Sustainable Aviation Fuel Updates and Recommendations:

Opportunities for Washington

Washington Alternative Jet Fuels Work Group

Report to The Washington State Governor and the Washington State Legislature

December 1, 2024

WASHINGTON STATE UNIVERSITY

Washington Alternative Jet Fuels Work Group Facilitators

The Washington Alternative Jet Fuels Work Group (AJF Work Group), formerly the Sustainable Aviation Biofuels Work Group, was convened by the Washington State University Office of National Laboratory Partnerships, formerly the Office of Clean Technology, as required by RCW28B.30.646.[1] Information and policy recommendations contained in this report are intended to reflect the statements, opinions, and decisions of the AJF Work Group as a whole, and do not necessarily reflect the position of member organizations or the university. Furthermore, this report should not be construed as an expression of support or opposition for any existing program or recommended policy by any legislative members of the AJF Work Group.

The WSU Office of National Laboratory Partnerships manages the institutional coordination between WSU and federal agency national laboratories. WSU has its largest relationship with Pacific Northwest National Laboratory (PNNL). WSU-PNNL have two joint research institutes: the Bioproducts Institute and the Advanced Grid Institute. Additionally, there is a WSU-PNNL Nuclear Science and Technology research community. The WSU-PNNL partnership has supported support over 40 faculty-level joint appointments, and over 40 Ph.D. students in the WSU-PNNL Distinguished Graduate Research Program.

The AJF Work Group facilitation team includes:

- Carol Sim, Washington State University
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Washington State University
Port of Seattle

Washington Alternative Jet Fuels Work Group Participants

Academia
- Washington State University

Agencies/Local Government
- Department of Commerce
- Department of Ecology
- Department of Natural Resources
- Department of Transportation
- U.S. Department of Agriculture

Aircraft Manufacturer
- The Boeing Company

Airlines
- Alaska Airlines
- Southwest Airlines
- Airlines for America (A4A)

Airports & Ports
- Port of Longview
- Port of Seattle - Seattle International Airport
- Snohomish County/Paine Field
- Washington Public Ports

Environmental/NGOs
- *Clean Energy Transition Institute*
- *Climate Solutions*
- *Sierra Club*

Feedstock Suppliers (Potential)
- International Paper
- King County Solid Waste Division

Fuel Producers/Suppliers
- bp America
- Gevo
- Neste
- Northwest Advanced Bio-Fuels
- LanzaJet
- Par Pacific
- SkyNRG America
- Twelve
- World Energy

National Laboratories
- Pacific Northwest National Laboratory/WSU Bioproducts Institute

Public-Private Partnerships
- Commercial Aviation Alternative Fuels Initiative (CAAFI)

Trade Organizations/Market Development
- Clean Fuels Alliance America
- Earth Finance
- Low Carbon Fuels Coalition
- Molecule
- Noyes Law Corporation

Elected Officials: Representatives*
- Rep. Mary Dye, 9th Legislative District
- Rep. Joe Fitzgibbon, 34th Legislative District
- Rep. Vandana Slatter, 48th Legislative District

Elected Officials: Senators*
- Sen. Andy Billig, 3rd Legislative District, AJF Work Group Chair
- Sen. Curtis King, 14th Legislative District
- Sen. Marko Liias, 21st Legislative District, AJF Work Group Chair Elect
- Sen. Liz Lovelett, 40th Legislative District

Observers**
- Amazon
- Aether Fuels
- BlueGreen Alliance (BGA)
- CarbonQuest
- G. Scott Richards, LLC
- Greater Spokane, Inc.
- Insight Strategic Partners
- Jacobs
- Northwest Community Partners, LLC
- Propeller Airports
- Warren Group
- Water Street Public Affairs

Invited Presenters
- International Council on Clean Transportation (ICCT)
- Roundtable on Sustainable Biomaterials (RSB)

* *Several legislative staff members also attended the meetings*

** *Observers attended AJF Work Group meeting(s) in 2023-2024*

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Washington Alternative Jet Fuels Work Group, 2023-2024

The Washington AJF Work Group seeks to further the development of sustainable aviation as a productive industry in Washington state. Through RCW 28B.30.646, the AJF Work Group is continued through December 2028.[1] The legislation appointed the Washington State University Office of Clean Technology, now the Office of National Laboratory Partnerships, as the convening body. The AJF Work Group is directed to provide a report, including any pertinent recommendations, to the governor and appropriate committees of the legislature by December 1, 2024, and December 1st of every even-numbered year until December 1, 2028.

In this report, when referring to federal legislation the term Sustainable Aviation Fuel (SAF) is used. When referring to Washington state legislation and the California Air Resources Board, the broader term Alternative Jet Fuel (AJF) is used. This report builds on the AJF Work Group's 2022 report, *Sustainable Aviation Fuel-Updates and Recommendations (Opportunities for Washington)*,[2] previous statewide and regional partnerships which document the need for, and challenges with, siting and funding SAF production facilities. It also provides updates on national and international developments that support SAF development and deployment.

The facilitation team convened the Washington AJF Work Group to share information and updates, identify opportunities, and develop consensus recommendations. The Washington AJF Work Group met virtually in July 2023, and in-person September 2023, May 2024, and September 2024. A subcommittee was formed to draft policy recommendations for consideration by the full Washington AJF Work Group membership. The subcommittee met virtually in June, July, August, and October 2024. During the September 2024 meeting, the full Washington AJF Work Group discussed and refined the outline and policy recommendations for this report.

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Executive Summary: Background

The AJF Work Group continues to benefit from the Washington legislature passing the Clean Fuel Standard program (CFS). There is an opportunity to align Washington's SAF and broader clean fuel policy with all U.S. West Coast states and British Columbia, which will help drive low carbon fuel deployment in the West.

Washington is a global leader in the aerospace industry and has the potential to lead in aviation decarbonization efforts. Prominent Washington aviation-related businesses and large multi-national companies support SAF development in the state. To be a leader, a stable, long-term policy framework and incentives are necessary to attract and retain a robust SAF industry, and to attract other companies to the state. In July 2023 SB 5447 became effective and is promoting the AJF industry in Washington.[3] The legislation includes a preferential Washington Business and Occupation (B&O) tax rate of 0.275 percent on the manufacturing and wholesaling of AJF.

SKYNRG Americas Inc. announced in 2024 it is working to establish a SAF, and renewable diesel production facility located at the Port of Walla Walla's Wallula Gap Industrial Business Park.[4] The facility, known as Project Wigeon, will have the capacity to produce 50 million gallons annually. Twelve Benefit Corporation has also announced its plans to establish an E-Jet® power-to-liquids (PtL) SAF facility in Moses Lake with an approximate capacity of 50,000 gallons per year.[5]

Nationally, the U.S. Department of Agriculture (USDA), Department of Energy (DOE), and Department of Transportation (DOT) released the *SAF Grand Challenge Roadmap: Flight Plan for Sustainable Aviation Fuels* in September 2022, which details action areas and work streams to achieve the Grand Challenge's aggressive SAF goals.[6] In September 2024, the USDA, DOE, and DOT released the *SAF Grand Challenge Metric Dashboard Factsheet*.[7]

This new Metrics Dashboard Fact Sheet included key accomplishments from the federal agencies:

- Domestic SAF use has grown 10x. Since the SAF Grand Challenge was announced in 2021, annual SAF production and imports have grown from 5 million gallons to 52 million gallons through the first six months of 2024.

