UNITED STATES

Aviation Greenhouse Gas Emissions Reduction Plan

U.S. Aviation Greenhouse Gas Emissions Reduction Plan Submitted to the International Civil Aviation Organization, June 2012

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AVIATION GREENHOUSE GAS EMISSIONS REDUCTION PLAN

I. SUMMARY

The United States Government (USG) is committed to addressing the climate change impacts of commercial aviation and is pursuing a multi-pronged approach to achieve greenhouse gas (GHG) emissions reductions. The USG already achieved significant reductions in GHG emissions from, and energy efficiency improvements in, the aviation sector over the past decade through public and private efforts, and it is on a trajectory to continue that progress in coming years. The USG has set an ambitious overarching goal of achieving carbon-neutral growth for U.S. commercial aviation by 2020, using 2005 emissions as a baseline[1]. Given current forecasts for aviation growth this equates to about a 115 million metric tons (MT) reduction in carbon dioxide emissions from commercial aviation by 2020, and by extending those approaches further there could be an additional 60MT reduction by 2026.[2] As part of the Next Generation Air Transportation System Plan, the USG has laid out plans and initiatives for improvements in technology and operations, advances in development and deployment of sustainable alternative fuels, and policies and selective measures to incentivize transition of the fleet and airspace system.

The USG efforts with respect to commercial aviation are supported and enhanced by research efforts of the United States Department of Defense (DoD) to improve energy efficiency in the defense sector.

This plan identifies actions and progress toward GHG emissions reductions in each of the following areas:

- **Aircraft and Engine Technology Improvement** – Within the USG technology research and development efforts there are multiple technology initiatives that are dedicated to developing technology with significantly improved fuel burn and lower GHG emissions. These plans are coordinated through the National Aeronautics Research and Development Plan.[3]

- **Operational Improvements** – The Federal Aviation Administration (FAA) is overhauling the National Airspace System through the NextGen program to improve efficiency and reduce aircraft fuel burn. NextGen is the top aviation priority for the USG, and it has bipartisan support in Congress. Additionally, the Obama Administration has identified a major NextGen project in Houston, Texas for expedited project delivery.

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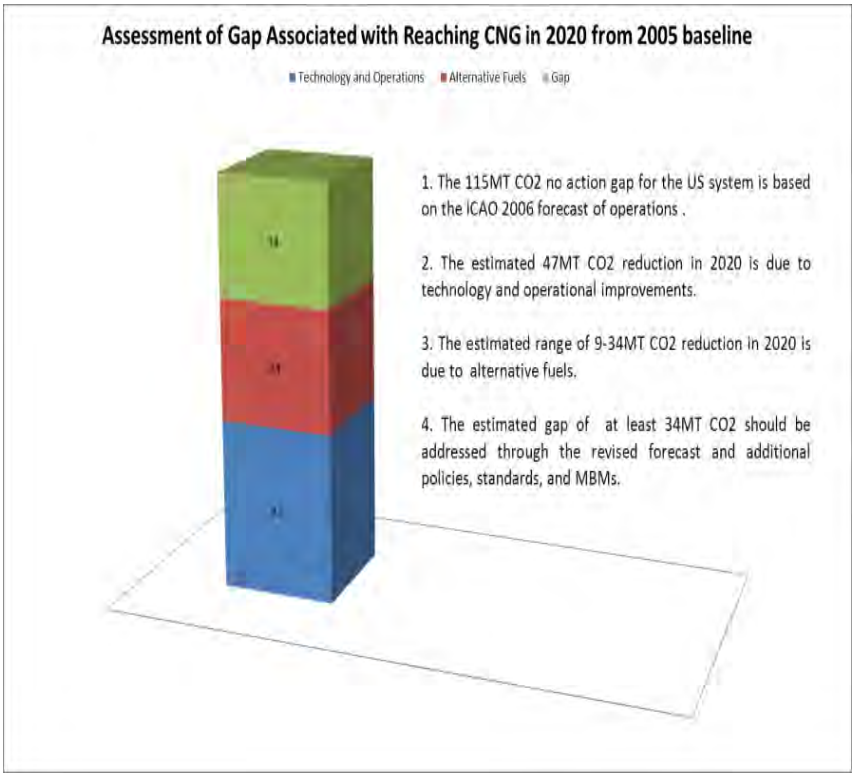
[1] Goal adopted by the Obama Administration and unveiled at COP/15 and subsequently proposed by the U.S., Canada and Mexico at the ICAO Assembly in 2010. The 2005 baseline is calculated using the FAA Aviation Environmental Design Tool.
[2] These estimates include all U.S. flights (foreign and U.S. carriers).
[3] National Aeronautics Research and Development Plan available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/aero-rdplan-2010.pdf

- **Alternative Fuels Development and Deployment** – The USG has taken significant steps during the last five years to facilitate the development and deployment of sustainable alternative aviation fuels. Future efforts are aimed at identifying new alternative fuels pathways as well as commercialization of fuels with up to 80 percent lower lifecycle GHG emissions.

