and for Pan Am from 3.8 billion [in 1958] to 17.1 billion [in 1969]." However, during this period, the ecology movement began taking shape against airlines, claiming that aircraft use was damaging the ozone layer. Since that time, the future of commercial air travel lies largely in the quest for environmentally acceptable aircraft designs. The greatest threat to the future of air travel is likely the growing sensitivity to

15 Id. at 128. Note that the "[a]verage income was approximately 43 cents per mile while operating costs began at about 50 cents per mile and went as high as 80 cents per mile." Id. at 114-15.
16 Grant, supra note 6, at 147.
17 Id.
18 Id. at 376.
19 Id. at 380.
20 Id.
21 See id. at 380-82. "The first turboprop airliner, the Vickers Viscount," was a British aircraft that "arrived on the scene in 1950." Id.
22 See id. at 382-83. The first commercial jet, the de Havilland Comet, entered the scene in 1952. However, due to some flight disasters in the mid-1950s, it lost its edge in the technology era. Id. "The Boeing 707 came into service in October 1958, flying the Pan Am transatlantic routes from . . . New York, to Paris and London." Id. at 383. The Boeing 707 flew at a maximum speed of 600 miles per hour and thus launched the airline industry into the era of the jet-powered engine. Id.
23 Id. at 386.
24 See id. at 393.
environmental damage caused by aircraft.\textsuperscript{25} Government agencies and other groups, including the FAA, Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), the International Civil Aviation Organization (ICAO), and the IATA, are working in tandem with aircraft manufacturers in an effort to combat global warming.\textsuperscript{26} The rise or fall of commercial air transportation in the future is undoubtedly linked to the next generation of aircraft design.

\section*{III. TRANSPORTATION AND ITS IMPACT ON THE ENVIRONMENT}

"Transportation [is] described as the world's most serious environmental villain."\textsuperscript{27} "As the major consumer of non-renewable energy resources (i.e., fossil fuels), transportation is among the world's most prominent polluters"\textsuperscript{28} and has been deemed "the largest end-use source of greenhouse gases."\textsuperscript{29} According to the EPA, "[i]n 2010, transportation contributed approximately 27\% of total U.S. greenhouse gas emissions."\textsuperscript{30} Transportation is also found to be the fastest growing source of greenhouse gas emissions in the United States.\textsuperscript{31}

Aircraft release gaseous emissions directly into the atmosphere, both at the ground level and into the upper atmosphere.\textsuperscript{32} While air transportation contributes to only 4\% of the

\begin{footnotes}
\footnote{25}{Glenn Research Center: Fact Sheet, NASA, http://www.nasa.gov/centers/glenn/about/fs10grc.html (last visited Sept. 9, 2012) [hereinafter NASA Fact Sheet].}
\footnote{26}{See Curtis Holsclaw, Emissions Div., FAA, FAA Perspective on ICAO's Progress on NO\textsubscript{x} Emissions as well as on Efforts for CO\textsubscript{2}, Particulate Matter, and Noise Standards (2010).}
\footnote{28}{Id. at 642.}
\footnote{30}{Transportation and Climate, supra note 29.}
\footnote{31}{Id. (Transportation "accounts for 45\% of the net increase in total U.S. greenhouse gas emissions from 1990–2010.").}
\end{footnotes}
total pollutants in our environment,"33 "it is the only industry which discharges harmful emissions . . . directly into the upper atmosphere."34

The Intergovernmental Panel on Climate Change (IPCC) determined that "[t]wo global environmental issues have emerged for which aviation may have potentially important consequences"—climate change and ozone depletion.35 Thus, "[c]oncerns over [the] consumption of non-renewable resources [including fossil fuels and increased global warming] . . . warrant careful examination of the role of [air] transport in making the planet less habitable."36

The EPA has identified certain pollutants that "cause or contribute to air pollution and [that can] endanger the public health or welfare": ozone, carbon monoxide, particulates, sulfur dioxide, nitrogen dioxide, and lead.37 Each of these six pollutants is emitted by aircraft directly into the atmosphere and/or in and around airports.

Aircraft transport has a direct impact on the depletion of the Earth’s ozone layer. "Ozone is Earth’s natural sunscreen, shielding life from excessive amounts of ultraviolet radiation."38 In a 2010 report prepared by the science advisors to the Montreal Protocol, it was determined that "[t]he impact of the Antarctic ozone hole on [the Earth’s] surface climate is becoming evident in surface temperature and wind patterns."39 Also concern-worthy is the fact that "increasing occurrences of skin cancer are [now] attributed to the thinning of [the Earth’s] ozone layer."40

33 Per the National Aeronautics and Space Administration (NASA), "[a]ircraft produce up to 4[%] of the annual global CO2 emissions from fossil fuels near the Earth’s surface as well as at higher altitudes." See NASA Fact Sheet, supra note 25. Note further that a 2010 study conducted by NASA determined that on-road transportation is the greatest net contributor to atmospheric warming. See Nadine Unger et al., Attribution of Climate Forcing to Economic Sectors, 107 PROC. NAT’L ACADEMY OF SCI. 3382, 3384 (2010), available at http://www.pnas.org/content/107/8/3382.full.pdf.html.

34 Dempsey, supra note 27, at 643.


36 Dempsey, supra note 27, at 640.

37 See FAA, AIR QUALITY PROCEDURES FOR CIVILIAN AIRPORTS & AIR FORCE BASES C-5 (1997) [hereinafter FAA AIR QUALITY PROCEDURES].


39 Id.

40 See NASA Fact Sheet, supra note 25.
Carbon monoxide and nitrogen dioxide are poisonous gases emitted by aircraft inside airport settings. While on-road vehicles contribute larger quantities of these gases than do aircraft, aircraft produce a significant amount of such gaseous emissions. A 2010 study on the specific climate impact of passenger and freight transport determined that while “[a]ir travel has the highest specific impact on short-term [global] warming,” automobiles “ha[ve] an equal or higher impact” on long-term global warming.

It has been established that the aeronautics industry is adding to the problem of increased global warming. Carbon dioxide is a greenhouse gas “produced . . . primarily through the combustion of fossil fuels.” “Global warming is caused by the emission of greenhouse gases,” and carbon dioxide emissions are considered “the most important cause of global warming.” Since the Industrial Revolution in the 1700s, human activities have increased carbon dioxide concentrations in the atmosphere. In 2005, global atmospheric concentrations of carbon dioxide were 35% higher than they were before the Industrial Revolution. While the largest sources of transportation greenhouse gases are from passenger automobiles, commercial aircraft accounted for 6% of total greenhouse gas emissions in the United States in 2010.

Aircraft are the main source of particulate matter emissions in and around airports. Particulate matter is material suspended

41 See FAA Air Quality Procedures, supra note 37, at C-7 to C-8.
48 EPA Inventory, supra note 42, at 2-20. Note that automobiles used primarily for personal travel accounted for 62% of the total transportation greenhouse gas emissions in the United States in 2010. Id.
49 FAA Air Quality Procedures, supra note 37, at C-7.
in the Earth’s atmosphere, including dust, fog, and fumes. Sulfur oxides and soot emitted from aircraft exhaust result in the formation of cloud particles. “Aircraft exhaust produces contrails—[the] condensation trails,” which eventually turn into cirrus clouds located “in the atmosphere about [five] miles above the Earth’s surface.” Contrails and cirrus clouds are believed to contribute to climate change. Of importance, it has been observed that “over the past [forty] years, cloudiness seems to have increased,” an increase which has been argued “may lead to global climate change.”

Finally, aircraft emit lead. The main source of lead emissions at airports is the combustion of lead-based aviation gasoline. “Lead . . . accumulates in soils and sediments . . . [and] [e]cosystems near point sources of lead demonstrate a wide range of adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in vertebrates.”

IV. SUSTAINABILITY OF AIR TRAFFIC AND THE ENVIRONMENT

A. REGULATORY STANDARDS

As previously noted, the commercial aviation industry, which lies at the heart of today’s modern world economy, anticipates a 2.8% increase in passenger growth annually over the next twenty years to a projected 1.27 billion passengers flying annually by 2031, a global net profit of $4.9 billion in 2012, and it already accounts for 56 million jobs worldwide. Despite these numbers, the industry generates only about 2% of the worldwide carbon dioxide emissions. However, with expected annual increases in air traffic and the airline industry’s growth as a
business enterprise, it is imperative that national and international agencies and organizations focus on the state of the environment and the pollution attributable to aircraft usage and work with the private sector to reduce the airline industry's carbon footprint. Still, the question remains as to whether the standards and goals currently in place are enough as compared to the expected increase in flight demand. To answer this question, a review of the regulatory standards currently in place with respect to aircraft emissions is vital.

B. Federal Aviation Administration (FAA)

The FAA, through its Office of Environment and Energy (AEE), recognizes that the aviation industry impacts the environment and acknowledges that more focus must be placed on aircraft emissions. As such, the AEE, in collaboration with the EPA's Office of Transportation and Air Quality (OTAQ), have issued recommended “best practices” for the quantification of organic gas emissions from aircraft. The measurement of air emissions associated with aircraft engines is an evolving process that is still under development and can only be refined via future research and additional attention to this issue. This collaborative effort is an initial attempt, and both the FAA and the EPA have affirmed their dedication to further develop these quantitative measures.