- Based on active projects in the U.S., possibly 2.6 and 4.9 billion gallons per year of SAF could be produced domestically by 2030, potentially creating a pathway to achieve the 2030 SAF Grand Challenge goal.

In March 2024, DOE released the updated *2023 Billion-Ton Report: An Assessment of U.S. Renewable Carbon Sources*,[8] and USDA released the complementary reports on *Building a Resilient Biomass Supply*[9] and *Implementation Framework*[10] to assess the potential biomass resources in the U.S. and to explore updates to available input data on the quantity, price, geographical density, distribution, and market maturity of America's sustainable, renewable carbon resources.

For the first time, in October 2024, the DOE Loan Program Office issued conditional commitments to Montana Renewables for up to $1.44 billion and to Gevo for up to $1.46 billion to produce SAF. [11,12]

In August 2024, the Federal Aviation Administration (FAA) announced $291 million in Inflation Reduction Act grant funding for projects that help reduce aviation greenhouse gases emissions.[13] In the Pacific Northwest, bp Products North America (Whatcom County, WA), and Phillips 66 Company (Portland, OR), were selected for Fueling Aviation's Sustainable Transition (FAST) SAF grants. The Boeing Company (Tukwila, WA), and ZeroAvia Federal, Inc. (Everett, WA) were selected for FAST-Technologies to Improve Fuel Efficiency and Reduce Emissions (TECH) grants.

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In April 2024, the U.S. Department of the Treasury, and the Internal Revenue Service (IRS), working closely with the DOE, DOT, USDA, and the Environmental Protection Agency (EPA) approved the GREET model for determining lifecycle analysis (LCA) emissions reduction to receive SAF credits under section 40B of the Inflation Reduction Act for the sale or use of SAF.[14]

There is significant activity outside of the Western states to promote SAF, including but not limited to:

- Minnesota established a refundable tax credit in 2023 equal to $1.50 per gallon for SAF with at least 50% emission reduction compared to it fossil equivalent that is produced or blended as well as sold and used in the state.[15]

- Nebraska adopted its SAF Tax Credit Act in April 2024.[16]

- In March 2024 New Mexico adopted the Clean Transportation Fuels Standard (CTFS), under which it is anticipated that SAF will be deemed a creditable fuel on a voluntary, opt-in basis.[17]

- Illinois established the tax incentive, the SAF Purchase Credit, that gives air carriers a credit of $1.50 per gallon of SAF purchased or used in the state.[18]

Internationally, there is significant activity on advancing SAF. The provincial government of British Columbia updated its Low Carbon Fuels Act in 2023 and mandated the use of low carbon jet fuel.[19] The new rules stipulate that renewable fuel constitutes a minimum of 1% of jet fuel starting in 2028, escalating to 2% in 2029, and 3% in 2030 and subsequent compliance periods. In October 2023, the European Union (EU) adopted the ReFuel EU Aviation Regulation,[20] which mandates the use of SAFs that have lower CO_2 emissions than fossil jet fuel. Fuel suppliers in Europe will have to incorporate 2% SAF in 2025, 6% in 2030, and 70% in 2050. Starting from 2030, 1.2% of fuels must also be synthetic fuels, rising to 35% in 2050. On January 1, 2025 the UK Government will begin implementing a SAF mandate that sets progressive targets for aviation fuel suppliers to provide increasing amounts of SAF from 2025-2040.[21] Initially 2% of jet fuel supplied in 2025 must be SAF, increasing to 10% in 2030, and 22% in 2040. Many other governments around the globe are considering SAF mandates and/or incentives.

Executive Summary: Recommendations

Property/Leasehold Tax Exemption for AJF facilities

- All property/leasehold interests in buildings, machinery, equipment, and other personal property which are used substantially for the manufacturing or blending of AJFs (as defined in RCW 70A.535.010), the land upon which this property is located, and land that is reasonably necessary in the manufacturing or blending of AJF, but not land necessary for producing feedstocks, which together comprise a new manufacturing or blending facility or an addition to an existing manufacturing or blending facility, are exempt from state leasehold taxes for a period of ten years from the date on which the new facility or the addition to the existing facility becomes "operational". [22]

Climate Commitment Act (CCA) Infrastructure Grant Program

- Designate funding for an AJF program to include research, development, demonstration, engineering designs, production facility, blending and use of AJF infrastructure under CCA grant funding.

Construction Sales Tax Deferrals

- The AJF Work Group supports modification of the existing construction tax deferral, Sales, and Use Tax Deferral Program for Clean Energy Investment Projects. The AJF Work Group would like this to apply to the construction of AJF facilities for not only production, but also add language for the installation of blending, storage, and fueling infrastructure of AJF, in addition to storage and fueling infrastructure for Zero Emission Vehicles (ZEVs), hydrogen, and electricity currently in RCW 82.89.010.[23]

Permitting

- Direct and fund the Department of Ecology to complete a study that would inform one or more Programmatic Environmental Impact Statement(s) (PEIS) for AJF production pathways.
- The AJF Work Group wishes to acknowledge that flexibility with permitting processes is encouraged for potential AJF facilities in Washington state to choose the optimal permitting process for their scenario.

Federal Policy Engagement

- The Washington congressional delegation should encourage the federal government to extend the time frame on federal tax credits for SAFs, preferably for a timeframe more consistent with construction of facility and investor requirements.

- The Washington congressional delegation thanks the FAA for the four the FAST grant program awards in Washington State (Bp America, ZeroAvia, APiJET, The Boeing Company). The Washington congressional delegation should encourage and support additional funding for the FAA to expand the FAST grant program.

For full details on the recommendations and background please refer to the Recommendations section below in the document (pages 22-24).

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Washington State Updates

Fuel Producer Update

- **bp** announced, in 2023, plans to deliver five biofuel projects across the globe that would focus on SAF production. The Cherry Point, Washington refinery was one of five refineries selected. In the spring of 2024, the company indicated that it is scaling back plans for development of new SAF and renewable diesel projects at its existing sites and that it will pause two of the SAF projects it had been considering. Email correspondence with a bp senior manager on the west coast indicated the Cherry Point refinery was one of the projects that were paused, and bp will instead focus on coprocessing of bio-feedstocks at the facility.

  The three projects that will continue to be assessed are in Kwinana, Australia; Castellon, Spain; and Rotterdam, the Netherlands.

  In August 2024, the FAA announced that bp Cherry Point was awarded a $27 million FAST-SAF grant to enable SAF in the Pacific Northwest through production and blending.[13] This grant will support coprocessing development at the facility. bp estimates being able to produce 10 million gallons of SAF annually. This new project would create 96 new jobs. bp's SAF production will be key to supplying SAF to airports in the region via the Olympic Pipeline.

- **SkyNRG** announced, in 2024, a SAF and renewable diesel production facility located at the Port of Walla Walla's Wallula Gap Industrial Business Park. The facility, known as Project Wigeon, will have the capacity to produce 50 million gallons annually.[4] Construction is expected to begin in 2026 and the facility is expected be operational in 2029. The facility will support 600 construction jobs and support up to 100 jobs once operations begin. Project Wigeon is supported by The Boeing Company and other partners with offtake agreements.

