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Agenda Item 16: Environmental Protection – International Aviation and Climate Change — Policy and Standardization

UNITED STATES EFFORTS TO ADDRESS AVIATION'S CLIMATE IMPACT

(Presented by the United States)

EXECUTIVE SUMMARY	
For years, the United States has been a leader in promoting, supporting, and funding efforts to increase aviation's efficiency, and these efforts are yielding noteworthy results. This information paper provides details on historical improvements of aviation's efficiency in the United States. It also examines ongoing research and development of improvements in technology, operations, and sustainable aviation fuels by the U.S. government and aviation sector.	
Strategic Objectives:	This working paper relates to Strategic Objective E - Environmental Protection.
Financial implications:	None
References:	

1. **SUMMARY**

1.1 The aviation sector's record in addressing climate change is one of increasing efficiency and action to reduce fuel burn. Since 1991,[1] the U.S. civil aviation sector's efficiency has increased by 71%. The United States has been a leader in promoting, supporting, and funding efforts to increase aviation's efficiency and reduce greenhouse gas emissions, and these efforts are yielding great results. These efforts are aligned with ICAO's focus on a basket of measures to reduce emissions, including but not limited to the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). While there continues to be a need for further progress, this information paper highlights historical improvements in efficiency by the United States aviation sector, recent efforts and successes, and concludes with an assessment of future trends. It should be noted that this progress reflects a collective and serious effort across aviation stakeholders, including governments, manufacturers, airlines, and airports, among others.

[1] Online access to official U.S. Government data compiled by the Department of Transportation's Bureau of Transportation Statistics goes back to 1991.

2. HISTORICAL IMPROVEMENTS

2.1 As Figure 1 below demonstrates, while U.S. aviation has seen increased traffic in terms of enplanements, the share of CO_2 emissions from aviation has remained relatively constant, indicating that the National Airspace System (NAS) is operating much more efficiently—moving more passengers on the same amount of energy. These data are captured in Figure 2. Today's fleet of aircraft has an average fuel efficiency of 57.5 passenger-miles per gallon of fuel, which is on par with a modern Toyota Prius hybrid, which has a fuel economy of 54 miles per gallon (MPG).[2]

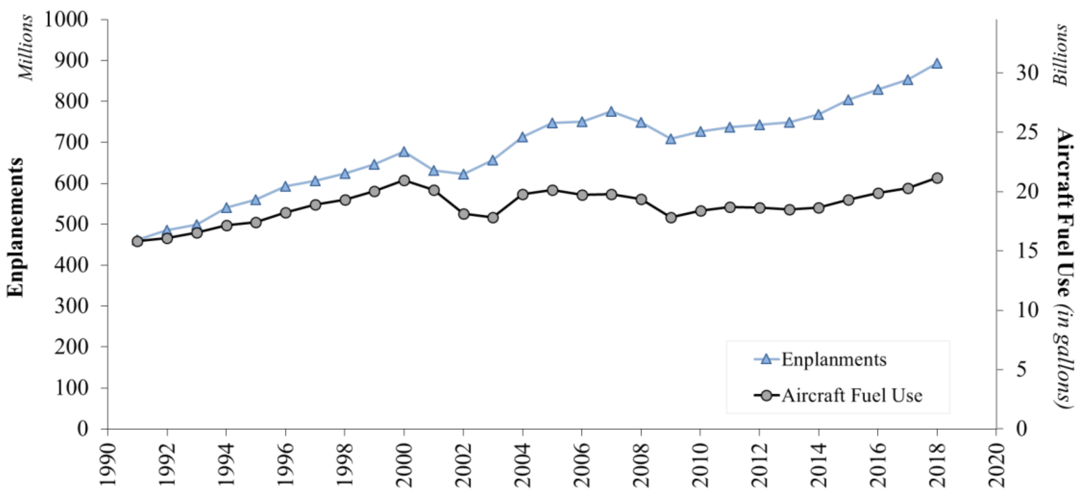

Fig. 1. Historical U.S. Revenue Passengers Enplaned (i.e., enplanements)[3] and Aircraft Fuel Use[4]