It is important to note “that there are currently no [f]ederal regulatory guidelines specific to [hazardous air pollutant] emissions from aircraft.” Thus, these best practices serve only as suggestions for addressing potential legislative action at the federal level. Until upper atmospheric aircraft emissions can be effectively quantified, the possibility of federal legislation remains in its infancy. More specifically, at present, approximately “29[\%] of the [organic gas] mass associated with the exhaust

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63 Id. at 2.
64 Id. at exec. summary.
65 Id.
from the tested commercial aircraft engines is presently unidentified.”

Certain aircraft operations play a significant role in the preparation of an emissions inventory of pollutants.\textsuperscript{67} Such operations include: “[t]he number of aircraft operations (i.e., landings and takeoffs) by aircraft type, [t]he type and number of aircraft engines, and [t]imes-in-mode for each of the aircraft operational modes (i.e., approach, taxi-in, taxi-out, idle (delay), take-off, and climbout).”\textsuperscript{68} These characteristics are used collectively to calculate the levels of commercial aircraft emissions, and they are of extreme importance in determining the amount and extent of the commercial airlines’ impact on the environment.

Another revolutionary endeavor in the FAA’s effort to minimize aircraft emissions is its project entitled The Next Generation Air Transportation System (NextGen). NextGen “is the [FAA’s] plan to modernize the National Airspace System (NAS) through 2025.”\textsuperscript{69}

Through NextGen, the FAA is addressing the impact of air traffic growth by increasing NAS capacity and efficiency while simultaneously improving safety, reducing environmental impacts, and increasing user access to the NAS. To achieve its NextGen goals, the FAA is implementing new Performance-Based Navigation (PBN) routes and procedures that leverage emerging technologies and aircraft navigation capabilities.\textsuperscript{70}

Several NextGen milestones are currently in the works to be implemented by 2015.\textsuperscript{71} First, NextGen aims to reduce airline
delays (both in-flight and on the ground) by 35% by the year 2018, thereby saving approximately 1.4 billion gallons of aviation fuel and reducing carbon dioxide emissions by 14 million tons during this period.\textsuperscript{72} Second, the implementation of several new technologies, including the Automatic Dependent Surveillance-Broadcast (ADS-B), Data Communications (Data Comm), and PBN will further aide in reducing aircraft emissions.\textsuperscript{79}

ADS-B is the FAA’s satellite-based successor to radar that more accurately tracks air traffic.\textsuperscript{74} ADS-B offers “increased situational awareness” by providing “free in-cockpit traffic and weather information.”\textsuperscript{75} “Data [Comm] will provide pre-departure clearances that allow amendments to flight plans.”\textsuperscript{76} On the ground, the flight crew’s situational awareness will improve via flight-deck displays portraying aircraft and surface vehicle movement.\textsuperscript{77} “In the tower, improved ground systems, such as surface-movement displays, will [also be available to] enable controllers to manage the use of taxiways and runways more efficiently.”\textsuperscript{78}

The FAA reports that the implementation of PBN procedures, which “encompass a set of enablers with [the] . . . capability to construct a flight path that is not constrained by the location of ground navigation aids,”\textsuperscript{79} has already “saved hundreds of thousands of gallons of fuel [thereby reducing] thousands of tons of carbon dioxide and [other] air pollutants.”\textsuperscript{80} “PBN procedures help reduce fuel use, emissions and miles flown at high altitudes.”\textsuperscript{81} In 2010, the FAA’s production of PBN routes and procedures exceeded its fiscal year goal.\textsuperscript{82}

As demonstrated by the FAA’s role in creating healthier skies, there are two key components to this agency’s effort to reduce aircraft emissions: (1) a consistent method for quantifying the amount of emissions, and (2) the introduction and adaptation of technology in order to reduce fuel consumption by aircraft.

\textsuperscript{72} Id. at 5.
\textsuperscript{73} Id.
\textsuperscript{74} Id. at 8.
\textsuperscript{75} Id.
\textsuperscript{76} Id. at 27.
\textsuperscript{77} Id.
\textsuperscript{78} Id.
\textsuperscript{79} Id. at 39.
\textsuperscript{80} Id. at 7.
\textsuperscript{81} Id. at 11.
\textsuperscript{82} Id.
Collectively, these two approaches should help to reduce the airline industry’s carbon footprint.

C. ENVIRONMENTAL PROTECTION AGENCY (EPA)

The “mission of the EPA is to protect human health and the environment.” In keeping with this mission, the EPA ensures that “national efforts [made] to reduce environmental risks are based on the best available scientific information.” Studying various air pollutant emissions created by the aviation industry and implementing regulations to reduce aircraft emissions is high on the EPA’s priority list, and, as such, the EPA has drafted key regulations and guidance to help reduce the airline industry’s carbon footprint.

The Clean Air Act, first enacted by Congress in 1955, defines the EPA’s role in protecting and enhancing the U.S. air resources and preventing air pollution. Part B of the Clean Air Act specifically targets aircraft emissions standards, documenting both the establishment of aircraft emissions standards as well as the enforcement of those standards.

The Clean Air Act authorizes the EPA to set national ambient air quality standards (NAAQS) for those pollutants that are considered harmful to public health and to the environment. The pollutants identified include carbon monoxide, lead, nitrogen dioxide, particulate matter, carbon dioxide, and sulphur dioxide. In December 2010, the EPA finalized revisions to the ambient monitoring requirements for measuring lead in the air, which included the monitoring of airports emitting lead, in order to better assess the EPA’s compliance with NAAQS.

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84 Id.
86 Clean Air Act (Air Pollution Control Act), ch. 360, 69 Stat. 322 (codified as amended at 42 U.S.C. §§ 7401-7477q (2006)).
91 Id. § 7403(g)(1).
92 See Revisions to Lead Ambient Air Monitoring Requirements, 75 Fed. Reg. 81,126, 81,127–28, 81,136 (Dec. 27, 2010) (codified at 40 C.F.R. pt. 58, app. D, § 4.5(a)(iii)). Note that the “[t]hree criteria . . . used to select airports for the lead monitoring study” were: (1) “[l]ead emissions greater than or equal to 0.50 tons per year”; (2) “[a]irport runway configuration and meteorology that lead to
In 2010, the EPA also issued Advance Notice of Proposed Rulemaking on Lead Emissions from Piston-Engine Aircraft Using Leaded Aviation Gasoline, as petitioned by Friends of the Earth, an organization that in 2006 requested that the EPA “find[] that lead emissions from general aviation aircraft endanger public health and welfare and issue a proposed emissions standard for lead from general aviation aircraft.”

In 2009, OTAQ and the AEE released the Quality Assurance Project Plan For the Development of a Commercial Aircraft Hazardous Air Pollutants Emission Inventory Methodology, a profile that uses the most recent data sets available for studying emission inventories of aircraft equipped with certain engine types fueled with kerosene-based fuel. The EPA also amended its 2005 emission standards for nitrogen oxides for new commercial aircraft engines in order to parallel the nitrogen oxides emission standards of the ICAO, thus “bring[ing] United States aircraft standards into alignment with the international standards.”

The EPA “work[s] with [both] the FAA and ICAO in the development of international aircraft emission standards.” The FAA’s role in this endeavor is to “enforce the aircraft emissions standards established by [the] EPA,” and the ICAO’s role is to “ensure safety, equality, and consistency among international air transport services,” including developing “standards and procedures for aircraft engines.” In its rulemaking, the EPA has

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96 Nonroad Engines, Equipment, and Vehicles: Aircraft, supra note 85.
98 Nonroad Engines, Equipment and Vehicles: Aircraft, supra note 85.
100 Id.
historically and will continue to adopt standards equivalent to the ICAO standards.\textsuperscript{101}

D. INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

In 1944, the Convention on International Civil Aviation (Chicago Convention) was signed by fifty-two countries, thus establishing the first world-wide effort to unify international aviation.\textsuperscript{102} Since its inception, nine editions of the document have followed, with the most recent published in 2006. The Chicago Convention created the ICAO as a specialized agency of the United Nations linked to the Economic and Social Council (ECOSOC).\textsuperscript{103} The purpose of the ICAO is to develop international civil aviation "in a safe and orderly manner," to establish "international air transport services . . . on the basis of equality of opportunity," and to see that they are "operated soundly and economically."\textsuperscript{104}

Along with other world-wide agencies and organizations, the ICAO has become the leading international organization pursuing measures to reduce civil aviation's impact on the environment across the globe.\textsuperscript{105} The ICAO Council's Committee on Aviation Environmental Protection (CAEP)—consisting of members and observers nominated by states and intergovernmental and nongovernmental organizations representing aviation industry and environmental interests—undertakes massive efforts to meet major environmental goals.\textsuperscript{106}

In 2004, the ICAO, through the CAEP, adopted three critical environmental goals to coincide with its purpose: (1) to "limit or reduce the number of people affected by significant aircraft noise"; (2) to "limit or reduce the impact of aviation emissions on local air quality"; and (3) to "limit or reduce the impact of aviation greenhouse gas emissions on the global climate."\textsuperscript{107} To address these goals, a "consolidated statement of continuing ICAO policies and practices related to environmental protec-

\textsuperscript{101} Id.
\textsuperscript{104} Chicago Convention, \textit{supra} note 102, 15 U.N.T.S. at 296.
\textsuperscript{105} ICAO 2006 Annual Rep., \textit{supra} note 103, at intro.
"tion" was prepared, and such document is revised and updated by the CAEP regularly. The purpose of this statement and subsequent revisions is "to reflect developments that have taken place . . . in the field of aircraft noise and engine emissions," "to promote information on scientific understanding of aviation’s impact and action undertaken to address aviation emissions," and to "emphas[ize] . . . those policy options that will reduce aircraft engine emissions without negatively impacting the growth of air transport." 