- **Twelve** and International Airlines Group (IAG) signed a 14-year, 260 million gallons PtL SAF purchase agreement in 2024. Twelve broke ground in Moses Lake, Washington in July 2023 on its first production facility, to be called AirPlant™ One, which will produce E-Jet® fuel (as well as E-Naphtha™) from biogenic CO2, water, and renewable energy.[24] Twelve's E-Jet® fuel is expected to achieve lifecycle GHG emissions up to 90% lower than conventional fossil jet fuel. In September 2024, Twelve announced an additional $645 million in funding led by TPG Rise Climate, and other leading funders in the renewable energy sector.[25] AirPlant™ One is expected to become operational in mid-late 2025 and eventually will produce five barrels per day, including approximately 50,000 gallons per year of E-Jet® fuel. Construction of the facility has involved roughly 200 construction-related jobs. Once operational, the facility will provide additional, permanent clean energy jobs for Moses Lake and the surrounding area, furthering the region's strength in the aviation industry and the clean energy transition.

- **Northwest Advanced Bio-Fuels (NWABF)**, a renewable bio-jet fuel refineries developer, announced Fluor Corporation as its Engineering, Procurement and Construction (EPC) contractor of record in April 2023.[26] In August 2023 NWABF selected IHI Power Services Corp. (IPSC), an owner and operator of U.S. power plants, to provide pre-mobilization, mobilization, start-up, and commissioning services for NWABF's development of a second-generation cellulosic renewable bio-jet fuel production facility in the Pacific Northwest.

Photo credit: Washington State University

Research and Development Update

Snohomish County is establishing a world-leading Sustainable Aviation Fuels (SAF) Center at Paine Field Airport.[27] In 2023, the county received a crucial $6.5 million allocation from the Washington State Legislature to begin developing the SAF Center. This project will have a significant impact on the climate economy locally and worldwide and could create widespread investment and jobs in our region. Snohomish County has four key goals as part of this initiative:

- Attract international investment to spur innovation and create jobs within the climate economy.
- Address the skills shortage and continue our efforts to create a gold-standard workforce development system by connecting local youth and dislocated workers with high-quality jobs in the field.
- Bridge the gap between academia and industry by partnering with national and international institutions.
- Lead the world in the development, distribution, and adoption of new technologies to reduce the economy's dependence on carbon-based fuels.

The SAF Center is envisioned to evolve into a multifaceted facility consisting of a distribution hub called a "repository" for bioproducts at various fuel technology readiness levels, a combustion test facility, some level of bioproducts refinement capability starting with distillation, and an advanced rheology laboratory, as well as all auxiliary systems. Paine Field is a suitable location for all facets of the Center. Snohomish County has led coordination of project partnerships, support, and feedstock suppliers and producers, as well as the development of a temporary SAF facility thus far.

The SAF Center will yield future outcomes that will offer vital support for regional SAF efforts in four main ways:

1. Repository for testing and distribution.
2. Research to reduce costs and environmental impact.
3. Large-scale testing for product safety and development.
4. Workforce development training in the specialized SAF field.

The comprehensive SAF repository will have the capacity for efficient data management, secure storage, and widespread distribution related to SAF. It will mark a pioneering achievement as a first-of-its-kind facility dedicated to advancing SAF technologies and addressing the global demand for reference samples that underpin ongoing research efforts. The repository will serve as a hub for blending and storage of SAF samples derived from both commercial and experimental production methods. In essence, the repository will play a role akin to that of seed banks in agricultural research, meticulously indexing, analyzing, and disseminating samples across the globe, thus establishing itself as an unrivaled global hub for essential information related to SAF properties, feedstock origins, pathway fuel batches, and more.

Washington Fueling Aviation's Sustainable Transition (FAST) Grant Recipients

The FAA announced $291 million in Inflation Reduction Act grant funding for projects that help reduce aviation greenhouse gas emissions.[13] The Fueling Aviation's Sustainable Transition (FAST) program provides:

- $244.5 million for projects that support the build out of infrastructure projects related to SAF production, transportation, blending, and storage, and for scoping studies related to infrastructure needs for SAF (named FAST-SAF). Tier 1 FAST-SAF grants are projects conducting SAF supply chain studies to identify infrastructure needs. Tier 2 projects are building infrastructure for SAF production, transportation, blending and storage.

- $46.5 million for low emission technologies to develop and demonstrate new aviation technologies to improve fuel efficiency and reduce emissions (FAST-TECH). Category 1 FAST-TECH grants are developing low-emission aviation technologies and Category 2 grants are for projects developing test capabilities to advance low-emission technologies.

Four Washington companies and one Oregon company were awarded FAST grants. A brief description of each project is provided below.

FAST-SAF

bp Products North America- Whatcom County, WA- $26,763,504 – Tier 2

The grant will support the initial development and integration of SAF production and blending at bp's Cherry Point Refinery in Washington state which is key for enabling SAF in the Pacific Northwest. The project will focus on integrating SAF into the refinery's operations, ensuring that the produced fuel meets the stringent requirements for aviation use while contributing to the reduction of greenhouse gas emissions. The project is estimated to be able to produce 10-25 million gallons of SAF per year.

Phillips 66 Company- Portland, OR- $11,299,500 – Tier 2

The project will enable SAF blending at the Phillips 66 Portland terminal, and it will provide storage for inbound neat SAF and hydrocarbon jet fuel receipts via marine vessel and from the Olympic pipeline and outbound transfer of up to 180,000 barrels per month (7,560,000 gallons) of blended SAF to Portland International Airport (PDX).

FAST-TECH

The Boeing Company- Tukwila, WA, Berkely, MO and Fairfax, VA- $2,595,522 – Category 1

The grant entitled SAF Quality Indication and will develop a method of fuel energy content (quality) indication as part of a new suite of technologies aimed at improving the measurement of fuel in an airplane fuel tank. This project will enable more accurate fuel load calculation, which is essential for optimizing aircraft performance and reducing fuel consumption. The technology will support the aviation industry's transition to SAF by ensuring that fuel quality is consistently maintained, thereby enhancing operational efficiency and sustainability.

ZeroAvia Federal, Inc. Everett, WA- $4,235,000 – Category 1

The grant entitled Project Hydrogen Aircraft Engine Zero Emission Leap-Design, will support ZeroAvia's work to further develop and validate its electric propulsion system designed for 2-5 megawatt powertrain applications. The research and development work will take place in ZeroAvia's Everett, WA propulsion center of excellence and will advance the design, fabrication, and testing of its proprietary electric motor and inverter toward eventual certification and commercial deployment.

APiJET LLC, Seattle, WA -$4,500,000 – Category 1

The grant entitled Optimizing Flight Routes using Real-Time Operating Constrains for Maximum Reduction of CO_2 Emissions via Scalable Ground-Based Software will enhance a ground-based software tool for use by airlines that recommends fuel optimized aircraft routings. This project will enable APiJET LLC to make its technology to optimize flight paths in real time available to more aircraft types helping airlines achieve substantial fuel costs savings while contributing to the aviation industry's broader sustainability goals with emission reductions.

