Sustainable Aviation Fuel: Just Taking Off

Prepared for the Aviation Noise & Emissions Symposium 2020

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1. Stillwater Associates leverage decades of experience to help clients navigate transportation fuels market challenges. **We see things others miss.**
2. Our clients: government agencies, oil and renewable fuels companies, fuel buyers, trade associations, technology developers, private equity firms, and law firms.
3. Leading experts on California's Global Warming Solutions Act (AB32) programs - the LCFS and Cap & Trade.
4. Stillwater's **LCFS Newsletter** offers producers, importers, traders, and investors the right information to make smart credit market decisions.
5. **Questions about Sustainable Aviation Fuel?** Our team of experts is available to provide specific analysis and tailored strategy for your unique needs.

Agenda

1. Airline industry goals to reduce GHGs
2. What is Sustainable Aviation Fuel (SAF)?
3. How much SAF supply is available?
4. What incentives are available to increase production?

Airline Industry Goals to Reduce GHGs

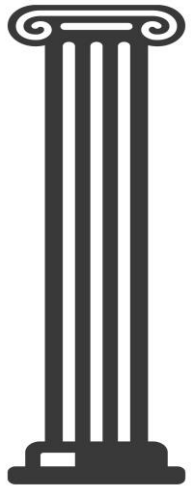
The airline industry has developed a strategy to reduce CO_2 emissions

These targets include:

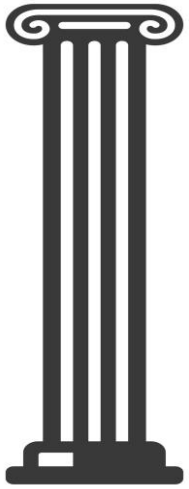
- Improve fuel efficiency by 1.5% per year from 2009 to 2020
- Cap net aviation CO_2 emissions at 2020 levels (CORSIA)
- Reduce net aviation CO_2 emissions by 50% relative to 2005 levels

The industry has a four-pillar strategy to meet the targets

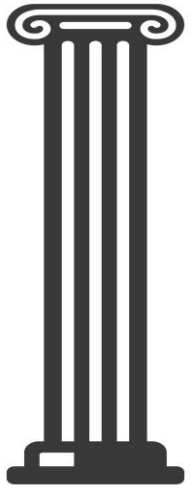
Deploying new technology, including SAF



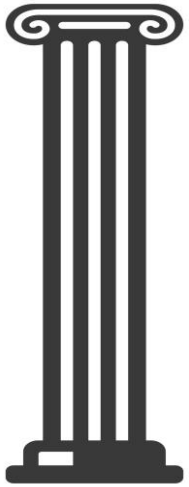
Improving aircraft operation efficiency



Improving and modernizing infrastructure, including air traffic management



A single Global Market-Based Measure (GMBM) to fill the remaining emissions gap (CORSIA)



Reducing the carbon in jet fuel will help reach reduction goals

What is Sustainable Aviation Fuel?

A Low-Carbon Solution

Source: United.com

SAF is a low-carbon, drop-in jet fuel

1. SAF is a blanket term for low-carbon jet fuel, also known as: renewable jet fuel (RJ), alternative jet fuel (AJF), or biojet
2. Made from renewable sources: woody biomass and forest residue; municipal solid waste (MSW); sugar; starch; cellulosic biomass; and fats, oils, and greases (FOG)
3. Production technologies include hydroprocessing esters and fatty acids (HEFA), Fischer-Tropsch (FT), and fermentation of sugars to create alcohol-to-jet synthesized paraffinic kerosene (ATJ-SPK)
4. Blended with conventional petroleum jet fuels
5. Carbon intensity can be up to 80% lower than petroleum jet fuel