In 1999, the Special Report on Aviation and the Global Atmosphere was prepared by the IPCC at the request of the ICAO. Among numerous findings, the report documented that aircraft emissions "alter the concentration of atmospheric greenhouse gases; . . . trigger formation of condensation trails (contrails); and may increase cirrus cloudiness—all of which contribute to climate change," and that aircraft contribute approximately 3.5% of the total radiative forcing (a measure of climate change) by all human activities and that such percentage is expected to grow.

In 2007, the ICAO requested that the IPCC update the main findings of the 1999 report in its Fourth Assessment Report. The findings in this report included data indicating that global warming is evident, that total carbon dioxide emissions grew by about 80% between 1970 and 2004, "that global increases in [carbon dioxide] concentrations are due primarily to fossil fuel use," and that there is evidence to suggest that "global [greenhouse gas] emissions will continue to grow over the next few decades." The Fifth Assessment Report is expected to be published in 2014 and will address the scientific understanding of aviation’s impacts on the global climate.

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109 See id. at 41, 57.
110 See INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), AVIATION AND THE GLOBAL ATMOSPHERE vii (Joyce E. Penner et al. eds., 1999).
111 Id. at 3.
112 See id. at 8.
114 Id. at 2.
115 See id. at 5.
116 Id.
117 Id. at 7.
Drafted in 1998, the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) identified the international role of the ICAO to limit or reduce emissions of greenhouse gases from aviation fuels. The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. It requires certain industrialized nations to reduce their collective emissions of six specific greenhouse gases.

While the ICAO works actively with many worldwide agencies and organizations, including the EPA and FAA, to improve the environmental performance of aviation, it maintains close relations with United Nations policy-making bodies having interests in civil aviation.

E. The Private Sector

As previously noted, certain national and international governmental agencies and organizations are major players in the hunt for a greener aviation industry. However, the private sector plays no small role in creating policies to reduce aviation emissions. The following examples provide a glimpse at the private sector’s role in improving the aviation industry’s impact on the environment.

1. International Air Transport Association (IATA)

IATA was incorporated in 1945 in order to “represent, lead, and serve the airline industry.” IATA represents 240 international member airlines in over 115 different countries. One of IATA’s main priorities in working amidst the standards re-

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120 Id. at 214.

121 See id. at Annex B.

122 See id. at Annex A (The six identified gases are: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF₆)).

123 See Environmental Protection, supra note 107.

124 See id. and accompanying text.


quired by the ICAO is "to achieve carbon neutral growth in the medium term and to build a plane that produces no emissions within [fifty] years."\textsuperscript{127} IATA has designed a strategy whereby carbon-neutral growth beginning in 2020, followed by a carbon-free future, is achievable by "cut[ting] emissions within the [air]line industry or by financing projects to cut an equivalent amount of emissions in other industries."\textsuperscript{128} In coordination with this strategy, IATA also "recommended [a] policy approach for adoption by governments" that will support efforts to meet the global challenge of climate change.\textsuperscript{129}

2. The Boeing Company

"Boeing is the world's largest aerospace company and leading manufacturer of commercial jetliners and defense, space and security systems."\textsuperscript{130} In recognizing the environmental challenges facing the eco-system, Boeing is instrumental in pioneering new technologies for environmentally progressive products and services.\textsuperscript{131}

As part of its pursuit to reduce emissions of greenhouse gases from its facilities and products, Boeing is constantly working to develop new technology to improve global transportation; to increase its research to improve efficiencies throughout the system, including the introduction of sustainable advanced-generation biofuels; to accelerate the adoption of environmentally progressive products and services; and to reduce carbon dioxide emissions by 15% with each new generation of


\textsuperscript{129} See IATA, AVIATION AND CLIMATE CHANGE, supra note 125.


commercial aircraft. In keeping with these goals, Boeing is currently working with NASA on the Environmentally Responsible Aviation (ERA) Project, which "explore[s] and document[s] the feasibility, benefits and technical risk of vehicle concepts and enabling technologies that will reduce the impact of aviation on the environment."

3. Airbus

Airbus is a global leader in aerospace, defense, and related services. Since its inception, "Airbus has put the highest priority on environmental performance," and it "has adhered to a philosophy of increasing the number of passengers (or amount of freight) per flight, while reducing overall . . . energy consumption."

To meet its environmental goals, the European Aeronautic Defence and Space Company (EADS), created its own Vision 2020 guidelines, which outline Airbus's environmental approach, social practices, and economic performance. In December 2010, Airbus also published the Airbus Global Market Forecast 2010–2029, which not only documents the aviation industry's anticipation of growth through innovation, but also dis-

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cusses the company’s intent to reduce environmental impact by way of new engine designs.\textsuperscript{138}

Airbus also partners with various organizations to proactively work toward a more sustainable aviation sector, including the Air Transport Action Group (ATAG),\textsuperscript{139} which advocates the environmentally responsible development of aviation infrastructure.\textsuperscript{140} In 2011, Airbus launched its ProSky subsidiary to focus on enhancing “the development and support of modern air traffic management (ATM) systems.”\textsuperscript{141} The company also lobbies with international bodies, including the European Commission, to promote the use of sustainable biofuels.\textsuperscript{142} Finally, Airbus has also partnered with Lufthansa to launch the first daily commercial passenger service using biofuels.\textsuperscript{143}

V. PROJECTIONS FOR FUTURE IMPROVEMENTS

With growing concerns emerging regarding the impact of aircraft emissions on the environment, what can society expect of the next generation of aircraft? As this article has already addressed, numerous regulatory standards are in place worldwide to help mitigate the environmental impact of aircraft use. However, putting these regulations into practice requires new aircraft and engine designs, and new infrastructure in the airline industry.

A. FAA

In December 2011, the FAA announced it was “awarding $7.7 million in contracts to eight companies to help advance alternative, environmentally-friendly, sustainable sources for commer-


cial jet fuel.” The goal of these eight companies is to assist “the FAA in develop[ing] and approv[ing] alternative, sustainably-sourced drop-in jet fuels that can be used without changing aircraft engine systems or airport fueling infrastructure.” Additionally, these contracts require that the companies “research . . . alternative jet fuel quality control[s], examin[e] . . . how jet biofuels affect engine durability, and provide guidance to jet biofuel users about . . . sustainability.” "These contracts stem from work the FAA is doing through the . . . Commercial Aviation Alternative Fuel Initiative (CAAFI) and the agency’s Continuous Lower Emissions, Energy and Noise (CLEEN) program."

Since its inception in 2006, CAAFI’s goal is “to enhance energy security and environmental sustainability for aviation by exploring the use of alternative jet fuels.” The purpose of CAAFI is to develop and deploy alternative jet fuels for commercial aviation with the objective to significantly reduce emissions associated with aviation operations. The CLEEN program set specific goals to be met by 2015 that include: (1) reducing aircraft fuel burn by 33%; (2) developing engine technology that reduces landing and takeoff cycle emissions by 60%; (3) developing aircraft technology to reduce noise levels by thirty-two decibels; and (4) examining “[t]he extent to which new en-

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146 Id.

147 Id.


149 Id.

gine and aircraft technologies may be used to retrofit or re-engine aircraft to decrease aviation's environmental impact.\textsuperscript{151}

B. ICAO

ICAO "facilitat[es] . . . the promotion and harmonization of initiatives that encourage and support the development of sustainable alternative fuels for international aviation."\textsuperscript{152} The organization not only "provid[es] . . . for education and outreach on sustainable alternative fuels for aviation," but also "facilitat[es] the exchange of information on financing and incentives for sustainable alternative fuels," and "facilitat[es] the establishment of a regulatory framework that assures sufficient quantities of sustainable alternative fuels are made available to [the] aviation" sector.\textsuperscript{153}

ICAO has also mandated that aircraft meet the engine certification standards adopted by the Council of ICAO.\textsuperscript{154} These standards establish limits for emissions of nitrogen oxides, carbon monoxide, unburned hydrocarbons, smoke, and vented fuel.\textsuperscript{155} These standards also limit emissions at altitude, with particular attention paid to nitrogen oxides, which turn into greenhouse gases at higher altitudes.\textsuperscript{156} "The standard for [nitrogen oxides], [which] was first adopted in 1981, [was] then made more stringent in" subsequent years—as recently as 2010.\textsuperscript{157} The most recent standard will hopefully "improve[ ] the current standard by up to 15[\%] with an effective date of 31 December 2013."\textsuperscript{158}

C. IATA

As discussed earlier, IATA has designed a vision for the airline industry to "[b]uild a zero-emissions commercial aircraft within

\textsuperscript{153} Id.
\textsuperscript{154} See ENVIRONMENTAL PROTECTION VOLUME II: AIRCRAFT ENGINE EMISSIONS, ANNEX 16 TO THE CHICAGO CONVENTION § 2.1.2 (3d ed. 2008).
\textsuperscript{155} Id.
\textsuperscript{157} Id.
\textsuperscript{158} Id.
While the engineering solution to this goal is not yet available, IATA is keen on meeting this goal through the use of building blocks, including creating new materials and engine designs and seeking the use of alternative fuel sources in order to reduce carbon dioxide emissions. To reduce aircraft emissions, IATA has created a four-pillar building-block strategy: (1) invest in technology; (2) improve operational efficiency; (3) build and use efficient infrastructure; and (4) institute economic measures to “close the gap.”