JetZero, Inc., Long Beach, CA $8,035,236 – Category 1

JetZero Inc. is a new partner of Alaska Airlines. The grant is entitled Blended Wing body Lightweight Composite Structures will develop key enabling technologies required to bring Blended Wing Body (BWB) technology to the market. The BWB design, which integrates the fuselage and wings into a single, cohesive airframe, offers a significant leap forward in fuel efficiency, reducing fuel burn and emissions by up to 50% compared to conventional aircraft. The grant will focus on producing lightweight composite structures capable of supporting non-cylindrical pressure vessels, and producible at rates required to meet market demand.

Regional Stakeholder Update

- **Pacific Northwest Coalition to Accelerate SAF Production**

  At an Alaska Airlines-DOE-Wells Fargo SAF Workshop in October 2024, Alaska Airlines announced that Earth Finance, Alaska Airlines, Boeing, WSU, PNNL, and Snohomish County were building a Pacific Northwest Coalition to rapidly accelerate SAF production by leveraging the regions unique capabilities. The Coalition believes the SAF ecosystem will require a systemic change across five integrated pillars: policy, feedstocks and energy, infrastructure, financing, and research and development to have production and deployment of SAF across the Pacific Northwest. Alaska Airlines committed funding to the effort and welcomed other entities to join the Coalition of stakeholders from across the entire SAF value supply chain in the Pacific Northwest.

- Center for Climate and Energy Solutions (C2ES)
  The Center for Climate and Energy Solutions (C2ES) forges practical and innovative solutions to address climate change and engages with leading businesses to accelerate climate progress. Founded in 1998 as the Pew Center on Global Climate Change, C2ES is known worldwide as a thought leader and trusted convener on climate change and energy.[28]

  C2ES hosted a SAF stakeholder roundtable in Seattle in April 2024 to develop federal policy recommendations to promote SAF development and deployment entitled *Scaling Sustainable Aviation Fuel: Recommendations to Federal Policy Makers from Washington State*.[29] C2ES hosted a fly-in to Washington, DC in July 2024 to meet with federal legislators to lobby for SAF policy.[30] Many members of the AJF Work Group participated in the workshop and the recommendations.

Other Activities

- **Port of Seattle/King County Solid Waste Division, Municipal Solid Waste to Liquid Fuels Study**
  The Port of Seattle and King County published the *Municipal Solid Waste-to-Liquid Fuels Study* in June 2023 to explore the feasibility of SAF production from municipal solid waste (MSW) to reduce greenhouse gas emissions and landfilled waste in the region.[31] The study indicated that there is adequate MSW in Washington and northern Oregon to support one or more SAF production facilities, but there are many obstacles and challenges to bringing a project to fruition. The need for further fuel technology development was identified as one of the biggest challenges. Commercial MSW-to-SAF facilities are still in their early stages, and it is not yet clear how efficient and cost-effective they will be.[32]

- **Washington State Academy of Sciences, Sustainable Aviation Symposium**
  In August 2023, the Washington State Academy of Sciences (WSAS) held a sustainable aviation symposium, bringing together regional stakeholders and members of the legislature. The symposium discussed the difficult technical and policy issues and workforce development needs that must be addressed to achieve aviation decarbonization. The symposium proceedings were published in the *Sustainable Aviation in Washington State: Connecting Policy, Technology, Infrastructure & Workforce Development Needs report.*[33]

- **Washington Alternative Jet Fuels Work Group response to U.S. Department of Energy Request for Information on Sustainable Aviation Fuel Grand Challenge: Building Supply Chains**
  In September 2023, the DOE Bioenergy Technologies Office (BETO) issued a Request for Information (RFI) regarding SAF Grand Challenge: Building Supply Chains.[34] The AJF Work Group provided a detailed overview of the supply chain development work conducted in Washington and the Pacific Northwest for over a decade. The AJF Work Group's response is provided in the Appendix. In May 2024, some of the AJF Work Group's comments were published the *Sustainable Aviation Fuel Grand Challenge: Building Supply Chains Summary Report.*[35]

Sustainable Aviation Fuel Grand Challenge

As noted in the AJF Work Group's 2022 report to the legislature, in late 2021 the U.S. government announced the *Sustainable Aviation Fuel Grand Challenge*.[36] The goal of the SAF Grand Challenge is to accelerate the development and deployment of a sufficient supply of SAFs to meet 100% of the domestic aviation fuel demand by 2050 while achieving a minimum of a 50% reduction in life cycle greenhouse gas emissions compared to conventional fuel. The SAF Grand Challenge sets U.S. SAF production goals of 3 billion gallons per year by 2030 and 35 billion gallons per year by 2050. The U.S. Departments of Transportation, Energy, and Agriculture released the *Sustainable Aviation Fuel Grand Challenge Roadmap: Flight Plan for Sustainable Aviation Fuel*[6] in September 2022, which details action areas and work streams to achieve the Grand Challenge's aggressive SAF goals.

In September 2024, the USDA, DOE, and DOT released the *SAF Grand Challenge Metric Dashboard Factsheet*.[7] The new Metrics Dashboard Fact Sheet includes key accomplishments from the federal agencies:

- Domestic SAF use has grown 10x. Since the SAF Grand Challenge was announced in 2021,[36] annual SAF production and imports have grown from 5 million gallons to 52 million gallons through the first six months of 2024.
- The U.S. has a potential pathway to meet the ambitious 2030 SAF Grand Challenge target. Based on active projects, between 2.6 and 4.9

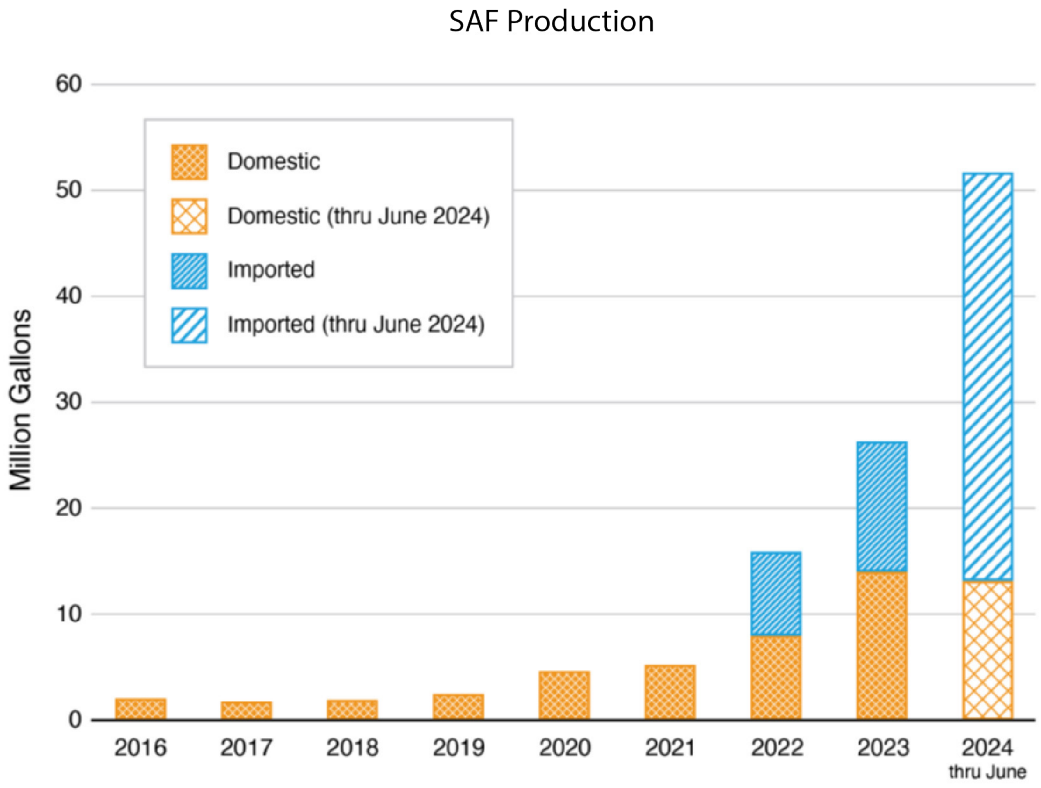

Figure 1. Source data for the future potential volumes will be available in a forthcoming ASCENT 01 publication. Brandt, K; Wolcott, M. (2024).
Renewable Diesel (RD) data source: U.S. Energy Information Administration.[38]
SAF data source: EPA. "Public Data for the Renewable Fuel Standard." [7,37]