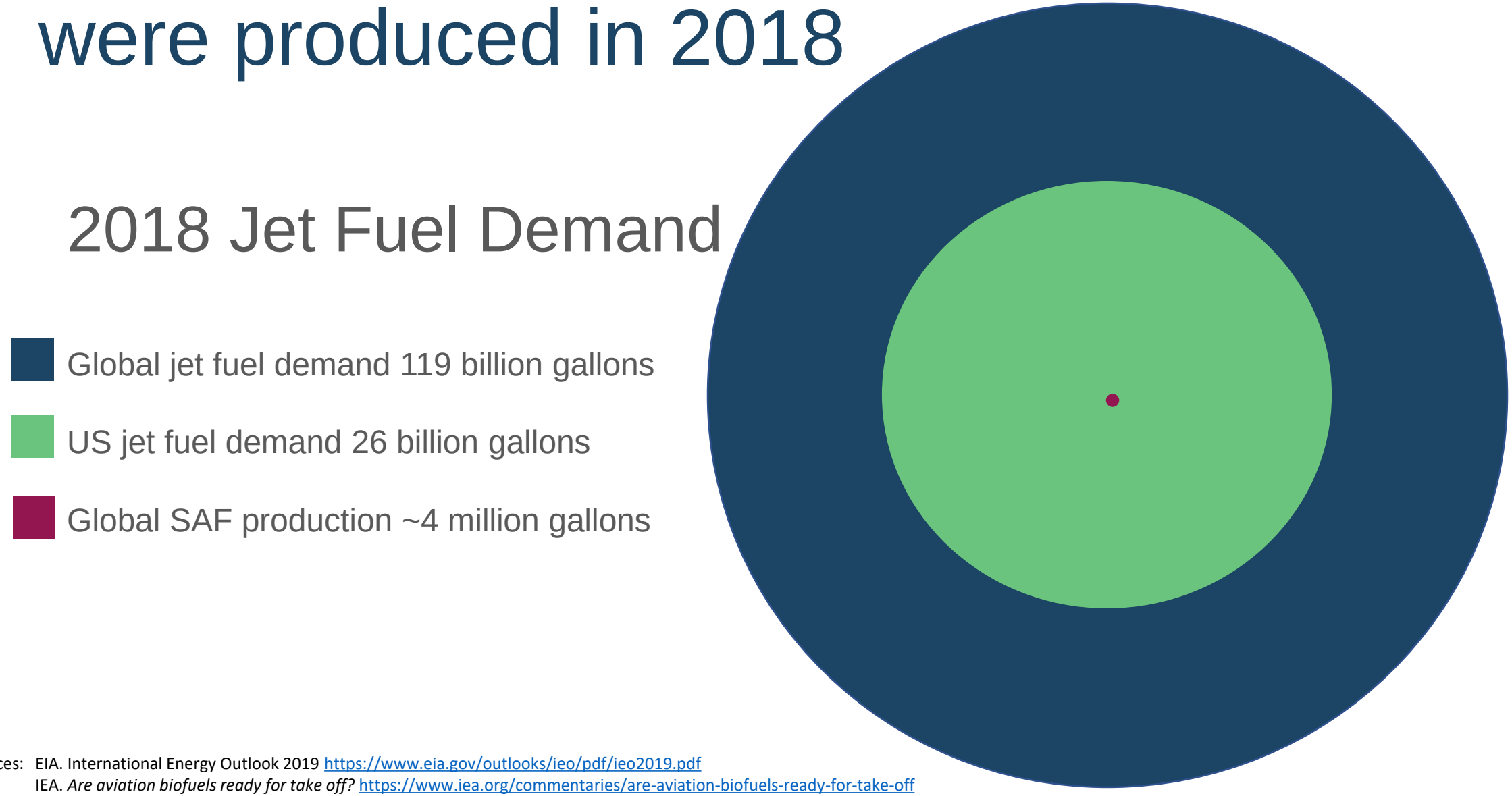
No need to modify aircraft engines and existing fuel distribution infrastructure

How much SAF is available?