Under Pillar One, the advent of newer, more radical technology will provide the best prospects for reducing aviation emissions, including new aircraft designs, new composite lightweight materials, new engine advances, and the development of biofuels. The goal of implementing these new technologies includes airlines spending $1.5 trillion on new aircraft by 2020, as well as the aviation industry replacing 5,500 aircraft by that same year, thus resulting in a 21% reduction in carbon dioxide emissions.

Regarding Pillar Two, IATA developed “green teams,” which “consist of experts that visit airlines and advise them on fuel and emissions savings measures and best practice[s].” The goals of these green teams are to improve operational practices, utilize more efficient flight procedures, and reduce aircraft weight in order to achieve 3% emissions reductions by 2020.

The goal of Pillar Three is to make the air transport infrastructure more efficient. To meet this goal, measures, such as developing programs across the globe to reduce route extensions and flight delays, will be implemented.

Pillar Four entails utilizing economic measures to “close the gap,” or more precisely “advocating a global sectoral approach to reducing emissions.” Under Pillar Four, IATA would act as the “appropriate UN body for developing and implementing a global sectoral approach to address aviation emissions.”

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159 IATA, A Global Approach, supra note 128, at 3.
160 Id. at 4.
161 Id. at 3.
162 Id. at 4.
163 Id.
164 Id. at 5.
165 Id.
166 Id.
167 Id.
168 Id.
169 Id. at 6.
In keeping with its goal to reduce aviation emissions, IATA is "working with the whole industry, including manufacturers, airports, [and] air navigation . . . to turn [its] vision into reality."\textsuperscript{170}

\section*{D. Aircraft Manufacturers}

Because the environmental impact of commercial aircraft has become a fundamental component of the aeronautics industry, aircraft manufacturers must constantly keep abreast of the latest agency regulations pertaining to aircraft emission standards. To meet the goals set by various organizations, manufacturers must continuously strive to design and build more fuel efficient aircraft.

Boeing is currently flight-testing two new commercial aircraft, the 787-8 Dreamliner (787) and the 747-8 Intercontinental (747).\textsuperscript{171} The 787, which seats up to 250 passengers,\textsuperscript{172} is designed to be 20\% more fuel-efficient than other comparable-sized aircraft.\textsuperscript{173} The 747, a wide-body jumbo jet seating up to 500 passengers,\textsuperscript{174} "is designed to be 16[\%] more fuel-efficient than the previous generation of jumbo jets."\textsuperscript{175} "Boeing [has] also announced performance enhancements to the Next-Generation 737 [737NG]," a short to medium range aircraft,\textsuperscript{176} "to improve fuel efficiency of the world's most popular airplane by 2[\%]."\textsuperscript{177} Structural improvements on this aircraft will result in an increase in fuel efficiency by approximately 1\%, and "hardware changes will contribute the other 1[\%] fuel savings."\textsuperscript{178}

In keeping with ICAO regulations, Boeing details that "[c]ompared to the Boeing 707, Douglas DC-8, and other early

\begin{thebibliography}{99}
\bibitem{170} Environment, supra note 127.
\bibitem{174} \textit{747 Family}, supra note 171.
\bibitem{175} 2010 Environment Report: Pioneering Environmental Technologies, supra note 171.
\bibitem{177} 2010 Environment Report: Pioneering Environmental Technologies, supra note 171.
\bibitem{178} \textit{Id.}
\end{thebibliography}
jetliners, today’s commercial airplanes generate 70[%] fewer emissions.179 Boeing further acknowledges that it is “committed to deliver[ing] at least a 15[%] improvement in fuel and [carbon dioxide] efficiency with each new generation of commercial airplane.”180

Over 90% of Airbus’s annual research and development budget is dedicated to environmental benefits for current-generation and future aircraft.181 In 2010, Airbus unveiled its idea of “what air transport could look like in 2050” with the Airbus Concept Plane, an aircraft characterized by its “ultra-long and slim wings, semi-embedded engines, a U-shaped tail and light weight ‘intelligent’ body.”182 This aircraft is anticipated to improve environmental performance of air transportation, lower fuel consumption, and significantly reduce emissions.183

Two of the smaller commercial global aircraft manufacturers—Canadian-based Bombardier Aerospace (Bombardier)184 and Brazilian-based Embraer185—are both looking to future innovations and investments in commercial aircraft in order to re-

179 Id.
180 Id.
183 AIRBUS, AIRBUS AND THE ENVIRONMENT 10 (2010).
184 Bombardier Aerospace (Bombardier) is a Canadian-based world leader in “design[ ], manufacture and support[ ] [of] innovative aviation products for the business, commercial, specialized and amphibious aircraft markets.” About Us, BOMBARDIER, http://www.bombardier.com/en/corporate/about-us (last visited Oct. 12, 2012). According to Bombardier’s 2011 Annual Report, net revenues were down in 2011 ($17,712 billion) as compared to 2010 ($19,366 billion). BOMBARDIER, ANNUAL REPORT, YEAR ENDED JANUARY 31, 2011 (2011) (information located in “Highlights” Section) [hereinafter BOMBARDIER ANNUAL REPORT]. Bombardier’s twenty-year forecast anticipates deliveries in the 100–149 seat mainland aircraft at 6,700 worth $393 billion. Id. at 76. At present, Bombardier employs 65,400 employees. Id. at 6. For more information on Bombardier’s 2011 financial position, see id.
duce aircraft emissions. Bombardier’s Learjet 85 aircraft program “will be the first business or commercial aircraft . . . to be built primarily from composites.” Bombardier’s CSeries family of commercial aircraft uses “leading-edge technology and proven methods to meet commercial airline requirements beginning in 2013 and beyond.” This CSeries aircraft family will use 20% less carbon dioxide and 50% less nitrogen oxides than other similar aircraft models on the market. For its part, Embraer boasts being “the first manufacturer to build a certified ethanol-fueled airplane.” Further, in 2009, Embraer partnered with Azul Airlines, General Electric, and Amyris to work “on a joint project to study the technical aspects and sustainability of a renewable jet fuel derived from fermented sugar cane.”

E. AIRLINES

Certain airlines across the globe are doing their part to reduce aircraft emissions. United Continental, which reported a 2011 net income of $1.3 billion, boasts certain environmental accomplishments, including a “32% improvement in fuel efficiency through investing in a modern, fuel-efficient fleet and equipment” and aircraft orders “that will deliver a 20% improvement in fuel efficiency” comprised of Boeing 787s, Boeing 737s, and Airbus A350s. In recognition of its environmental commitments, Continental Airlines won the Design for Environmental Stewardship Award from the EPA in 2008. It should be noted that “[t]he consolidated network [of United Continental]

186 See BOMBARDIER, ANNUAL REPORT, supra note 184, at 85.
189 EMBRAER, MARKET OUTLOOK 2010–2029 6 (7th ed. 2010).
190 Id.
operated more than two million flights and had 142 million passengers in 2011.”

“In 2008, the Lufthansa Group established fifteen guiding principles, based on its Strategic Environmental Programme, with a view to making further crucial [environmental] progress by 2020.” These guidelines include reducing and cutting carbon and nitrogen oxides emissions, modernizing its current fleet, promoting alternative fuels, and implementing emissions trading on a global scale. This company’s lofty goals include reducing its carbon dioxide emissions 25% by 2020 (as compared to 2006 levels) and cutting nitrous oxide emissions by 80% relative to 2000.

Virgin Atlantic Airways has partnered with Boeing to assist the company in its “quest to become the most sustainable airline in the world.” Virgin Atlantic ordered fifteen 787s from Boeing and participated in a biofuel demonstration with Boeing, Virgin Fuels, and General Electric Aviation. Further, in 2008, Virgin flew its Boeing 747-400 aircraft using a combination of biofuel (a mixture of coconut and babassu oil) and conventional jet fuel. Virgin Atlantic’s environmental goal is to achieve a target of improving its fuel efficiency by 30% by 2020.