Photo credit: Washington State University

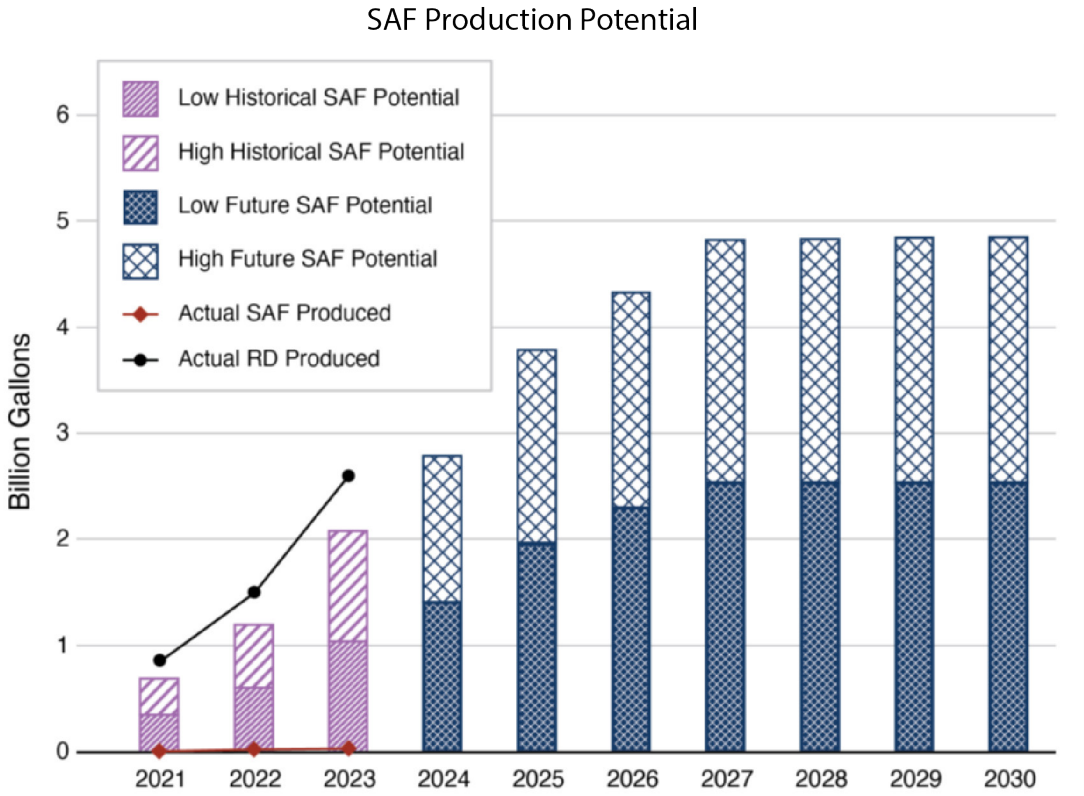

Figure 2. "Based on a database of active projects, between 2.6 and 4.9 billion gallons per year of SAF may be produced by 2030…"[7] Please note "Active projects are RD and SAF projects that are either currently producing, in construction, or announced and proceeding with development. To be included, projects must have publicly announced start date, conversion technology, and capacity."[7] While progress has been made since 2021, there is still a significant, comprehensive amount of work to be done before 2030.

billion gallons per year of SAF may be produced domestically by 2030, creating a potential pathway to achieve the SAF Grand Challenge near-term goal. However, much of this potential volume is from existing renewable diesel facilities that will need significant, secure, long-term policies to overcome the policy advantages provided to renewable diesel production and promote switching production to SAF.

- U.S. SAF production is cutting emissions. More than 300,000 metric tons of CO_2 have been reduced through June 2024 with U.S. SAF production.

"Based on U.S. Environmental Protection Agency (EPA) Renewable Identification Number (RIN) values, SAF annual domestic production and imports grew from 5 million gallons in 2021 to 26 million gallons in 2023; 52 million gallons have been produced and imported through June 2024."[7] Based on U.S. EPA RIN values, U.S. SAF domestic production and imports combined have grown to 103 million gallons by October 2024.[37]

In November 2024, the USDA, DOE, and DOT, released the report *SAF Grand Challenge Roadmap Implementation Framework*.[39] The Implementation Framework highlights current Federal agency capabilities and programs aligned with the actions called out in the SAF Grand Challenge Roadmap[6] and identifies existing gaps where additional effort, public-private partnerships, and support will be needed to meet the goals set forth in the SAF Grand Challenge.[36] The gaps include:

- Creating certainty in U.S. government policy to support the build-out of SAF supply chains.
- Expanding and improving both data, and analysis, and enhancing models to perform transparent and credible SAF supply chain analysis to inform business models and policy development.
- Expanding purpose-grown feedstocks and tapping the potential of waste and residual feedstocks.
- Optimizing economically viable and sustainable feedstock supply chains.

- Leveraging existing ethanol and petroleum industry infrastructure to accelerate scale-up and deployment of large volumes of SAF.
- Reducing the risk of scale-up of new technologies and significantly enhancing regional coalition-building.
- Communicating SAF Grand Challenge progress and benefits transparently and effectively.

Additional progress on meeting the SAF Grand Challenge goals are described below and are available on the participating agency websites.

Department of Agriculture

The USDA rolled out the *Building a Resilient Biomass Supply: A Plan to Enable the Bioeconomy in America*[9] and *Implementation Framework for a Plan to Enable the Bioeconomy in America: Building a Resilient Biomass Supply*[10] reports in March 2024 which "define bold goals and new priorities to catalyze action inside and outside of government to advance America's domestic bioeconomy and directs USDA agencies to support the plan." Elements of the Implementation Framework that may be of interest in Washington state include:

- Develop the next generation of biomass feedstocks and increase the use of cover crops.
- Improve access and utilization of woody biomass for biobased products.
- Invest in resilient infrastructure and capacity to utilize biomass feedstocks for more jobs and stronger rural economies.
- Support new and better markets for biobased products and drive demand for biomass feedstocks.
- Promote climate-smart practices to enhance productivity and sustainability of biomass feedstocks.