- **Policies, Standards, and Measures** – The USG is pursuing or considering a variety of policies, standards, and measures that will supplement, and in some cases support, efforts on technology, operations and fuels in order to achieve the carbon neutral growth goal.

- **Scientific Understanding and Modeling/Analysis** – The USG conducts ongoing scientific research to better understand and quantify the impacts of aviation on the climate, including consideration of interdependencies and tradeoffs with other environmental impacts. These efforts help identify and prioritize the most effective mitigation options.

Expected Reductions: The USG is undertaking detailed analyses to estimate projected reductions from technology, operations, and alternative fuels in order to assess progress toward the carbon neutral growth goal for U.S. commercial aviation and to identify any gap to be addressed by policies, standards, and measures. This detailed analysis is not ready for submission with the Action Plan, but will be published once completed. Based on preliminary previous work, improvements in aircraft technology and air traffic operations are expected to result in an estimated reduction of 47 MT of CO_2 in 2020.[4] Thus, a substantial portion of the carbon neutral growth 2020 goal is expected to be covered with technology and operational innovation. With respect to alternative fuels, preliminary computations show potential reductions in life cycle CO_2 emissions from alternative fuels between 9 and 34 MT. [5] By assuming the best case for



[4] This reduction is calculated based on an expected 1.5 percent improvement in fuel efficiency per year due to technology and operational improvements, measured relative to a baseline year of 2010.
[5] This reduction is based on a "bottom up" projection conducted by the Volpe Transportation Center that analyzed responses from 61 companies using 18 fuel production processes to estimate potential of alternative aviation fuel

alternative fuels, to achieve carbon neutral growth in 2020 using a 2005 baseline, would require another 34 MT. These reductions can be achieved from a combination of lower actual emissions growth rates[6] and use of policies, standards, and measures.

II. AIRCRAFT AND ENGINE TECHNOLOGY IMPROVEMENT

The evolution of newer, more fuel-efficient airframes and engines has produced the most significant aviation emissions reductions historically and will drive more reductions in the future. The USG is leading a number of efforts and collaborating with the aviation industry to develop and improve technology that results in better fuel efficiency and reduced emissions. USG actions to improve aircraft and engine technology are carried out by the FAA, the National Aeronautic and Space Administration (NASA) and the Department of Defense (DoD) and coordinated through the National Aeronautics Research and Development Plan[7].

A. PROGRAM SPECIFICS

FAA's Continuous Lower Energy, Emissions and Noise Program

The Continuous Lower Energy, Emissions, and Noise (CLEEN) program, launched by FAA in 2010, is a collaborative partnership with five aviation manufacturers to develop technologies that will reduce emissions and fuel burn, to enable alternative fuel use and to expedite integration of these technologies into current and future aircraft. CLEEN is focused on the complete aircraft and includes improvements in aerodynamic and structural efficiency as well as civil propulsion efficiency. The total federal investment is expected to be $125 million over five to six years with the five aviation manufacturers contributing cost-share that matches or exceeds the federal investment. The CLEEN program focuses on advancing pre-commercial technologies for inclusion in the commercial aircraft fleet beginning in 2015. [8]

The CLEEN program is fully authorized and has received at a minimum full appropriation each year. Given the bipartisan support for this program so far, continued support for this program in the budget is expected.

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production in North America (the United States, Canada, and Mexico) in 2020. The range of values represents potential variation in the amount of alternative fuels these companies produce for the jet fuel, diesel fuel, and gasoline markets.

[6] Note that these preliminary computations are based on an ICAO 2006 forecast of aviation growth that has substantially overestimated U.S. aviation growth. This forecast is being refined and we expect that the new forecast will create a smaller gap.