VI. THE JUDICIAL SYSTEM’S IMPACT

Setting regulatory standards and implementing new aircraft designs play significant roles in reducing the airline industry's impact on the environment. However, implementing standards goes hand in hand with judicial interpretation. As such, case law pertaining to the aviation industry, with particular emphasis placed on emissions standards, has come forward both nation-

196 Id.
197 Id.
199 Id.
ally and internationally. However, it is important to note that very few cases exist in the United States pertaining to aircraft emissions issues.

In _National Ass’n of Clean Air Agencies [NACAA] v. EPA_, the court sided with the EPA on its interpretation of the Clean Air Act with respect to the EPA’s ability to study, investigate, and adopt regulations on aircraft emissions.\(^{202}\) In its discussion of the facts, the court mentioned _West Virginia v. EPA_, where the “petitioners sought review of EPA rules requiring various states to revise state implementation plans as to [nitrogen oxides] emissions and establishing emission limits for major [nitrogen oxides] sources.”\(^{204}\) In both cases, the court found that “petitioners . . . had demonstrated injury where EPA lowered states’ total [nitrogen oxides] emissions budgets, requiring states to revise their [state implementation plans] to impose additional controls.”\(^{205}\) However, in NACAA, the court determined that the EPA’s construction of the Clean Air Act was appropriate.\(^{206}\)

In a case against the FAA, County of Rockland, New York lost on appeal on the issue of the FAA’s analysis of environmental impacts on the redesign of New York, New Jersey, and Philadelphia airspace.\(^{207}\) This case is intriguing because the court found that the petitioner had not been harmed by the FAA’s determination that the redesign would in fact reduce emissions in the redesign study area.\(^{208}\) In its analysis of whether the airspace redesign would harm local property via aircraft emissions, the FAA “relied upon a fuel burn analysis that showed the redesign [would] reduce fuel consumption . . . in the study area.”\(^{209}\) Petitioners argued “that, notwithstanding the result of the fuel burn analysis, the FAA [failed] to calculate ‘the total of direct and

\(^{202}\) 489 F.3d 1221, 1230 (D.C. Cir. 2007). The petitioner’s argument specifically pertained to the EPA’s interpretation of § 231 of the Clean Air Act (42 U.S.C. § 7571 (2006)) regarding increasing the stringency of certain emission standards applicable to newly certified commercial aircraft gas turbine engines. _Id._ at 1226, 1230.

\(^{203}\) 362 F.3d 861 (D.C. Cir. 2004).

\(^{204}\) _NACAA_, 489 F.3d at 1227.

\(^{205}\) _Id._; _West Virginia_, 362 F.3d at 868. It is important to note that the court’s discussion of the _West Virginia_ case pertained to the issue of whether NACAA had standing to sue the EPA. _NACAA_, 489 F.3d at 1226.

\(^{206}\) _NACAA_, 489 F.3d at 1230.

\(^{207}\) See Cnty. of Rockland v. FAA, 335 F. App’x 52, 53 (D.C. Cir. 2009).

\(^{208}\) _Id._ at 57.

\(^{209}\) _Id._ at 56 (internal quotation marks omitted).
REducing aircraft emissions’ resulting from the project.\textsuperscript{210} While the petitioners lost this case, it was quite clear that the court demanded higher standards of emissions inspection than what was required by the FAA under the Clean Air Act.

Most recently, and perhaps the most significant case to date pertaining to aircraft emissions, on December 21, 2011, the European Union Court of Justice upheld the validity of the EU’s Emissions Trading Scheme (ETS).\textsuperscript{211} This decision originates from a suit filed in 2009 by the Air Transport Association of America (ATA) and three member carriers—American Airlines, Continental, and United—against the UK Secretary of State for Energy and Climate Change on the legality of the EU’s plan to apply its ETS (also known as the “cap-and-trade” principle) to non-EU airlines.\textsuperscript{212} The argument posed by the ATA was that the unilateral approach taken by the EU to reduce carbon emissions by aircraft violated international principles and imposed costly policies on international aviation.\textsuperscript{213}

Beginning in 2005, the EU instituted limits or “caps” on the total amount of specified greenhouse gases that could be emitted by factories, power plants, and other installations.\textsuperscript{214}

Within this cap, companies [could] receive emission allowances which they [could] sell to or buy from one another as needed. . . . At the end of each year each company [would be required] to surrender enough allowances to cover all its emissions, otherwise heavy fines [would be] imposed. If a company reduce[d] its emissions, it [could] keep the spare allowances to cover its future needs or sell them to another company [which fell] short of allowances.\textsuperscript{215}

\textsuperscript{210} Id. at 56 (quoting 40 C.F.R. § 93.153(c)(1) (2010)). The provision of the Clean Air Act quoted requires that the FAA conduct a full-scale conformity determination of the project as to whether it will result in, at most, de minimis emissions of critical pollutants. 40 C.F.R. § 93.153(c)(1).


\textsuperscript{212} Id. ¶¶ 1-4.

\textsuperscript{213} JANE A. LEGGETT ET AL., CONG. RESEARCH SERV., AVIATION AND THE EUROPEAN UNION’S EMISSION TRADING SCHEME 23 (2012).


\textsuperscript{215} Id.
The ultimate goal of this system is to reduce the total emissions by 2020 by about 21% as compared to 2005.\textsuperscript{216} Beginning January 1, 2012, the ETS was scheduled to include airlines, and more specifically, any domestic and international aircraft flying into or out of the EU.\textsuperscript{217} In an effort to disallow this unilateral approach to emissions reduction, U.S.-based airlines and the China Air Transport Association challenged the EU’s efforts to implement the ETS for the aviation sector.\textsuperscript{218} Opponents argue that the ETS is subjecting foreign airlines to a carbon tax on fuel consumption in the EU by requiring airlines to purchase carbon permits (such tax implementation would directly violate the Chicago Convention, the Kyoto Protocol, and the Open Skies Agreement), and that the EU’s initiation of the ETS is a unilateral effort to control greenhouse gas emissions by the aviation sector—something that the entire aviation industry is currently working on at a global level.\textsuperscript{219} More specifically, opponents argue that rather than tackle the carbon emissions problem unilaterally, the EU should work with the ICAO to promulgate methods of carbon emissions reductions—as other agencies and entities currently do.\textsuperscript{220}

Still, on December 21, 2011, the EU Court of Justice upheld the ETS, holding that it does not constitute a tax and that the uniform application of the ETS to all flights arriving and departing from the EU is consistent with the prohibition against discrimination among aircraft operators.\textsuperscript{221} Further, the court reiterated that in making its decision to uphold the ETS, the European Commission reaffirms its commitment to work with the ICAO and with other countries to limit greenhouse gas emissions from international aviation.\textsuperscript{222}

\begin{itemize}
\item \textsuperscript{216} Id.
\item \textsuperscript{217} Stephanie Switzer, \textit{Aviation and Emissions Trading in the European Union: Pie in the Sky or Compatible with International Law?}, \textit{39 Ecology L. Currents} 1, 2 (2012).
\item \textsuperscript{218} Id.; Jonathan Watts, \textit{Chinese Airlines Refuse to Pay Carbon Tax}, GUARDIAN (Jan. 4, 2012), http://www.guardian.co.uk/environment/2012/jan/04/china-airlines-eu-carbon-tax.
\item \textsuperscript{219} See Switzer, \textit{supra} note 217, at 3–6.
\item \textsuperscript{221} Case C:366/10, \textit{supra} note 211, ¶ 135, 145.
\item \textsuperscript{222} Id. ¶ 33.
\end{itemize}
The EU court’s decision to uphold the ETS is a landmark decision affecting both airlines and passengers flying into and out of the EU. “Given the findings of the Court of Justice, the U.S. airline industry will likely consider alternative legal routes to challenge the extension of the ETS to include aviation emissions.” Hence, it is highly anticipated that there will be future judicial and political actions pertaining to the EU’s implementation of the ETS.

VII. PROPOSALS TO FURTHER REDUCE COMMERCIAL AIRCRAFT EMISSIONS

As noted, several regulatory and private sector standards are now in place both nationally and internationally in an effort to curb aircraft emissions in a growing industry. Agencies and corporations continuously strive to reduce the airline industry’s carbon footprint generated by commercial air travel, and judicial involvement is likely to increase due to the debate over the EU’s implementation of the ETS system. Still, with commercial air travel anticipated to increase 2.8% annually in the United States over the next twenty years, including an expected annual airline passenger increase of 4.5% through 2030, the question beckons: Are the standards and goals currently in place enough to curb the impact of commercial aviation emissions as compared to the expected increase in flight demand? The answer—given the historical growth of the commercial airline industry, as well as its anticipated future set-backs of agency and private sector project deadlines due to budget constraints, and unilateral actions taken by regions (e.g., the EU’s institution of a cap-and-trade system) resulting in heavy international opposition and judicial action—is that more must be done in order to minimize the impact of aircraft emissions on the environment.