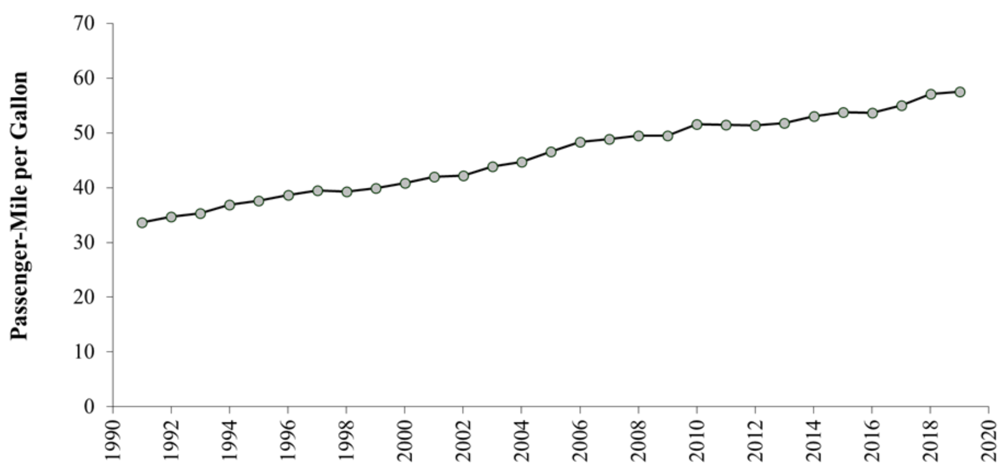

Fig. 2. Historical U.S. Fuel per Passenger Mile[5]

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[2] U.S. Department of Energy and U.S. Environmental Protection Agency (EPA), Fuel Economy Information, *available at:* https://www.fueleconomy.gov/feg/Find.do?action=sbs&id=41489.

[3] U.S. Department of Transportation – Bureau of Transportation Statistics, Air Carrier Summary Data, Form 41 and 298C Schedule T1: U.S. Air Carrier Traffic & Capacity Summary by Service Class for 1991-2019 (Aug. 2, 2019). *Available at:* http://www.transtats.bts.gov/.

[4] U.S. Department of Transportation – Bureau of Transportation Statistics, Air Carrier Summary Data, Form 41 and 298C Schedule T2 for 1991-2019 (July 29, 2019). *Available at:* http://www.transtats.bts.gov/.

2.2 Data from the Bureau of Transportation Statistics (BTS) show that the aviation sector has increased efficiency to the point that it has decoupled its growth in emissions from its growth in traffic. Aviation's share of U.S. CO_2 emissions remains at about 2.7% (including both commercial and non-commercial). Since 1991, traffic by U.S. airlines, measured in Revenue Ton Miles, has increased by 133%. In 2018, the U.S aviation sector carried about 32% more passengers than in the year 2000, while using almost the same amount of fuel. As mentioned, today's U.S. fleet of aircraft operates with a fuel efficiency better than today's hybrid-electric cars. In addition, many passenger aircraft are also hauling cargo, which adds further value to each gallon of fuel being used by aviation. As noted above, these historical improvements in efficiency are a result of collective efforts across aviation stakeholders, to address fuel burn and CO_2 emissions through a variety of measures. The net result of this collaboration is that the U.S. aviation sector has a strong track record and continues to improve its environmental performance.

3. ONGOING U.S. EFFORTS AND SUCCESS

3.1 The United States Government (USG) has been investing resources over many years to advance technologies that improve aircraft fuel efficiency, improve the architecture that underlies national air space system operations, and enable the development of sustainable aviation fuels. Each of these endeavours provides both economic and environmental benefits to society.

3.2 Overall, the efforts by the USG serve to reinforce and amplify leadership by the private sector to improve efficiency and reduce fuel burn and emissions. As one of the largest costs for operators, reducing fuel burn makes both business and environmental sense, and the industry has shown a continued commitment to developing and deploying cleaner, more efficient technology. As mentioned in Paragraph 1.1, the collaboration among stakeholders has been key to our successes. The following sections highlight some of the successes of these investments.