[7] See National Aeronautics Research and Development Plan *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/aero-rdplan-2010.pdf

[8] For additional information on the CLEEN program, please see http://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/.

NASA's Environmentally Responsible Aviation and Subsonic Fixed Wing Programs

The CLEEN Program is complemented by NASA's efforts via the recently launched Environmentally Responsible Aviation (ERA) Project within the Integrated Systems Research Program (ISRP) for next generation technologies and the Subsonic Fixed Wing (SFW) Project within the Fundamental Aeronautics Program for longer term technology development.[9] Created in 2010, ERA is a six year focused effort performed in collaboration with the FAA and DoD with the aim to reduce mission fuel burn by 50 percent. Similar to CLEEN, ERA is focused on the complete aircraft and includes improvements in aerodynamic and structural efficiency as well as civil propulsion efficiency. In 2011, ERA received $65 million in funding and the project is expected to be funded at over $70 million each year from 2012 through 2015. ERA will accelerate development of these technologies for potential introduction into emerging subsonic passenger and cargo transport aircraft and engine designs no later than 2020.

NASA's enduring Fundamental Aeronautics Program continues to focus and pursue fundamental research into advanced rotary wing, subsonic and supersonic transport aircraft designs and associated enabling technologies. The goal of the SFW project is to decrease fuel burn by 70 percent below today's technology by maturing emerging aircraft and engine designs slated for introduction into the fleet beyond 2030. The SFW project is funded at the level of about $90M to explore and advance the most promising long-term technologies for subsonic transports.

Department of Defense Programs

Beyond efforts by FAA and NASA focused on commercial applications, DoD is investing significant resources in more energy efficient aircraft technology to address escalating fuel cost and supply volatility. DoD and its various branches have a number of specific military propulsion programs and initiatives underway to improve aircraft energy efficiency, which will also reduce GHGs. The VAATE (Versatile Affordable Advanced Turbine Engines) Program provides a framework to develop advanced engine technologies for all DoD services, in collaboration with the Defense Advanced Research Projects Agency (DARPA), Department of Energy (DOE), NASA, FAA and industry. There are several technology development programs under VAATE that strive to meet specific energy goals. The Adaptive Versatile Engine Technology (ADVENT) Program is developing critical technologies to enable military turbofan engines with 25 percent

On September 7, 2010, a U.S. Air Force C-17 flew with all engines burning a JP-8, biofuel, and synthetic coal-derived fuel blend.

[9] For additional information on the ERA project, please see http://www.aeronautics.nasa.gov/isrp/era/index.htm. For additional information on the SFW project, please see http://www.aeronautics.nasa.gov/fap/subfixed.htmlhttp://www.aeronautics.nasa.gov/isrp/era/index.htm

improved fuel efficiency that reduce fuel burn and provide more range, persistence, speed and payload. The Adaptive Engine Technology Development (AETD) program is following the ADVENT program to accelerate technology maturation and reduce risk for transition of these technologies to a military engine in the 2020+ timeframe; the technology would be applicable to a range of military aircraft (fighters, bombers, etc.). In addition, the DoD is investing in advanced aircraft configurations and lightweight structures to improve aircraft efficiency. Many of the technologies being developed under these programs will be transferable to the commercial aviation fleet and vice-versa.

B. TIME FRAME AND TARGETS

The FAA CLEEN, NASA ERA, NASA SFW Program and DoD VAATE Program goals are complementary in their reduction targets and their timeframes.

- A primary goal of the CLEEN program is to develop and demonstrate, by 2015, technology that reduces fuel burn by 33 percent relative to current technology. The technology would then be available for commercialization.

- The Environmentally Responsible Aviation (ERA) project has a goal to reduce mission fuel burn by 50 percent not later than 2020 for subsonic passenger and cargo transport aircraft. In addition, the DoD ADVENT and AETD programs have a goal of a 25 percent improvement in fuel efficiency for military engines by 2020.

- The Subsonic Fixed Wing (SFW) Program intends to mature technology associated with emerging aircraft and engine designs slated for introduction into the fleet beyond 2030 to decrease fuel burn by 70 percent.