“Future technological and operational improvements are likely to help reduce emissions from commercial aircraft, but likely not by enough to fully offset estimated market growth” in the industry. While the FAA’s implementation of NextGen

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224 See supra notes 1-5 and accompanying text.
and ADS-B are perhaps the loftiest agency goals currently in place in the United States to reduce airline emissions, delays in developing these programs were announced early in 2012, thus affecting the FAA’s timetable target goals due to new and expanded runways at various national airports, a softer economy, airline schedule cuts, and budget pressures. Though engineering companies work tirelessly to develop and deliver new and improved aircraft to reduce carbon emissions, “further advances in these technologies may face high development costs . . . , and some may not be available for commercial use any time soon because engineers still face challenges in improving engine technology.” Currently, many commercial airlines still utilize older aircraft for daily commercial use. According to Boeing, “[a]pproximately 63[%] of the 10,500 Boeing commercial airplanes in service were built according to type designs that are more than 20 years old.” While “[t]hese airplanes may not be more than 20 years old, [certain Boeing aircraft] were designed before 1979 and have accumulated 67[%] of the 403 million total hours flown.” Southwest, United, and Delta Airlines have the highest average fleet age of commercial aircraft as of 2011 at 14.3, 14.3, and 14.5 years old, respectively. Further still, the IATA’s goal of obtaining a 21% reduction in carbon dioxide emissions by 2020 will arguably only offset the anticipated growth of the commercial airline industry rather than actually reduce the impact the industry has on the environment. Thus, the fact remains that more must be done to further reduce the airline industry’s carbon footprint.

The current challenge should not be to simply offset aircraft carbon emissions by the anticipated industry growth, but rather to reduce carbon emissions in greater quantity as compared to the anticipated growth of commercial air travel. Not only does this challenge need to be implemented in the United States, but

227 U.S. GOV’T ACCOUNTABILITY OFFICE, supra note 225, at 23.
229 Id.
231 See IATA, AVIATION AND CLIMATE CHANGE, supra note 125, at 2.
also toward a global effort to employ new and improved changes over and above those already in place. One possible way to curb the growth of emissions in the aviation sector is to find avenues for tax imposition within the industry. However, Article 15 of the Chicago Convention "limit[s] the reach of the sovereign taxing power by defining the scope of national regulations that involve charges (and by implication, taxes) imposed on international civil aviation." Still, nothing in Article 15 specifically limits a state from imposing taxes "on its own airlines for activities occurring within its [own national] territory." Hence, the unilateral act of the United States to impose taxation opportunities on domestic flights would not run afoul of the Chicago Convention. Further, while the singular movement of one nation to invoke an action to curb domestic airline emissions may not control the entire global problem, it may arguably influence a movement in the right direction.

Take, for example, Wal-Mart. In May 2009, discount retailer Wal-Mart launched a marketing campaign aimed at putting its purchasing and communication power behind “going green.” The multi-billion dollar retailer “pledged to work with its top suppliers to help improve their operations, teaching them how to increase energy efficiency and how to cut the amount of raw materials they use.” Wal-Mart threatened that it "would pull its orders from companies not meeting the new standards." By rolling out an environmental labelling program disclosing to consumers the environmental costs of making products sold at Wal-Mart, [the retailer unilaterally] transformed green standards from nice-to-have to must-have.” As touted by Harvard Business Review: “This is one small step for Wal-Mart and one giant leap for Planet Earth.” “Wal-Mart’s unilateral decision . . . behind going green . . . show[ed] that a single company using its unique clout can accelerate public action to reduce

233 Id.
234 Id.
236 Id.
238 Id. (emphasis added).

While Wal-Mart is not the first company to go green, nor even the first company . . . to require that suppliers meet particular standards . . . it is the biggest, the most visible . . . company that uses its power to improve an outcome for society, while knowing that its [green] innovations will create profits as well as social benefits.

In a similar light, a Mumbai-based think tank ranks the United States as the most influential country in the world, and many would argue the most powerful country in the world, followed by the EU. As such, it can be argued that, akin to the Wal-Mart movement, any movement made by the United States to formulate a "going green" strategy could very well be emulated by other countries. Already being seen, the unilateral decision made by the EU to institute a cap-and-trade strategy on aircraft landing and taking off within its borders has been met with not only an outcry of dissent, but also a movement to strategize a global cap-and-trade movement directed by the ICAO. Unilateral decisions made by powerful companies can and often do result in smaller companies following suit. In the parallel environment, if the United States were to adopt strategies to enhance its efforts not only to curb aviation emissions, but also to build profits, less influential and powerful countries may follow suit to adopt similar strategies, thus enhancing the overall goal of reducing commercial aircraft emissions.

Still, even if an independent movement within the United States to implement a domestic emissions taxing scheme to further reduce aviation emissions at a national level does not result in a larger international audience adopting similar taxing meth-

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239 Id.
244 McGregor, *supra* note 220.
ods, such domestic action should still result in an overall commercial aviation emissions reduction. Of the approximately 22 million flights in 2010, 245 8.7 million were domestic flights in the United States.246 If the United States were to “go greener” domestically with respect to aviation emissions by implementing an emissions-reduction taxing scheme without a strong global following, any resultant domestic emissions reduction would still impact the total global commercial aviation emissions figure.

The question of whether taxing the domestic aviation sector is a good idea has been an issue of much debate in this country, as the commercial airline industry is a huge contributor to the U.S. economy.247 The main purpose of taxation is to build governmental revenue in order to fulfill various functions. Taxes within the aviation industry include taxes on jet fuel, passenger tickets,248 a flight segment tax, and international departure and arrival taxes, along with a myriad of fees.249 Such taxes and fees could “add more than $75 to a roundtrip domestic journey.”250 However, none of these collected charges are specifically targeted for use in the endeavor to reduce aviation emissions.251 As “rough . . . figures suggest that a modest tax on emissions


248 The Air Transportation Excise Tax is an excise tax under Section 4291 of the Internal Revenue Code on the purchase of airline tickets. Internal Revenue Serv., Excise Tax—Air Transportation Audit Techniques Guide (ATG) 1–3 (rev. ed. 2008). “The amounts collected are deposited into the Airport and Airway Trust Fund,” which is “primarily used to improve and maintain the nation’s airport and air traffic control systems. In addition, taxes on aviation kerosene and aviation gasoline are transferred from the Highway Trust Fund to the Airport and Airway Trust Fund.” Id. For more information on the Air Transportation Excise Tax, see id.


from fossil fuels alone [in the United States] would likely raise between $75 billion and $100 billion per year," such tax collection, if used for the development of low-carbon energy alternatives within the commercial airline industry, could make a great impact on the reduction of emissions in the United States and globally.252

Taxes are a contentious issue, and nobody likes to pay them.253 In the aviation industry, taxes have increased swiftly due to the industry being a "soft target."254 Not only are such charges easy to collect, but up until January 2012,255 the general public was unaware of the amount of taxes being paid when purchasing an airline ticket due to such taxes being folded into the advertised ticket price.256 Without question, adding more taxes to already high-priced airline tickets could lead to a deterioration of the commercial airline industry itself if passengers boycott air travel for substitute methods of travel. As discussed below, such substitution could actually further harm the environment rather than help offset aviation emissions. Instead, the two proposals presented offer the possibility of low-percentage tax rates imposed on either ticketed passengers or on airlines, with an alternate possibility of tax credits offered to airlines purchasing newer, more efficient aircraft models to include in their commercial fleets.

The question in the United States is whether it is better to implement a cap-and-trade system (similar to that instituted in the EU) or to implement an emissions tax in order to help reduce greenhouse gas emissions from commercial aviation. "Economic research indicates that an emissions tax is generally a more economically efficient policy tool to address greenhouse gas emissions than other policies, including a cap-and-trade program, because it would better balance the social benefits and costs associated with the emissions reductions."257 Tax imple-
mentations “provide a price signal to commercial airlines and other emission sources, creating an economic incentive for them to reduce their emissions.”258 Further, “within the broad realm of social equity, there is also a general tendency to favor taxing items that are in some way seen as anti-social (e.g., tobacco and alcohol).”259 As the second proposal offers the possibility of implementing a tax based upon aircraft model use akin to a “sin tax,” the hopeful outcome is that airlines will make efforts to reevaluate the use of certain models of aircraft for specific flight patterns in order to best reduce aircraft emissions per flight path, thus promoting social justification for a greener environment.260

While in recent years, U.S. legislative proposals for an emissions tax have generally targeted a tax on carbon,261 the proposals presented in this article embark on a different type of tax implementation altogether; rather than suggesting the imposition of a tax based solely on carbon-output, both proposals offer to implement a tax based upon domestic flight path or aircraft model use. Such proposals were designed with the specific goals of generating revenue to be put back into the airline industry, discouraging the substitution of alternative modes of travel, and simultaneously encouraging airlines to utilize the most emissions-efficient aircraft available for designated flight plans within the United States. Such proposals were designed with the ulti-