3.3 Technology: The evolution of modern, more efficient airframes and engines has historically produced the most significant aviation fuel, emissions, and noise reductions. Technology will continue to drive more reductions in the future. The USG is leading a number of efforts and collaborating with the aviation industry to mature new technology that results in increased fuel efficiency and reduced noise and emissions. USG actions to improve aircraft and engine technology are carried out by the FAA, the National Aeronautics and Space Administration (NASA), and the Department of Defense (DoD), among others, and are coordinated through the *National Aeronautics Research and Development Plan*.

3.3.1 NASA continues to push research and exploration of environmentally sustainable aviation technologies. NASA does this primarily through its Advanced Air Vehicles Program (AAVP) and Transformative Aeronautics Concepts Program (TACP), which include the Advanced Air Transport Technology (AATT), and Transformational Tools and Technology (TTT) projects among others. These projects focus on new vehicle technologies that have the potential to significantly reduce aviation's impact on the environment. NASA does not build engines or engine components, but rather, NASA programs and research generate advanced technologies and knowledge.

3.3.2 The Continuous Lower Energy, Emissions, and Noise (CLEEN) program is the FAA's principal effort to accelerate the development and maturation of new aircraft and engine technologies.[6] While NASA conducts low technology readiness level (TRL) fundamental aeronautics research and development, CLEEN fills a gap by focusing support to promising, pre-commercial TRL technologies.

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[5] *Id*.
[6] *See* https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/.

CLEEN funding helps mature these technologies to a point where industry led commercialization can follow. The program goals for CLEEN include the development and demonstration of certifiable aircraft technology that reduces aircraft fuel burn, emissions, and noise. The CLEEN program is currently nearing conclusion of its second five-year phase, and the third five-year phase of CLEEN is scheduled to begin in 2020. Georgia Institute of Technology conducted an independent assessment of the technologies in the initial CLEEN Program. The assessment found that use of the technologies that were supported in the first five-year phase of CLEEN could reduce U.S. fleet-wide fuel burn by 2% from 2025 through 2050, representing a cumulative savings of 22 billion gallons of jet fuel.[7]

3.3.3 These research programs include close cooperation with industry. Typically, five to ten years after the conclusion of a NASA program, and at the conclusion of the CLEEN program, industry can build on results and integrate the associated knowledge into commercial products.

3.3.4 A comprehensive analysis of future technology development was carried out by the Volpe Center using data from the Aviation Sustainability Center (ASCENT),[8] a leading aviation cooperative research organization with a broad portfolio of contributions. The analysis indicates a fuel reduction potential from the baseline scenario of approximately 30% in 2050 for a moderate use of technologies and of 52% in 2050 for the aggressive improvement scenario due to aircraft technology and operational improvements, both being measured relative to 2016. These rates of improvement are similar to the ICAO Environmental Trends Analysis. However, both of these analyses were based on the use of conventional tube-and-wing technologies, and if further reductions are needed, then industry will likely need to work with governments to collaboratively reduce the risk of developing additional technologies, potentially including new airframe architectures.

3.4 Infrastructure and Operations: Achieving more efficient aircraft operations is another critical element for reducing fuel and emissions from aviation. The FAA is implementing a comprehensive, multi-year modernization of the NAS known as NextGen. While the benefits of NextGen are many and go well beyond environment, among the key elements of NextGen are reducing delays, establishing more precise routes, and improving overall efficiency of the NAS, all of which can contribute to reduced fuel burn and emissions. Data from 2010-2017 show achieved benefits of 264.6 million gallons of fuel saved, translating to 2.53 million metric tons of CO_2.[9]

3.5 Sustainable Aviation Fuels: Jet fuels produced from waste materials and renewable resources, also known as sustainable aviation fuels (SAF), have the potential to provide economic development, increased supply certainty, a hedge against petroleum price volatility, reduced life cycle GHG emissions, and reduced air quality emissions relative to conventional jet fuel. These fuels can play a central role in generating domestic economic development and providing energy security for sustained aviation growth while simultaneously mitigating aviation’s contribution to climate change and emissions that impact air quality. Since 2006, the United States has been actively supporting and facilitating the development and deployment of these fuels through the Commercial Aviation Alternative Fuels Initiative® (CAAFI), a public private partnership that brings together all of the stakeholders who are involved in fuel production and use.[10] While centered in the United States, CAAFI has grown to include participants from around the world, and the achievements of the CAAFI team—such as establishing the protocols and procedures for approval of SAF under the jet fuel specifications—are shared by the aviation sector worldwide.