C. EXPECTED EMISSIONS IMPACTS

An independent expert panel convened in ICAO, and supported by U.S. experts, estimated that new technologies and changes to aircraft mission specifications, such as reduction in cruise speed, could result in as much as 20-30 percent improvement in fuel efficiency by 2020 (when compared with 2000) and 25-50 percent improvement by 2030. The independent experts noted that greater reductions could be expected beyond 2030.[10]

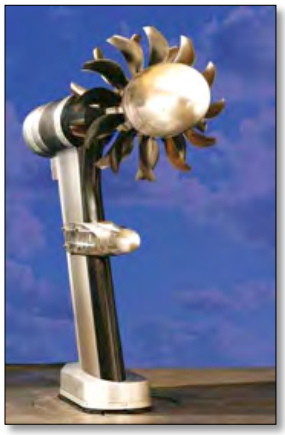
These technologies are currently being advanced by industry as well as FAA and NASA funded research. The aircraft and engine technologies being developed in the CLEEN program have a goal of a 33 percent reduction in fuel burn, relative to current technology, in the near term. The introduction of the aircraft concepts and technologies currently being developed by NASA in ERA and the SFW Program, which, after maturing further, could be brought closer to commercialization by the CLEEN program, could yield much larger reductions on the order of 50 to 70 percent below current levels.

[10] See Report of the Independent Experts of Fuel Burn Reduction Technology Goals, CAEP Steering Group 2010, Working Paper 11 at Paragraph 8.

D. SUCCESSES SO FAR

In partnership with industry, CLEEN is already accelerating development of aircraft technologies that reduce fuel burn. Following were some of the program achievements in FY11:

- Boeing: Completed Adaptive Trailing Edge wind tunnel tests in May 2011, demonstrating improvements in aerodynamic efficiency, leading to an estimated 2 percent reduction in aircraft fuel burn and emissions. Flight tests are scheduled for August 2012.
- GE: Completed sub-scale open rotor wind tunnel tests in January 2012. Early assessments using test data show at least a 26 percent reduction in fuel burn for a single aisle class aircraft. Independent assessments by NASA using test data show a 35 percent reduction in fuel burn is possible.
- Boeing: Completed Alternative Fuel Impact on Aircraft Fuel System tests, demonstrating rubber seals are not adversely affected by a blend of alternative jet fuel and Jet A fuel.
- Rolls-Royce: Completed turbine blade component tests in July 2011, demonstrating a reduction in weight and increase in engine efficiency.


Open rotor model

III. OPERATIONAL IMPROVEMENTS

Achieving more efficient aircraft operations is another critical element for reducing GHG emissions from aviation. The FAA is currently implementing a comprehensive, multiyear overhaul of the National Airspace System known as NextGen. The benefits of NextGen are many and go well beyond environment, but key elements of NextGen include reducing delays, establishing more precise routes, and improving overall efficiency of the National Airspace System, which all result in less fuel burn and lower emissions.

A. PROGRAM SPECIFICS

Implementation of FAA's Next Generation Air Transportation System (NextGen) is a comprehensive means for achieving more efficient aircraft operations and reduced GHG emissions through airspace, operational, and infrastructure improvements (note the CLEEN program referenced above is an element of NextGen). There are a range of operational improvements being implemented that result in lower fuel burn, including use of more precise flight paths with advanced avionics, use of continuous descent arrivals that require limited engine thrust when descending to an airport, and overall airspace optimization.

The USG has dedicated significant resources to implementing NextGen and measuring progress toward NextGen goals, including efforts to measure and quantify environmental benefits. These

efforts with detailed information about investments, timelines, etc. are addressed in FAA's NextGen Implementation Plan[11] and NextGen Segment Implementation Plan.[12]

The FAA is working very closely with various segments of the U.S. aviation sector, as NextGen requires not only new infrastructure and systems, but avionics equipage, pilot training, and new ways of operating by the commercial sector. U.S. industry is very supportive of NextGen modernization given the efficiency gains and fuel costs savings enabled.

NextGen has generally received broad congressional support, and even in the recent years of budget challenges, has been funded at or near requested levels. The recent passage of a four-year FAA reauthorization provides further evidence of the widespread support for implementing NextGen, and also provides specific additional authority and support for NextGen programs.

B. TIME FRAME AND TARGETS

Given the broad scope of NextGen, there is a comprehensive planning and implementation process for achieving the full range of NextGen benefits. Implementation of many improvements under NextGen is occurring now with individual elements being implemented throughout the next ten years. The emissions reductions resulting from NextGen are intended to support the overall goal of carbon neutral growth by 2020.