Not much…yet

Slightly more than 4 million gallons of SAF were produced in 2018

2018 Jet Fuel Demand



Sources: EIA. International Energy Outlook 2019 https://www.eia.gov/outlooks/ieo/pdf/ieo2019.pdf
IEA. *Are aviation biofuels ready for take off?* https://www.iea.org/commentaries/are-aviation-biofuels-ready-for-take-off
EIA. Table F1: Jet fuel consumption, price, and expenditure estimates, 2018 https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_jf.html

The SAF industry in the U.S. is in the demonstration phase

Active and Planned SAF Facilities in the U.S.

Producer	Location	Current Capacity (mgy)	Planned Capacity (mgy)	When?	Off-Taker
World Energy	Paramount, CA	**4**	150	2020	United Airlines, World Fuel Services, Gulfstream, Air BP, and KLM
Gevo	Silsbee, TX and Luverne, MN	**0.1**	Not Public	2022-2023	Air Total SA, Lufthansa, Scandinavian Airline System (SAS), Delta, and Virgin Airways
Red Rock Biofuels	Lakeview, OR		15.1 total renewable fuels including SAF	2020	FedEx and Southwest Airlines
Fulcrum BioEnergy	Gary, IN		33 mgy total renewable fuels including SAF	2022	Air BP, United Airlines, Cathay Pacific
	Storey Co., NV		10.5 total renewable fuels including SAF	2020	
LanzaTech	Soperton, GA	**.0015**	10	2021	Virgin Airways and All Nippon Airways (ANA)
Northwest Advanced Bio-Fuels	Washington State		64	2024	Delta Airlines

Commercial volumes of SAF are coming from Renewable Diesel Producers

World Energy currently delivers 1 mgy of RJ to LAX. World Energy plans to expand to their Paramount facility to process 306 mgy of RJ, RD, and other renewable fuels by 2020.

Neste supplies RJ volumes to airports in Europe and have announced agreements in the U.S. with SFO, Alaska Air, Jet Blue, and UPS. They have a built capacity of 100,000 tonnes per year (or 34 mgy) of SAF, with plans for up to 1 million tonnes (340 million gallons) by 2022.

What incentives are available to increase production?

Airlines are competing to decarbonize

"Among all airlines around the world, United holds more than **50% of all publicly announced purchase commitments to using sustainable aviation fuels** and is the only U.S. carrier to currently use this fuel on a continuous basis." ~ United Airlines

"Starting in 2020, we've agreed to **purchase sustainable aviation fuel (SAF) from Neste**…and will start flying with SAF on flights from San Francisco. With agreements like these, JetBlue is helping to kick-start the market and lead the economics on these new evolutions." ~ jetBlue

"Delta's work to create a **sustainable future** continues with a long-term offtake agreement under which **Delta will purchase 10 million gallons per year of advance renewable biofuels from Gevo**." ~ Delta

"As part of Alaska Airlines' efforts to **fly greener and expand use of sustainable aviation fuels**, Neste and Alaska have signed a MOU…the agreement will allow Neste and Alaska to more closely work together to **design, create and implement solutions that lay the groundwork for the wider adoption of renewable fuels within the airline industry**." ~ Alaska Air

Airlines see the investment in and use of SAF as enhancing their value proposition

Policy incentives are required to overcome cost barriers

According to IATA, SAF production costs can be 2-7 times greater than petroleum jet fuel costs.

Renewable Fuel Standard (RFS)
+
Biodiesel Producer's Tax Credit (BTC)

+

California's Low Carbon Fuel Standard (LCFS)

+

Oregon's Clean Fuels Program (CFP)

=

Valuable Production Incentives

Based on current credit prices, RJ sold in California receives $5 of incentive per gallon

With industry investment and regulatory support, SAF will be a major factor in airline industry decarbonization.

Stillwater Associates

...experience runs deep

Thank you.

Questions?