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[7] Assessment available at http://partner.mit.edu/projects/eds-capability-demonstration-assessing-cleen-program.
[8] More information on ASCENT is available at https://ascent.aero/. More information on the referenced study is available at https://ascent.aero/project/aircraft-technology-modeling-and-assessment/.
[9] For detailed information on NextGen, see https://www.faa.gov/nextgen/.
[10] For more information about CAAFI, see http://www.caafi.org/.

3.5.1 Sustained commercial production and use by air carriers of SAF began in the United States in 2016, when Altair Fuels (now World Fuels Paramount) began production of SAF made from waste tallow at their facility near Los Angeles, California. This fuel has been certified by the Roundtable on Sustainable Biomaterials (RSB) as providing a greater than 60% greenhouse gas reduction over petroleum fuel.[11] The end of 2018 marked the third year of sustained commercial production and continuing use of SAF by a wide range of operators. In 2016, total U.S. SAF use was approximately 1.1 million neat gallons. In 2017, total use expanded to approximately 1.5 million gallons by 10 airlines, two aircraft manufacturers, and deliveries to five U.S. airports. In 2018, total use was approximately 1.2 million neat gallons, again by airlines, manufacturers, and business aviation.[12]

3.5.2 As shown in Figure 3, below, production capacity across the United States is also increasing. All told, the production capacity represented has the potential to reach more than 250 million gallons per year of neat SAF within the next five years if market conditions warrant, and numerous companies are working on additional financing, engineering, and planning to build out additional facilities. A recent analysis from ASCENT showed that there are sufficient renewable and waste resources in the United States to supply all of the jet fuel requirements in the United States in 2050, but considerable effort would be needed to realize this potential.[13]