Because of the importance of NextGen to the U.S. economy, President Obama identified one significant NextGen project for fast-tracking as part of the Administration's efforts to speed infrastructure development.[13] The accelerated project involves operational improvements in and around the two largest Houston airports and surrounding airspace. The estimated annual benefits of the project are (1) reducing fuel consumption between 3 and 8.6 million gallons; and (2) reducing GHG emissions by 31,000 to 87,000 metric tons.

C. EXPECTED EMISSIONS IMPACTS

Benefits from NextGen efforts are projected to result in a cumulative reduction of approximately 1.4 billion gallons of fuel or 14 MT of CO_2 by 2020. This is a system-wide estimate and is highly sensitive to FAA's air traffic forecast, which has been highly variable in recent years due to a number of factors, including fluctuation in fuel prices and the economy.

[11] *Available at* http://www.faa.gov/nextgen/media/ng2011_implementation_plan.pdf
[12] *See also* National Airspace and Procedures Plan for additional details regarding the milestones and products that will support achieving success in NextGen
[13] *See* Presidential Memorandum regarding "Speeding Infrastructure Development through More Efficient and Effective Permitting and Environmental Review" (Aug. 31, 2011) *available at* http://www.whitehouse.gov/the-press-office/2011/08/31/presidential-memorandum-speeding-infrastructure-development-through-more

D. SUCCESSES SO FAR

The following are a few of the many NextGen projects and programs that have demonstrated emissions reductions and will lead to greater reductions as they are fully implemented or expanded upon.

- **FAA Metroplex Initiative:** FAA's Metroplex initiative is undertaking efforts to optimize the complex airspace in the vicinity of busy U.S. airports. Under this initiative, implementation of optimized descents and shorter flying distances in Washington, D.C. and north Texas has resulted in a substantial reduction in aircraft fuel burn. For Washington, the estimate is $6.4 to $19 million per year in fuel savings, and the north Texas Metroplex estimated to save $10.3 to $21.7 million. In Houston alone, between 3 and 8.6 million gallons of fuel will be saved, the equivalent of taking 4,000 to 8,000 cars off the road in the metropolitan area. The Washington and north Texas projects moved to the design and implementation phase in 2011.[14]

- **Atlantic Interoperability Initiative to Reduce Emissions (AIRE)**: AIRE is a collaborative effort between the U.S. and the European Commission to promote and harmonize environmental initiatives and procedures in European and North American airspace. In 2010 and 2011, the U.S. participated in three AIRE demonstration projects utilizing a combination of flight optimization procedures to reduce fuel burn and emissions. Benefits ranged from a savings of 100 to 400 gallons of fuel per flight.

- **Reduced Surface Emissions**: During 2010, the Port Authority of New York and New Jersey implemented a surface congestion reduction program at JFK airport to avoid disruption while the airport's longest runway was being rebuilt. Adapting software used during de-icing operations, JFK managers tracked and limited access to taxiways for departing aircraft until they could take off without delays. JFK retained the procedure after the runway work was completed, and analysts were able to compare operations using the system under normal circumstances with operations before the runway work began. Through FAA analysis, it is estimated that the procedure has the potential to save 14,800 hours of taxi-out time per year at JFK, reducing fuel consumption by 5 million gallons and carbon dioxide emissions by 48,000 metric tons.

Surface congestion at Kennedy International Airport.

[14] NextGen Implementation Plan, Page 20.

IV. ALTERNATIVE FUELS DEVELOPMENT AND DEPLOYMENT

The USG is actively supporting and facilitating the development and deployment of sustainable alternative fuels with lower lifecycle GHG emissions than conventional petroleum fuel.

A. PROGRAM SPECIFICS

The USG has taken significant steps during the last five years to facilitate the development and deployment of "drop-in" alternative aviation fuels. "Drop-in" jet fuel can be used without changes to aircraft systems or fueling infrastructure and may reduce aircraft emissions and enhance U.S. energy security. The Commercial Aviation Alternative Fuels Initiative (CAAFI), a public/private partnership between the USG, airlines, aircraft manufacturers and airports, has led efforts in research and development, environmental assessment, fuel testing and demonstration and commercialization of alternative aviation fuels. CAAFI efforts contributed to the creation of testing protocols and new alternative fuel specifications that have enabled approvals for aviation to use new fuels in commercial service. This is paving the way to large scale production and use of these fuels. This leadership has also helped make aviation a major target market for the alternative fuels sector.

US agencies contribute to aviation alternative fuels efforts with R&D, fuel testing, and production investments.