The USDA report complements the DOE's updated 2023 Billion-Ton Report-An Assessment of U.S. Renewable Carbon Sources, published in March 2024.[8]

Department of Energy

The DOE's 2*023 Billion-Ton Report* includes assessments of potential biomass resources in the U.S. and explores updates to latest available data input data on the quantity, price, geographical density and distribution and market maturity. The report found that the U.S. has the potential to produce from 1.1 to 1.5 billion tons of biomass annually in a future mature market. One billion tons per year of biomass is roughly enough biomass to produce approximately 60 billion gallons of fuel, or 1.7 times the quantity needed to achieve the SAF Grand Challenge while meeting demands for food and environmental services. The report proposed near-term (next 5-10 years) resources can provide approximately 350 million tons per year of biomass above current uses, which would roughly double the current U.S. bioenergy economy.

This report compared to prior Billion-Ton reports included the new resources:

- Intermediate (i.e., off-season) oilseeds.
- Western forest fuels (as case studies, not included in national totals).
- Macroalgae and point-source waste carbon dioxide (CO_2).

Market pull is needed to realize the potential production of biomass resources reported in the report.

In July 2024, National Renewable Energy Laboratory (NREL), in partnership with DOE BETO, released the first two parts of the SAF State-of-Industry Report which focuses on how to achieve the near-term fuel production goals set forth in the SAF Grand Challenge.

- **Part 1 - State of SAF Production Process**: Part 1 examines the overall state of the SAF production process and covers challenges and gaps in meeting near-term targets associated with the SAF Grand Challenge.[40] This segment of the report is designed to address broad challenges facing the bioenergy industry when producing SAF and is not specific to any single feedstock or production pathway.
- **Part 2 - Hydroprocessed Esters and Fatty Acids Pathway**: Part 2 focuses on evaluating the current supply chain for the Hydroprocessed Esters and Fatty Acids (HEFA) pathway.[41] Facilities using this pathway are already producing volumes of liquid fuel today, and they are expected to play a major role in meeting the 2030 production target

from the SAF Grand Challenge. This segment of the report looks at potential obstacles that could hinder the commercial production and use of SAF from these facilities.

In October 2024, the DOE Loan Program Office issued conditional commitments to two companies to produce SAF for the first time:

- **Montana Renewables**, a subsidiary of the industrial manufacturer Calumet, could receive a loan guarantee of up to $1.44 billion to expand its existing renewable fuels facility in Great Falls, Montana.[11] The company makes biofuels for planes and trucks using vegetable oils and leftover animal fats and greases. The expansion would allow Montana Renewables to produce about 315 million gallons per year of biofuels, most of which will be SAF.
- **Gevo**, based in Colorado, could receive a loan guarantee of up to $1.46 billion to build a new jet-fuel refinery in Lake Preston, South Dakota.[12] The facility, named Net-Zero 1, would turn corn into ethanol to produce up to 60 million gallons of SAF per year. Because the ethanol-making process creates carbon dioxide emissions, Gevo is planning to capture CO_2 at the refinery and send it via pipeline to a storage site in North Dakota.

In November 2024, the DOE released the report *Pathways to Commercial Liftoff: Sustainable Aviation Fuel.*[42] The SAF Liftoff report provides a roadmap for how the public and private sector can collectively accelerate the commercialization of SAF technologies in the U.S. economy by 2030 and beyond. The SAF Liftoff report identifies three synergistic imperatives that must be met to establish SAF commercial viability in the U.S.:

1) Scale Supply: 8-12 operational, commercial scale production facilities (with an average 100 million gallons per year capacity each).
2) Long-Term Demand: Normalized >10-year offtake agreements with airlines.
3) Supportive Policy: Robust supply and demand side policy in the U.S. and abroad.

Inflation Reduction Act Update

Federal Aviation Administration

As mentioned in the Washington State update above, in August 2024 the FAA, Office of Environment and Energy announced $291 million in Inflation Reduction Act grant funding for projects that help reduce aviation greenhouse gases emissions.[13]

U.S. Department of the Treasury

The U.S. Treasury Department and IRS approved the GREET model for determining lifecycle analysis (LCA) emissions reduction to receive SAF credits under section 40B of the Inflation Reduction Act. Revisions were released in April 2024.[14] Fuels that meet the 50% emission reduction requirements under Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) will also be eligible for credits.

The SAF Credit 26 U.S. Code 40B provides a tax credit for the sale or use of SAF, which achieves a lifecycle greenhouse gas emissions reduction of at least 50% as compared with petroleum-based jet fuel producers and blenders of SAF-jet fuel mixtures for aviation.[43] The base credit amount is $1.25/gallon of SAF. There is a bonus credit amount of $0.01/gallon for each percentage point by which the SAF lifecycle greenhouse gas emissions are reduced above 50 percent compared to petroleum-based jet fuel, up to $0.50/gallon. Qualified SAF mixture and fueling of the aircraft must occur in the U.S. The SAF credit 40B is available January 1, 2023, to December 31, 2024.

Legislative Activities

Federal Aviation Administration

The FAA reauthorization bill, Section 1017,[44] signed on May 16, 2024, continues the operation of the Center of Excellence for Alternative Jet Fuels and Environment, commonly known as the Aviation Sustainability Center or ASCENT.[45] The Center, directed by Washington State University and Massachusetts Institute of Technology, includes 16 partner universities researching the "development, quantification and certification of aviation fuels from alternative or renewable sources (such as biomass, next-generation feedstocks, alcohols, organic acids, hydrogen, bio-derived chemicals and gaseous carbon) for commercial aircraft. In addition, ASCENT "assists in informing the safe use of alternative aviation fuels in commercial aircraft that also apply to electrified and hydrogen aircraft propulsion systems and does research to reduce community exposure to civilian aircraft noise and pollutant emissions…"

Congressional Bipartisan Sustainable Aviation Caucus

In June 2024, U.S. Representatives Dusty Johnson (R-SD) and Sharice Davids (D-KS) announced the creation of the Congressional Sustainable Aviation Caucus (CSAC) which will work to reduce the aviation industry's environmental impact and maximize its financial sustainability.[46] By accessing federal policy, holding forums, and bringing together public and private partners, the caucus will play a key role in the integration of new technologies into the nation's aviation network.

Summary of select proposed Federal Legislation connected to SAF in 2024:

Farm to Fly Act of 2023, HR 6271 (Introduced November 7, 2023)

- Lead sponsor is Representative Max Miller, R-OH.[47]
- Includes a common definition of SAF for USDA purposes.
- Directs the Secretary of Agriculture to incorporate the advancement of SAF through all USDA mission areas including public-private partnerships.
- Expands the USDA bio-energy program to include SAF (this program helps with the development of new and emerging technologies in biofuels).
- Currently listed as of November 22, 2024, as referred to the Subcommittee on General Farm Commodities, Risk Management, and Credit, and the Subcommittee on Commodity Markets, Digital Assets, and Rural Development on March 1, 2024.

Farm to Fuselage Act, HR 5235 (Introduced August 18, 2023)

- Lead sponsor is Representative Jasmine Crockett, D-TX.[48]
- Increases SAF expertise on a multiple agencies research coordination board at USDA by directing the Secretary of Agriculture to examine the composition of the Biomass Research and Development Board for the appropriate expertise in SAF.
- Makes bio-based assistance available for SAF as grants versus only financing or loans within the Bioenergy program for advanced fuels (SAF).
- Ensures bio-based USDA education programs include SAF.
- Addresses barriers to SAF refiners receiving equitable payouts from USDA.
- Removes hurdles to farmers receiving Biomass Crop Assistance Program (BCAP) funds for producing feedstock for SAF.
- Currently listed as of November 22, 2024, as referred to the Subcommittee on General Farm Commodities, Risk Management, and Credit, and the Subcommittee on Commodity Markets, Digital Assets, and Rural Development September 25, 2023.