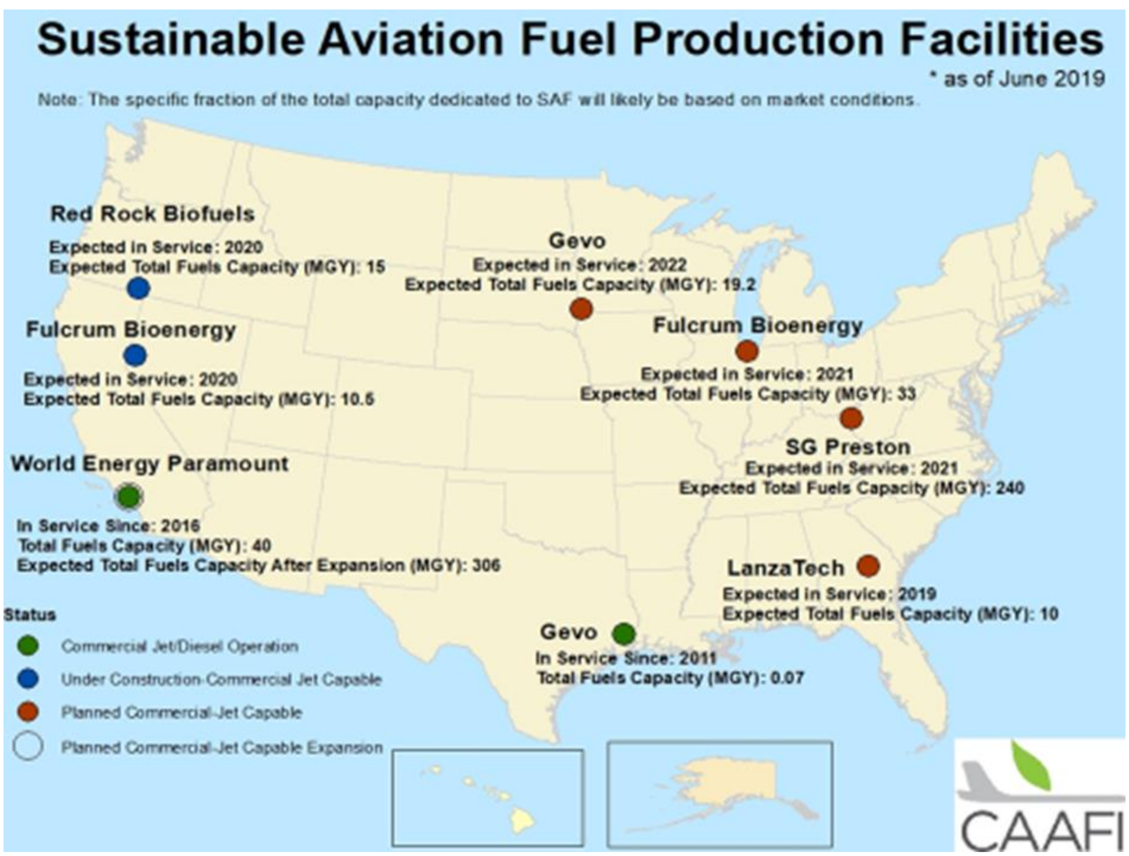

Fig. 3. Existing and Planned SAF Production Facilities in the United States[14]

[11] *See* https://rsb.org/2018/01/29/altair-rsb-certification-biofuel-refinery/.
[12] The current state of SAF deployment is available from CAAFI at http://www.caafi.org/focus_areas/docs/Alternative_Jet_Fuel_Deployment_Status_July%202019.pdf.
[13] *See* http://www.caafi.org/resources/pdf/2.3_Future_Production.pdf.
[14] *See* http://caafi.org/focus_areas/deployment.html.

3.6 Policies, Standards, and Measures: In addition to domestic efforts across the board, international efforts will also yield tremendous benefits for aviation.

3.6.1 In 2016, ICAO/CAEP reached consensus on adopting an aircraft fuel efficiency standard with support from the USG, U.S. industry, and other global stakeholders. The primary aim of the aircraft fuel efficiency standard is to incentivize faster development of fuel efficient technology and serve as a basis for ensuring that less efficient aircraft technologies are eliminated over time. Since 2016, the USG has been working to promulgate the international standard into domestic regulations. This is a dual-regulatory process whereby the EPA sets regulatory emissions levels, and the FAA enforces the EPA emissions regulations via airworthiness certification.

3.6.2 When considered with other measures internationally, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) will serve to offset CO_2 emissions from international aviation from a 2020 baseline. CORSIA was carefully negotiated among all ICAO Member States, and it will serve as a critical springboard for all Member States and their operators going forward. CORSIA provides a single, agreed-upon measure that will be more effective globally at reducing emissions with manageable compliance costs, so resources can be invested on additional in-sector reductions.

4. CONCLUSION

4.1 Aviation is an integral part of our everyday lives. It connects billions of travellers and moves millions of tons of cargo every year. The global aviation industry supports $2.7 trillion (3.5%) of the world's gross domestic product (GDP),[15] this connectivity enables economic growth around the world including in many developing areas. Air travel has helped change the way people see and experience the world. Families now live all over the globe and are connected by rapid and affordable flight.

4.2 Aviation is an industry that has been making air travel much more sustainable for decades now. Collaborative efforts to implement ICAO's "basket of measures" within the United States involving government, manufacturers, airlines, and airports have and will continue to yield significant benefits to address aviation's climate impact. We have and will continue to invest in these efforts as they yield positive economic and environmental benefits, and we look forward to partnering with other ICAO Member States to continue to build on the significant progress made to date. We are confident that with the right investments and partnerships, aviation can meet the environmental challenges of the 21st century.

— END —

[15] International Civil Aviation Organization, "Aviation Benefits 2017," *available at*: https://www.icao.int/sustainability/Documents/AVIATION-BENEFITS-2017-web.pdf.