The U.S. Department of Agriculture (USDA) considers aviation a key strategic partner and market for accomplishing its goals of promoting bioenergy production and supporting rural development. The USDA is focused, in particular, on crop and investment programs to support aviation fuel production. Likewise, the Air Force, the Navy, NASA and Department of Energy have also become key government contributors to aviation alternative fuels efforts with research & development, fuel testing and fuel production investments. The U.S. Renewable Fuel Standard (RFS) mandates the use of 36 billion gallons of renewable fuels by 2022 but does not mandate jet fuel production. The U.S. Environmental Protection Agency (EPA) has proposed that alternative aviation fuels get credit toward the volume requirement thereby enhancing the potential commercial value of the qualified fuels and creating further incentive for production.

B. TIME FRAME AND TARGETS

In general, for an alternative jet fuel to be broadly used by commercial aviation, it needs to be approved by ASTM International (ASTM), a widely recognized industry standards setting organization. To date, ASTM has approved two alternative jet fuels that could use vegetable and waste oils as well as lignocellulosic materials with Fischer-Tropsch synthesis. The approval of additional alternative jet fuels is being pursued to ensure that a wide range of feedstock and fuel producers have access to the

jet fuel market, reducing cost and thereby providing greater opportunity to meet U.S. environmental goals.

FAA, DoD, and NASA are currently collaborating with industry to advance additional fuel pathways that could more cost effectively convert materials to alternative jet fuels. Once sufficient testing is completed, ASTM is expected to consider approval of the next fuel types, in late 2013 or 2014. In the interim, the FAA is working with the Brazilian government to facilitate the use of alcohol-to-jet fuel on a specific aircraft type in Brazil in time for the World Cup in 2014. This fuel pathway could use a wide range of feedstocks that can be converted to alcohols, which are then upgraded to jet fuel. In parallel, additional fuel pathways are also under development and testing and being considered for approval.

A forthcoming analysis from the Volpe Transportation Center presents a "bottom up" projection of the potential production of alternative aviation fuels in North America (the United States, Canada, and Mexico) in 2020 that is based on 61 companies using 18 fuel production processes.[15] It must be noted that this is a preliminary analysis that was derived using a number of assumptions that are currently being vetted. For North America, alternative aviation fuel production in these specific scenarios was projected to range from 2.5 billion gallons per year (BGY) to more than 9 BGY. The projections reflect individual company stated plans – as opposed to the underlying market forces – for production and expansion. The analysis also projects the role that alternative fuels may play in achieving carbon neutral growth goals under various production scenarios.

The Volpe Center projects alternative aviation fuel production could range from 2.5B to more than to more than 9B gallons per year by 2020.

The FAA has set a goal of annual use by U.S. aviation of 1 billion gallons of alternative jet fuel, by 2018, displacing 1 billion gallons of petroleum jet fuel. The U.S. Air Force (USAF) has a goal of being ready to cost competitively acquire 50 percent of USAF domestic aviation fuel from domestically sourced 50/50 alternative fuel blends by 2016.[16] The U.S. Navy has a goal to have 50 percent of the Naval fleet's total energy consumption from cost competitive alternative sources by 2020.[17] It is a

[15] John A. Volpe National Transportation Systems Center Draft Report entitled "Alternative Aviation Fuel Scenario Analysis Report" Version: 9/23/11.
[16] "Air Force energy plan: 2010," The United States Air Force, 2010.
[17] "A Navy energy vision for the 21st century," The United States Navy, 2010.

legal requirement that alternative fuels be produced in a manner that has a lower greenhouse gas footprint than conventional petroleum based fuels.[18]

C. EXPECTED EMISSIONS IMPACTS

The fuel production pathways examined in the preliminary Volpe "bottoms up" projection had an estimated average 1/3 reduction in life cycle CO_2 emissions.[19] With this life cycle CO_2 value, and the preliminary range of fuel production values from 2.5 to 9 BGY, the overall annual reduction in life cycle CO_2 emissions could be between 9 and 34 MT of life cycle CO_2 emissions by 2020 relative to traditional petroleum fuels.

Alternative fuel analyses conducted by the PARTNER Center of Excellence have shown reductions of up to 80 percent for some renewable alternative jet fuel pathways with many HEFA pathways showing approximately a 50 percent reduction.[20] With an optimistic life cycle CO_2 emissions reduction of 80 percent, the range of fuel volumes presented above could correspond to annual reductions of 23 to 82 MT of life cycle CO_2 emissions by 2020 relative to traditional petroleum fuels.