Farm to Fly Act, S3637 (Introduced January 23, 2024)

- Lead sponsor is Senator Jerry Moran, R-KS.[49]
- Clarifies eligibility for SAF within current USDA Bio-Energy Programs, thus expanding markets for American agricultural crops through aviation bioenergy.
- Provides for greater collaboration for aviation biofuels throughout USDA agency mission areas, increasing private sector partnerships.
- Affirms a common definition of SAF for USDA purposes, as widely supported by industry, to enable U.S. crops to contribute to aviation renewable fuels most effectively.
- Currently listed as of November 22, 2024, as read twice, and referred to the Committee on Agriculture, Nutrition, and Forestry January 23, 2024.

Sustainable Aviation Fuels Coalition

In April 2024, forty companies and organizations that hold a stake in the development and deployment of SAF announced the formation of the Sustainable Aviation Fuel Coalition (SAF Coalition).[50] The organization is comprised of airlines and aircraft operators, agricultural enterprises, aircraft and aircraft equipment manufacturers, airports, technology developers, labor unions, and biofuel producers. "The goal of this new nonprofit, nonpartisan coalition is to rapidly scale investment in the SAF sector and advocate for the incentives and policies necessary to promote U.S. economic competitiveness in the emerging SAF marketplace. While SAF Coalition members have been working together informally for years, this newly formed organization will leverage the collective strength of the entirety of the SAF value chain to accelerate the development and deployment of SAFs in the U.S."

In July 2024, the SAF Coalition submitted comments in response to the USDA request for information on Docket No. USDA-2024-0003, Procedures for Quantification, Reporting, and Verification of Greenhouse Gas Emissions Associated with the Production of Domestic Agricultural Commodities Used as Biofuel.[51] The SAF Coalition supports USDA's objective of accelerating the development and deployment of SAFs in the U.S. The Coalition urged USDA to consider four overarching principles during the rulemaking process:

- Ensure federal policies are science-based and data driven to unlock the full potential to develop and deploy SAF and build on Congressional directives provided by the 40B and 45Z tax credits.
- Ensure federal policies are technology and feedstock neutral with the aim of reducing carbon intensity in a realistic and verifiable way.
- Provide sufficient flexibility to accommodate new feedstocks and technologies.
- Ensure simple and clear administrative practices that are implementable and manageable.

The Clean Fuel Production Credit 26 U.S. Code 45Z provides a tax credit for clean fuel production.[52] For a fuel to meet the credit's definition of "transportation fuel," it must be suitable for use in highway vehicles or aircraft. To qualify as "clean" fuel produced must emit no more than 50 kilograms of CO_2 (or CO_2 equivalent) per 1 million British Thermal Units (mmBTU). For producers meeting prevailing wage and registered apprenticeship requirements, the maximum credit is $1.75 per gallon of aviation fuel. For producers not meeting prevailing wage and registered apprenticeship requirements, the maximum credit is 35 cents per gallon of aviation fuel. To determine the size of each producer's credit, the maximum credit value is multiplied by an emissions factor that is a function of the fuel's "carbon dioxide equivalent" (CO_2e) per mmBTU.

Emissions Factor = [(50 kg. of CO_2e per mmBTU) – (Fuel kg. of CO_2e per mmBTU)] / [50 kg. of CO_2e per mmBTU].

Qualified SAF mixture must be made in the United States, or U.S. territories. The transportation fuel credit 45Z is available January 1, 2025, to December 31, 2027.

Photo credit: Port of Seattle

Policy Developments in Other States

California

The California Air Resources Board (CARB) issued proposed revisions to its Low Carbon Fuel Standard on December 19, 2023, to modify the Life Cycle Analysis (LCA) Models and Documentation. The California Air Resources Board scheduled a public hearing to consider amendments to the Low Carbon Fuel Standard (LCFS) on November 8, 2024. CARB released the Final Regulation Order with proposed amendments to the Low Carbon Fuel Standard regulation on November 6, 2024 with final approval yet to be reached.[53]

CARB staff analyzed and incorporated modifications to the rulemaking proposal including a near term step-down in carbon intensity benchmarks of 7% or greater, as well as refinements to feedstock sustainability provisions, zero-emission vehicle infrastructure eligibility provisions (provisions that would increase support for zero-emission vehicle fueling), and other provisions. The amendments, if approved by the CARB, are expected to be in effect in early 2025.[54] The original proposal would have made AJF an obligated fuel under the new LCFS. In response to numerous comments, CARB revised and deleted that proposal and AJF remains as an opt-in fuel.

In October 2024 CARB and Airlines for America (A4A) committed to goal of increasing the availability of SAF for use in California to 200 million gallons by 2035, an amount that meets about 40% of intrastate travel demand and a more than tenfold increase in current levels.[55] To achieve these goals, CARB and A4A will work together to identify, evaluate, and prioritize new policies and actions, including incentives for investment and timely permitting to help accelerate the availability and use of SAFs for intrastate flights in California. The partnership will establish a SAF working group of government and industry stakeholders that will meet annually to report progress and address barriers to meeting these goals.

Colorado

The Colorado legislature proposed a refundable income tax credit for research, development, or production of SAF or alternative propulsion systems and a separate section on electric ground support equipment (HB23-1289).[56] A qualified investor would be allowed a credit against income taxes for a qualified investment in an amount equal to 30 percent of the qualified investment. The maximum credits available to all taxpayers would be:

- $ 750,000 for tax year 2024
- $ 1,750,000 for tax years 2025 and 2026
- $ 2,750,000 for tax year 2027
- $ 4,750,000 for tax years 2028-2033

This legislation was not approved to become law in Colorado.

The Colorado legislature passed Tax Policy that Advances Decarbonization (HB 23-1272) on May 11, 2023.[57] Section 10 creates a refundable income tax credit for income tax years commencing on or after January 1, 2024, but before January 1, 2033, for a percentage of the actual costs incurred to construct, reconstruct, or erect a SAF production facility in the state. The credit can be claimed by an aviation business, a SAF producer, or an airport for the income tax year in which the production facility is put in service. The maximum credits available to all taxpayers for each income tax year are:

- 2024 tax year, must not exceed $1 million
- 2025 and 2026 tax years, must not exceed $2 million for each year
- 2027 through 2032 tax years, must not exceed $3 million

Additionally, the credit is subject to recapture if the SAF production of a facility comprises less than 60% of the total fuel production of the facility in any of the three taxable years immediately following the taxable year that the facility was placed in service.

Photo courtesy Washington State University

Illinois

The Illinois Clean Fuel Standard bill SB1556 was sponsored by Illinois Senator David Koehler (D).[58] The bill would direct the Illinois Environmental Protection Agency and Pollution Control Board to establish an LCFS requiring a 20% reduction in gasoline and diesel carbon intensity by 2038. The proposed law would also require consideration for low-carbon agricultural practices. As of November 2024, it has progressed to Senate Committee Amendment No. 2 Rule 3-9(a) and re-referred to assignments on May 17, 2024.

