EFFICIENT AVIATION

Aviation is responsible for 2.5% of global emissions,[1] 11% of U.S. transportation emissions,[2] and the number of flights per year is increasing.[3] Minimizing the need for air travel through telepresence and high-speed rail is one way to address this, but for those flights that cannot be avoided, the aviation industry must improve its efficiency and develop alternative fuels. In the efficiency realm, existing aircraft can implement fuel-saving operating practices, and planes can be retrofit with aerodynamic winglets, better engines, and lighter interiors. In addition, engineers are designing new airplane models with dramatically different and more efficient body designs.[4] Tech-based solutions like SkyBreathe, an AI technology that helps optimize flight routes to reduce carbon emissions, offer low-hanging fruit.[5]

In addition, a variety of sustainable aviation fuels (SAFs) are in development. These include biofuels made from corn grain, oil seeds, algae, recycled cooking oil, industrial waste, agriculture and forestry residues, municipal solid waste, wet waste (sewage sludge and manure), and dedicated energy crops.[6] SAFs can be blended with conventional fuels to be used in existing aircraft. SAFs have been in use at the Los Angeles airport since 2016 and at the San Francisco airport since 2020. Only one processing facility exists in the U.S., located in Los Angeles, but several more are under construction.

There are seven technological pathways for synthesizing SAF that are approved under international standard ASTM D7566 ("Standard specification for aviation turbine fuel containing synthesized hydrocarbons"). When blended with conventional aviation fuel, they meet ASTM D1655 ("Standard specification for aviation turbine fuels"), which allows them to be used in existing aircraft.

- Fischer-Tropsch (FT) hydroprocessed synthesized paraffinic kerosene (SPK) fuel using solid biomass resources (e.g., wood residues) (FT-SPK); maximum blend level 50%;
- Synthesized paraffinic kerosene from hydroprocessed esters and fatty acids (HEFA) fuel derived from used cooking oil, animal fats, algae, and vegetable oils (e.g., camelina) (HEFA-SPK); maximum blend level 50%;
- Synthesized isoparaffin fuel from hydroprocessed fermented sugars (SIP), formerly known as direct-sugar-to-hydrocarbon fuel (HFS-SIP); maximum blend level 10%;
- FT-SPK with aromatics fuel using solid biomass resources (e.g., wood residues) (FT-SPK/A); maximum blend level 50%;

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[1] Drawdown. "Efficient aviation." https://drawdown.org/solutions/efficient-aviation

[2] The White House (September 9, 2021). "Fact sheet: Biden administration advances the future of sustainable fuels in American aviation." https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/09/fact-sheet-biden-administration-advances-the-future-of-sustainable-fuels-in-american-aviation/

[3] Drawdown. "Efficient aviation." https://drawdown.org/solutions/efficient-aviation

[4] Drawdown. "Efficient aviation." https://drawdown.org/solutions/efficient-aviation

[5] Timperley, Jocelyn (May 25, 2021). "The fastest ways aviation could cut emissions." *BBC. https://www.bbc.com/future/article/20210525-how-aviation-is-reducing-its-climate-emissions*

[6] DOE. "Sustainable aviation fuels." https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuels

- Alcohol-to-jet SPK fuel produced from isobutanol or ethanol (ATJ-SPK); maximum blend level 50%;
- Catalytic hydrothermolysis (or hydrothermal liquefaction) jet fuel derived from fats, oils, and greases (CHJ); maximum blend level 50%;
- HEFA with hydrocarbons (HC-HEFA) produced from esters and fatty acids at 10% maximum blend concentration.

SAFs offer several side benefits. Producing SAFs from wet wastes can reduce pressures on watersheds while keeping methane from entering the atmosphere. In addition, SAFs contain fewer aromatic compounds and they burn cleaner than conventional jet fuel. As a result, SAFs emit fewer pollutants during takeoff and landing, and they cut down on contrails, which contribute to global warming.[7]

In 2017, the International Civil Aviation Organization (ICAO) adopted a CO_2 emissions standard for new aircraft.[8] In 2020, the EPA finalized a matching U.S. GHG emission standard for airplanes used for commercial and business travel. In 2021, the U.S launched the SAF Grand Challenge, a collaboration among the U.S. Departments of Energy, Transportation, and Agriculture. The SAF Grand Challenge aims to achieve a 50% reduction in lifecycle GHG emissions compared to conventional fuel, and to supply sufficient SAF to meet all aviation demand by 2050, with a near-term goal of producing 3 billion gallons of SAF annually by 2030.[9] The industry has a long way to go before this goal is met: in 2019, only 0.01% of aviation fuel used globally was made up of SAFs.[10]

- Fishery friendliness: As with all biofuels, feedstock cultivation has a number of potential environmental impacts that may impact marine and aquatic resources. Potential impacts of terrestrial feedstock production include deforestation and runoff of nutrients, pesticides, and sediments. Potential impacts of marine production include spatial displacement of fishing activities and impacts to carbon cycling and food webs. Fishery-friendly impacts may also occur: for example, kelp can help buffer ocean water pH against acidification and provide habitat and refuge for marine organisms.
- Co-benefits: Production of biofuels for SAFs can provide supplemental income for farmers. When produced from waste products, such as recycled restaurant grease, wood chips, or algae grown in wastewater, biofuels can help repurpose a waste stream into a useful product.
- Environmental externalities: Producing SAFs from wet wastes can reduce pressures on watersheds while keeping methane from entering the atmosphere. SAFs burn cleaner than traditional fuel and emit fewer pollutants and contrails. As with all biofuels,

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[7] DOE. "Sustainable aviation fuels." https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuels
[8] ICAO (March 6, 2017). "ICAO Council adopts new CO_2 emissions standard for aircraft." https://www.icao.int/newsroom/pages/icao-council-adopts-new-co2-emissions-standard-for-aircraft.aspx
[9] DOE. "Sustainable aviation fuel grand challenge." https://www.energy.gov/eere/bioenergy/sustainable-aviation-fuel-grand-challenge
[10] Timperley, Jocelyn (May 25, 2021). "The fastest ways aviation could cut emissions." *BBC. https://www.bbc.com/future/article/20210525-how-aviation-is-reducing-its-climate-emissions*

production of feedstocks has a significant potential for environmental externalities that should be considered and guarded against. Potential impacts of terrestrial production include displacement of human food crops (with consequent increases in food prices), deforestation, and runoff of nutrients, pesticides, and sediments. Potential impacts of marine production include mammal entanglements and impacts to carbon cycling and food webs. Potential positive impacts may occur as well: for instance, kelp can help buffer ocean water pH against acidification and provide habitat and refuge for marine organisms.

- Policy catalysts: Development of SAFs can be promoted through grants for research and development and aviation emissions standards.
- More information:
    - Drawdown: Efficient aviation
    - C2ES: Reducing carbon dioxide emissions from aircraft
    - EPA: Regulations for greenhouse gas emissions from aircraft
    - DOE: Sustainable aviation fuels
    - Federal Aviation Administration: Sustainable alternative jet fuels
    - ICAO: Sustainable aviation fuels
    - Timperley, Jocelyn (May 25, 2021). "The fastest ways aviation could cut emissions." *BBC.*

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