258 Id.
259 BUTTON, supra note 253, at 5.
260 See id.
261 See, for example, the 2007 Dingell Proposal, which proposed “a charge of $10 per ton of carbon content of coal, oil, and natural gas—plus an additional 10 cents/gallon for gasoline and jet fuel (kerosene),” and “[b]y the end of the five-year period the charges would reach $50/ton of carbon plus 50 cents/gallon of gasoline and jet fuel.” Charles Komanoff, Rep. John Dingell Introduces His Hybrid Carbon Tax, GRIST (Sept. 27, 2007), http://grist.org/article/dingell-opens-the-door/. See also the 2007 Larson Proposal (H.R. 3416), which proposed a “first-year tax rate of $15 per ton of carbon dioxide” with a raise in the rate by $10/ton per year, and “[a]fter five years, that increase[d] rate [would] automatically bump[ ] up to $15/ton if U.S. emissions stray from an EPA-certified glide path to cut emissions by 80% from 2005 levels in 2050.” Charles Komanoff, New Larson Bill Raises the Bar for Congressional Climate Action, CARBON TAX CTR. (Mar. 6, 2009), http://www.carbontax.org/blogarchives/2009/03/06/new-larson-bill-raises-the-bar-for-congressional-climate-action. See also the 2007 Stark Proposal (H.R. 2069), which proposed that starting in 2008, a tax rate of $10/ton carbon would increase by $10/ton annually until subsequently freezing the tax when carbon dioxide emissions reach 20% of the 1990 levels. Save Our Climate Act of 2007, H.R. 2069, 110th Cong. § 4691 (2007).
mate goal of reducing commercial aviation emissions at a global level.\textsuperscript{262}

A. Implement an Emissions Fuel/Carbon Tax Based on Flight Path

One possibility to further reduce the environmental impact of airline carbon emissions in the United States is to implement a fuel or carbon tax based on flight pattern. "The primary objective of emissions taxation in the airline industry is to reduce the amount of carbon dioxide that is emitted by planes."\textsuperscript{263} Arguably, adding a fuel tax to already expensive flights will deter a percentage of passengers from flying, thus reducing the total number of flights in the United States.\textsuperscript{264} However, a counter-argument to this proposal is that those passengers who chose not to fly will find an alternate or substitute method for travel—either by vehicle or train; hence, "a change in the . . . volume of one transportation mode [could] entail a change in the aggregate traffic volume of another mode" of travel.\textsuperscript{265}

A 2005 study of the air transport market in Florida, for example, showed "that a 1% decrease in short-haul air traffic\textsuperscript{266} could lead to an increase in automobile traffic by about 0.3%."\textsuperscript{267} Further, an increase in airfare via a carbon tax of 2% would likely decrease passenger-flown miles by about 2.3%.\textsuperscript{268} Thus, such a tax would effectively decrease the amount of miles flown in the

\textsuperscript{262} Note that while Article 15 of the Chicago Convention allows aviation facilities and service providers to assess charges to recover their costs, subsequent ICAO guidance on Article 15 suggests that charges should not exceed the identifiable costs of facilities or services provided. ICAO, ICAO's Policies on Charges for Airports and Air Navigation Services 15 (7th ed. 2004). Further, Article 9 of the U.S. Model Open Skies Agreement exempts from national taxes fuel on aircraft in international aviation. Press Release, U.S. Dep't State, Current Model Open Skies Agreement (Jan. 12, 2012), available at http://www.state.gov/e/eb/rls/othr/ata/114866.htm. Thus, the proposal to implement a carbon tax in this paper is directed for U.S. domestic flights only. See Reagan, supra note 32, at 373–74; see also Chicago Convention, supra note 102, art. 15.


\textsuperscript{264} Id.

\textsuperscript{265} Id. at 39.

\textsuperscript{266} While there is no universal definition for the term "short-haul air traffic," it generally includes flights entailing less than 500 miles of travel or less than 1.5 hours of flying time. Alternatively, long-haul air traffic involves lengthy, non-stop flights generally requiring more than one crew to operate the aircraft and entail more than six hours of flying time.

\textsuperscript{267} Hofer, supra note 263, at 40; see also Button, supra note 253, at 4.

\textsuperscript{268} Hofer, supra note 263, at 39.
United States, but increase to a certain degree the amount of vehicles driven on the road, thereby only partially offsetting the environmental benefits of reduced air traffic. The question then remains whether most or all passengers boycotting a flight due to the implementation of a tax would substitute driving for flying rather than canceling their trip altogether. In a period where gasoline prices are rising with little relief in sight, it is arguable that not every passenger would choose to drive rather than fly to their final destination; rather, travel itself, either by commercial air travel or automobile, could inevitably decrease altogether.

In contrast, there is a likelihood that passengers will not substitute automobile or train use when flying long distances due to the high cost of automobile fuel as well as the time entailed in driving significant distances. Thus, a carbon tax implemented on longer-distance flights may be a viable option resulting in relatively little substitution effect. For flights entailing great distances, the chances that passengers would take the extra time to drive or ride a train is highly unlikely.

One possible way to minimize the substitution effect is to implement a carbon tax only on air travel spanning certain distance ranges (e.g., flights longer than 500 nautical miles). However, being that many domestic flights require a short “jumper” flight to regional airports, or even two or three transfers across the United States before arriving at the final destination, a better solution would be to implement a carbon tax rate based on the length of the flight. For instance, a lower carbon tax of 0.05% could be imposed on flights spanning less than 500 miles flown, while a higher carbon tax of 1.5% could be imposed on

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269 Id. at 39-40. A remarkable example of the possible negative ramifications of implementing a carbon tax on air travel in the United States as drafted by Christian Hofer et al. ensues—assume a 2% fuel tax is implemented on all domestic flights in the United States. For a short-haul flight from Philadelphia to Washington, D.C., air traffic would decrease by about 1.33%, thereby lowering carbon emission by about 3,302 pounds. Id. at 41. If 80% of those passengers choosing not to fly due to the increase in fare instead chose to drive, automobile emissions would increase by 2,674 pounds, thus effectively reducing the amount of carbon emissions otherwise spent on such flight pattern. Id. However, if all non-flying passengers substituted automobile driving for the flight, vehicle emissions would actually rise by 3,342 pounds, and total emissions would actually increase rather than decrease. Id.

270 Id. at 43.

271 Id.
domestic flights over 500 miles. This plan would allow for a higher tax on flights where there is little substitution concern for alternate modes of transportation and allow for a very low tax on flights where there is a greater possibility of substitution to occur. Imposing a low-percentage tax on short flights would hopefully minimize the potential for vehicular use over aircraft use, while still allowing for a carbon offset via implementation of the tax; and while imposing the higher tax on longer-duration flights would cost passengers more money and possibly result in lower air travel demand, those same passengers would likely not substitute the longer trek for alternate modes of travel.

The final step to the effective implementation of a valid fuel or carbon tax would require that Congress draft legislation requiring that all money collected via this tax be put directly back into the airline industry, and more specifically, toward the development of low-carbon energy alternatives within the commercial airline industry. As the U.S. Government Accountability Office (GAO) has noted, experts have observed “that establishing a price on emissions through . . . a tax would help promote the development and adoption of a number of low-emissions technologies for airlines.” Thus, such money should subsequently be used only by various agencies and the private sector to continue the research, development, and achievement of projects, including NextGen, ADS-B, biofuel substitutes, and more fuel-efficient aircraft designs.

B. Implement a Tax Based on Aircraft Model Use

A second approach to help reduce the environmental impact of airline carbon emissions in the United States is to implement a tax based upon aircraft model use akin to a “sin tax.” It is well documented that different aircraft models have different emission factors. For example, Delta operates a number of various

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272 For example, if the base price of a round-trip ticket is $300, adding a .05% tax to such ticket price equates to a $0.15 tax per ticket. In contrast, adding a 1.5% tax to a $300 ticket would entail a $4.50 tax per ticket. Note, however, that while the exact tax rate that should be utilized is beyond the scope of this article, “the optimal tax rate would be where the marginal benefit of abatement equals the marginal cost of abatement. To set such a tax, the government . . . would need to estimate both the marginal abatement cost curve and the marginal abatement benefit curve.” See Metcalf & Weisback, supra note 251, at 511.

273 U.S. Gov’t Accountability Office, supra note 225, at 36.

aircraft within its commercial fleet, including the Airbus 300, Airbus 320, Boeing 737, Boeing 737-400, Boeing 747, Boeing 757, Boeing 767, and the SAAB 340 Turboprop.\textsuperscript{275} The following table provides the amount of carbon dioxide emission for the landing take-off (LTO) cycle\textsuperscript{276} based on certain aircraft models currently in use by major airliners in the United States:

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
\textbf{Aircraft Design} & \textbf{CO$_2$ Emissions in Kilograms per LTO Cycle} \\
\hline
Airbus 300 & 5,470 \\
Airbus 320 & 2,560 \\
Boeing 737 & 2,750 \\
Boeing 737-400 & 2,625 \\
Boeing 747 & 10,145 \\
Boeing 757 & 4,110 \\
Boeing 767 & 5,405 \\
SAAB 340 & 945 \\
\hline
\end{tabular}
\caption{Carbon Dioxide Emission for LTO Cycle, KG/LTO\textsuperscript{277}}
\end{table}