D. SUCCESSES SO FAR

The following are several examples of the progress and successes in the development of sustainable alternative fuels for aviation.

- On July 1, 2011, the standard-setting organization ASTM International approved a bio-derived sustainable alternative jet fuel known as Hydroprocessed Esters and Fatty Acids, or HEFA, for commercial use up to a 50 percent blend level. This approval required extensive collaboration with all stakeholders over a period of three years with the FAA's CLEEN Program supporting key testing that enabled the approval. In late 2011, two U.S. commercial airlines, United Airlines and Alaska Airlines, flew their first domestic flights powered by HEFA biofuels.

Alaska Airlines flew its first biofueled domestic flight in 2011.

[18] Energy Independence and Security Act of 2007," Section 526, One Hundred Tenth Congress of the United States of America, 2007
[19] John A. Volpe National Transportation Systems Center Draft Report entitled "Alternative Aviation Fuel Scenario Analysis Report" Version: 9/23/11.
[20] Stratton RW, Wong HM, Hileman JI (2010) Life Cycle Greenhouse Gas Emissions from Alternative Jet Fuel, Version 1.2. Cambridge, Massachusetts: PARTNER/MIT.

- USDA provided a $40 million research grant to a University of Washington lead team to focus on using sustainably grown woody energy crops for transportation fuels. The project aims to develop a regional source of renewable aviation fuel. Production of bio-based jet and diesel fuel by project partner Zeachem is expected to begin as early as 2013.

- USDA has invested in a New Mexico facility to produce "green crude" oil from algae, which can be refined into transportation fuel. And USDA and DOE have invested in another algae production facility in Arizona.

- In August 2011, USDA, Department of Energy and U.S. Navy announced a partnership to invest up to $510 million during the next three years to produce advanced, drop-in aviation and marine biofuels to power military and commercial transportation. DOE and DoD plan to invest money under the Defense Production Act Title III, which allows the U.S. to invest in strategically significant industries. USDA plans to provide its contribution through the use of its Commodity Credit Corporation.

- In December 2011, the Navy announced that the Defense Logistics Agency had signed a contract to purchase 450,000 gallons of advanced drop-in biofuel, the single largest purchase of biofuel in government history, for a demonstration off the coast of Hawaii in the summer of 2012.

- The U.S. Department of Energy's ongoing Integrated Biorefineries Program supports development of pilot and demonstration scale fuel production facilities with 11 projects focused on hydrocarbon fuels including jet fuel. DOE is planning additional funding of alternative jet fuel development.

- In April 2012, the Air Force completed testing and certification of the entire fleet on Fischer-Tropsch synthetic fuel and continues to certify the fleet on hydro-processed renewable jet (HRJ) and alcohol-to-jet (ATJ biofuel blends).

- In October 2010, the FAA and USDA signed a five-year agreement that creates a framework of cooperation to leverage expertise of the two agencies to develop alternative jet fuel production. Under the partnership, the agencies bring together their experience in research, policy analysis and air transportation to assess the availability of different kinds of feedstocks that will be needed by biorefineries to produce renewable jet fuels. A recent concrete outcome is the development of a feedstock readiness measurement tool to inform aviation fuel users about availability and feasibility of the key raw materials for alternative fuel production.

- In July 2010, the USDA joined with CAAFI co-sponsor Airlines for America (A4A) and the Boeing Company in a "Farm to Fly" resolution to "accelerate the availability of sustainable aviation biofuels in the United States, increase domestic energy security, and establish regional supply chains and support rural development."

V. POLICIES, STANDARDS, AND MEASURES

The USG is pursuing the development of a meaningful CO_2 standard and considering additional policies, standards, and measures that would supplement efforts on technology, operations and alternative fuels in order to achieve the carbon neutral growth goal.

1. Development of a Meaningful Aircraft CO_2 Standard

The USG is committed to the development of a meaningful CO_2 standard in ICAO for implementation in the U.S. under the Clean Air Act. In this regard, the ICAO Committee on Aviation Environmental Protection (ICAO/CAEP) is currently working toward adopting a meaningful CO_2 standard for aircraft with support from the USG and industry and environmental stakeholders. The CO_2 standard would incentivize faster development of technology and serve as a basis for ensuring that less efficient aircraft and engine technologies are eliminated over time[21].