As seen in Table A, there is a vast difference in the amount of carbon emitted during the LTO cycle based on aircraft model type. Thus, a potential avenue for legislators and regulators to further reduce aircraft emissions is to consider adding a direct tax to airline ticket purchases or to directly tax private carriers based on the specific aircraft model used for a particular flight. For example, a ticket purchased for travel on a Boeing 747 would be taxed at a higher rate (e.g., 1.5\%) than the cost of a flight booked on a SAAB 340 (e.g., 0.05\% tax) due to the fact that the Boeing 747 emits the highest carbon dioxide emissions as compared to various other aircraft models, while the SAAB 340 emits the least amount of carbon dioxide as compared to nu-

\begin{itemize}
\item \textsuperscript{276} Note that the landing take-off (LTO) cycle includes all activities near the airport that take place below the altitude of 3,000 feet, including taxi, take-off, climb-out, and approach. See Annex 16 to the Chicago Convention, supra note 154, § 2.1.4.3.
\item \textsuperscript{277} See Rypdal, supra note 274, at 96.
\end{itemize}
nerous other aircraft models.\textsuperscript{278} Implementing such a tax on the U.S. domestic airline industry would complement a recent political movement to place carbon emission caps on factories and energy producing companies.\textsuperscript{279}

Further, legislators must take into consideration the travel range of aircraft models as such ranges vary depending upon aircraft model. Specifically, by taxing aircraft based on carbon dioxide emissions for each LTO cycle, legislators can encourage airline companies to use commercial aircraft that are deemed more environmentally friendly. Table B provides the travel range for each of the aircraft previously presented in Table A, as well as the seating capacity available upon each aircraft.

\begin{table}[h]
\centering
\begin{tabular}{|l|l|l|}
\hline
Aircraft Design & Range (Nautical Miles Flown) & Seating Capacity \\
\hline
Airbus 319 & 2,399 & 126 \\
Airbus 320 & 2,420 & 150 \\
Boeing 737 & 2,925–2,930 & 124–160 \\
Boeing 737-400 & 1,960–2,160 & 146–188\textsuperscript{1} \\
Boeing 747 & 7,365 & 376–393 \\
Boeing 757 & 2,800–4,722 & 174–224 \\
Boeing 767 & 3,740–6,640 & 208–261 \\
SAAB 340 & 1,496\textsuperscript{2} & 27–34\textsuperscript{3} \\
\hline
\end{tabular}
\caption{Travel Range of Aircraft\textsuperscript{280}}
\end{table}

\textsuperscript{1} The Boeing 737-400, AIRLINERS.NET, http://www.airliners.net/aircraft-data/stats.main?id=93 (last visited Nov. 5, 2012).


To illustrate this tax model, a flight from New York’s JFK airport to Los Angeles (LAX) is approximately 2,470 nautical miles, while a flight from LAX to Honolulu International Air-

\textsuperscript{278} See id.


\textsuperscript{280} Aircraft Types & Layouts, supra note 275.
port is 2,556 nautical miles. Currently, Delta Air Lines uses a Boeing 757 for flights from New York to Los Angeles, while it uses a Boeing 767 or 757 for flights from Los Angeles to Hawaii. Based on the information presented in Tables A and B, neither of Delta’s aircraft selections for these particular flights is favorable from an environmental standpoint.

The Boeing 757, with a range of 2,800–4,722 nautical miles and seating capacity between 174 and 224 passengers, emits 4,110 KG/LTO of carbon dioxide, and the Boeing 767, with a range of 3,740–6,640 nautical miles and a seating capacity between 208 and 261 passengers, emits 5,405 KG/LTO of carbon dioxide. If legislators encouraged airline companies (such as Delta) to use more environmentally friendly aircraft based on flight range by implementing a higher tax rate on passenger tickets based on the model of aircraft used for a particular flight pattern (for example, in this case, use the Boeing 757 with a tax rate of 1% in lieu of the Boeing 767 with a tax rate of 1.5% for flights from LAX to Hawaii, and use the Boeing 747-400 with a tax rate of 1% in lieu of the Boeing 757 with a tax rate of 1.5% for flights from JFK to LAX, as the travel range for both aircraft models is virtually the same and the seating capacity is similar), the hopeful outcome would be a gradual transition whereby airlines would be encouraged to utilize more environmentally friendly aircraft based on the particular flight pattern. Such congressional encouragement could be in the form of either a tax imposed directly on the purchase price of airline tickets and paid by consumers or a tax imposed on airline companies’ ticket prices based upon their use of certain aircraft models as applied to the travel range of each flight.

Further expanding on the importance of the selection of aircraft model in the effort to reduce aircraft emissions based on the LTO cycle, legislators and regulators should encourage the use of aircraft such as the Airbus 320 (range of 2,420 nautical miles) as well as the Boeing 737 (range of 2,925–2,930). Each of these aircraft models emits substantially lower amounts of carbon dioxide emissions per LTO cycle as compared to other

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283 See supra Tables B and A respectively.
284 See supra Table A.
commercial aircraft.\textsuperscript{285} "With more than 13,000 regional airline flights [taking off] every day, . . . about 50[\%] of the nation's commercial schedule" is now regional.\textsuperscript{286} Therefore, it is imperative to note which aircraft should be encouraged for use in short distance flights. While taxes should arguably be levied based on carbon dioxide emissions, it is also important to consider the size of the aircraft necessary to meet passenger demand. For example, while the SAAB 340 has far more favorable emission levels than the Airbus 320 (945 KG/LTO of carbon dioxide versus 2,560 KG/LTO of carbon dioxide), there is a sizeable difference in the seating capacity of these two aircraft.\textsuperscript{287} Thus, tax policy should encourage the use of both of these two aircraft as compared to less environmentally friendly aircraft models when the range and passenger requirements permit.

To be offered in tandem with the tax implementation scheme based on aircraft model use, tax incentives and credits similar to the credits available to purchasers of hybrid vehicles as part of the Energy Policy Act of 2005 should be available to airlines agreeing to use more environmentally friendly aircraft models and to purchase newer, next-generation aircraft, which are more environmentally sustainable. "Replacing an older aircraft at the end of its lifecycle in passenger service [with newer aircraft designs] . . . would give a one-off improvement in fuel efficiency of 20–25\%, which equates to around 1\% gain per year."\textsuperscript{288} Such incentives and credits would not only encourage airlines to utilize and purchase more environmentally friendly aircraft, but would also benefit manufacturers, including Boeing and Airbus, in their efforts to design, build, and sell newer, more environmentally sustainable aircraft.

As noted earlier with regard to the implementation of an environmental fuel or carbon tax, legislation regarding the implementation of a tax on aircraft model use must require that all taxes collected via this model be put directly back into the airline industry for the development of low-carbon energy alternatives within the commercial airline industry, and for use by

\textsuperscript{285} See supra Table B.
\textsuperscript{287} See supra Tables A and B.
\textsuperscript{288} Peter Morrell, The Potential for European Aviation CO\textsubscript{2} Emissions Reduction Through the Use of Larger Jet Aircraft, 15 J. AIR TRANSPORT MGMT. 151, 152 (2009).
various agencies and organizations to continue their research, development, and implementation of environmentally sustainable aircraft designs, projects, and future legislation.

VIII. CONCLUSION

The most important question for the future of aviation is whether all of the regulations, goals, and technological implementations currently in place are enough to minimize the commercial aviation industry's impact on the environment. With the growth of the airline industry expected to continue in an upward movement over the next twenty years, the answer is no. More must be done to offset the growth of the aviation industry as compared to the effect that the commercial airline industry has on the environment. In a sector where growth and increased aircraft use is virtually guaranteed, the potential for continued climate change due in part to commercial aircraft use is certain.

While it is clear that a myriad of federal agencies and organizations, both governmentally run and privately operated, spanning an international scale are working together to tackle the airline industry's footprint on the environment, the impact that the aviation sector has on the environment should be the cornerstone of this industry's commitment to reducing aircraft emissions in our skies. Still, it is arguable that the standards currently in place will only offset the expected growth of the industry as compared to the current emissions problems rather than actually reduce the amount of aircraft emissions generated by the commercial airline industry.

One proposal to work simultaneously with those implementations already in place, both domestically and globally, is to implement an emissions fuel/carbon tax on U.S. domestic flights with specific targeted rates based upon the distance aircraft fly. A lower carbon tax rate should be imposed on short-duration flights, while a higher carbon tax rate should be imposed on long-haul flights. The goal of imposing a low-percentage tax on short flights is to minimize the potential for vehicular use over aircraft use, while still allowing for a carbon offset and imposing a higher tax on longer-duration flights would result in lower air travel demand with less concern that passengers might substitute alternative modes of travel.

A second proposal is to implement a tax on airline ticket purchases or to directly tax private carriers based on the specific aircraft model used for a particular flight pattern. Implement-
ing such a tax on the U.S. domestic airline industry would encourage commercial airline companies to utilize more environmentally friendly aircraft choices based upon travel range and passenger requirements. In connection with this proposal, tax incentives and credits should be offered to airlines agreeable to using more environmentally friendly aircraft models, as well as purchasing newer, next generation aircraft that are more environmentally sustainable.

With regard to both proposals, legislation must require that all taxes collected via these models be put directly toward the development of low-carbon energy alternatives within the commercial airline industry, and for use by various agencies and organizations to continue their research, development, and implementation of environmentally-sustainable aircraft designs, projects, and future legislation in this area.