2. Aviation Fuel Charge

The USG currently applies a domestic per gallon fuel charge of 4.3 cents that contributes to funding $1B yearly NextGen infrastructure development investment and emissions reduction through the Airport and Airway Trust Fund.

3. Incentives for Equipping Aircraft with Advanced Avionics

The recently passed FAA reauthorization grants authority to FAA for the establishment of an incentive program to facilitate the purchase of advanced avionics for aircraft in order to facilitate the implementation of NextGen. The incentive program is in the early stages of design given the recent passage of reauthorization, and the potential for environmental improvement is a critical factor in the design of the program. In addition, by hastening the implementation of NextGen, the incentive program will help lead to overall emissions reductions from aviation.

Advanced avionics facilitate NextGen implementation.

4. Voluntary Airport Low Emissions Program

FAA's Voluntary Airport Low Emission Program (VALE) is a national program designed to reduce all sources of airport ground emissions. Airports can apply for funding to purchase lower emissions technology. Examples of previously funded projects include: preconditioned air units, electric ground support equipment like bag tugs and belt loaders; natural gas refueling stations for airport buses and shuttles; gate electrification; and alternative fuel systems including geothermal systems and solar facilities. In fiscal year 2011, the FAA issued VALE grants for 12 projects at 11 airports for low-emission projects. Since 2005, the FAA has funded 52 low-emission projects at 30 airports

[21] The efficacy of the standard will depend on both the stringency (over time) and applicability of the standard (i.e., to what types of aircraft is the standard applied such as applying to current in-production), both of which are under discussion in ICAO. ICAO/CAEP is aiming to complete work on the standard by 2013.

representing a total investment of $138 million ($109 million in federal grants and $29 million in local airport matching funds) in clean airport technology.

5. NextGen Environmental Management System

FAA has developed and is improving upon a NextGen Environmental Management System (EMS). The EMS will assist in measuring progress toward NextGen Environmental goals and obtain input and commitments from stakeholders on initiatives to reduce fuel burn and emissions from aviation. With the use of analytical models, and information from stakeholders, FAA can provide transparency and information regarding progress toward goals.

6. Market-Based Measures

The USG is considering the possibility of market-based measures (MBMs) for aviation to meet any gap in achieving aviation emission reduction goals. In this regard, the USG is supporting efforts in ICAO to develop a framework for MBMs and to explore the feasibility of a global MBM scheme, consistent with Assembly Resolution A37-19.

A. SCIENTIFIC UNDERSTANDING AND MODELING/ANALYSIS

The USG conducts research to better understand the environmental impacts of aircraft, including climate impacts. This research includes identification of the interdependencies among various emissions and noise, and the extent to which there are tradeoffs in mitigation. The analytical methods and models that we use to assess the environmental impacts are regularly enhanced and improved. Our analytical models are used to provide annual fuel burn and emissions inventories as well as to create future projections of fuel burn and emissions, offering a great deal of transparency. The current and future states are then compared against future goals to identify gaps; thus, allowing us to do a better job at identifying and prioritizing the mitigation solutions that should be pursued. As aircraft technology evolves and operational patterns change we plan to use our improved knowledge base to refine our mitigation solutions to achieve maximum benefit and avoid or minimize negative and unintended consequences.

VI. CONCLUSION

The United States is committed to addressing the climate change impacts of commercial aviation through an integrated strategy of technology, operations, and policy innovation. Our NextGen plan seeks to transform how commercial aircraft operate in our airspace system, the kind of technology used in these aircraft, and the fuels that power them to achieve an ambitious goal of carbon neutral growth for U.S. commercial aviation by 2020, using 2005 emissions as a baseline. It involves a number of public-private partnerships and alignment of economic and environmental incentives that offers a way forward for improvements in system performance that achieves safer, more efficient, and sustainable aviation. Given past ICAO forecasts for aviation growth, the carbon neutral growth goal equates to about a 115 MT reduction in carbon dioxide emissions from commercial aviation by 2020. Preliminary estimates indicate technology improvements, operational changes, and alternative fuels in NextGen offer a plan that could produce about 81 MT in carbon dioxide emissions reductions. The

remainder would need to be addressed by other measures or, as we expect, we will have a smaller gap to address as aviation emissions growth will be substantially slower than forecast by ICAO in 2006.