SAF sold to or used by a common air carrier for use in Illinois earns SAF purchase credit (SAFPC) that was enacted in July 2023.[18] The credit is available to air common carriers that purchase or use SAF in Illinois from July 1, 2023, through December 31, 2032. The amount of SAFPC earned is $1.50 per whole gallon purchased and can be used to offset the 6.25% state sales or use tax on aviation fuel. SAFPC is earned at the time that SAF is purchased for use in Illinois. The amount of SAFPC is based on the number of whole gallons of SAF purchased. Partial gallons will not earn a credit. SAFPC may be used by a purchaser at the same time it is earned. Purchasers must pay any locally imposed taxes (e.g., home rule, mass transit) directly to the supplier. A qualifying purchase is considered to take place as of the date of invoice of the SAF. The credit is considered to be earned on SAF that is purchased under an installment contract or progress payment contract at the time that each installment or progress payment is invoiced and based on the number of whole gallons of SAF purchased by the installment or progress payment. United Airlines highlighted the role of the Illinois SAF purchase credit when it announced the purchase of one million gallons of SAF for use at O'Hare International Airport in Chicago beginning in August 2024.[59]

Minnesota

The Minnesota Clean Transportation Standard Act was introduced into the Senate SF 2584 and House HF 2602.[60,61] The legislation would have created a Clean Transportation Standard that would have required an at least 25% reduction in carbon intensity of transportation fuel below the baseline in 2018 by the end of by 2030, 75% by 2040, and 100% by 2050. Aviation fuel providers would have been eligible to elect to participate in the clean transportation standard and earn credits by meeting the carbon intensity goal. The proposed legislation did not make it through the legislature during the session.

Minnesota established a refundable tax credit equal to $1.50 per gallon for SAF produced or blended in Minnesota and sold and used in Minnesota.[15]

Allocation of credits may not exceed:

- $7,400,000 for fiscal year 2025
- $2,100,000 for each of fiscal years 2026 and 2027

If the entire amounts are not allocated in fiscal year 2025 or 2026, any remaining amount is available for allocation through fiscal year 2030 until the entire allocation has been made. No credits are available for fiscal years beginning after June 30, 2030, and any unallocated amounts cancel on that date.

In August 2023, led by the Greater Minneapolis-Saint Paul (MSP) Partnership, and anchored by Bank of America, Delta Air Lines, Ecolab, and Xcel Energy, in conjunction with other regional stakeholders, the coalition formed the Minnesota SAF Hub with a goal of delivering affordable, low-carbon SAF to the MSP International Airport as quickly as possible.[62] The coalition also has a goal of scaling production to hundreds of millions, possibly billions, of gallons each year.

Nebraska

Nebraska adopted a SAF Tax Credit Act, LB 937, Sec. 50-55, in April 2024. The SAF Tax Credit provides a $0.75/gallon nonrefundable income tax credit to producers of SAF provided that the fuel meets at least a 50% reduction in greenhouse gas emissions.[16] A supplemental credit of $0.01/gallon is available for each additional percentage decrease in greenhouse gas emissions. The maximum supplemental credit is $0.50/gallon for a total maximum credit of $1.25/gallon. A producer cannot claim the credit for more than five taxable years.

The Nebraska department of revenue may issue up to $500,000 worth of SAF credits per tax year. The credit is available from January 1, 2027, through January 1, 2035.

DG Fuels announced that it has selected Phelps County, Nebraska to build a 193-million-gallon SAF production facility. DG Fuels' manufacturing process uses cellulosic biomass, in the form of lower-value agricultural by-products such as corn stover, as its carbon feedstock. Production is expected to begin in 2030.[63]

New Mexico

Governor Lujan Grisham signed the Clean Transportation Fuels Standard (CTFS) (HB 41) in March 2024.[17] CTFS established goals of reducing the lifecycle carbon intensity of transportation fuels by 20% by 2030 and 30% by 2040 compared to 2018 baseline. Rules are in development and expected by July 1, 2026, and it is anticipated that SAF will at least be deemed a creditable fuel on a voluntary, opt-in basis.

Other States

Additional states that have considered or are considering a clean transportation fuels standard include Hawaii, Massachusetts, Michigan, New Jersey, and New York.

U.S. SAF Commercialization Efforts and Obstacles

- **LanzaJet**'s Freedom Pines facility in Soperton, Georgia was opened on January 24, 2024.[64] The facility has a 10 million gallon per year capacity. In February 2024, Southwest Airlines Renewable Ventures announced a $30 million investment in LanzaJet. In August 2024 LanzaJet was selected for a FAST-SAF, Tier 2 grant for up to $3.1 million to install a pre-fractionation column and ethanol storage tank at Freedom Pines. The project is projected to lead to an additional 518,300 gallons of SAF production annually. The company uses the alcohol-to-jet (ATJ) conversion technology.

- **Gevo** is developing its Net-Zero 1 project in Lake Preston, South Dakota with the capacity to produce 65 million gallons per year of liquid hydrocarbons using abundant, sustainable corn as a feedstock. Gevo uses the non-edible portion of the corn to produce its fuel. Gevo was awarded a $30 million grant from the USDA for its Climate Smart Farm-to-Flight Program[65] and also received a $16.8 million FAST-SAF, Tier 2 grant from the FAA to convert an existing facility in Luverne, Minnesota to a fully integrated alcohol-to-jet facility.[13] As of October 2024, Gevo had been issued a conditional commitment from the DOE Loan Program Office for a loan guarantee of up to $1.46 billion to build a new jet-fuel refinery in Lake Preston, South Dakota.[12]

- **Fulcrum Bioenergy** closed its municipal solid waste-to-fuel facility in Nevada in May 2024. The company filed for bankruptcy protection in September 2024.[66]

- **Montana Renewables**, located in Great Falls, Montana, is an unrestricted subsidiary of Calumet, Inc. In 2022, it began converting existing assets into a renewable fuels production facility using the HEFA conversion pathway.[67] Montana Renewables intends to produce 30 million gallons per year of SAF initially, with plans to expand to 230 million gallon per year capacity. The company has a multi-year agreement with Shell. Its first production and shipments were in Q2 2023. Montana Renewables was issued a conditional commitment from the DOE Loan Program Office in October 2024 for a loan guarantee of up to $1.44 billion to expand its existing renewable fuels facility in Great Falls, Montana to produce more SAF.[11]

- **USA Bioenergy** and Southwest Airlines announced, in November 2023, a 20-year offtake agreement for 680 million gallons. Southwest Airlines plans to begin purchasing SAF from USA Bioenergy's Bon Wier, Texas refinery as early as 2028.[68] USA Bioenergy converts woody biomass to renewable liquid fuels via gasification and Fischer-Tropsch (FT) Technology.

- **Marquis Sustainable Aviation Fuel**, part of the Marquis group of companies, was founded in 2022.[69] The company is constructing a 120 million gallon per year integrated sustainable fuels plant to produce SAF and renewable diesel via the ethanol-to-jet process. Marquis received a $8.5 million DOE grant to host, commission and operate a LanzaTech skid-mounted gas fermentation polit plant at its Hennepin, IL biorefinery.[70] Marquis R&D Energy, LLC was selected in August for a FAST-SAF, Tier 2 grant for up to $9.9 million to combine its ethanol production capability with leading ethanol-to-jet technology providers and U.S. supply chain capabilities to produce, distribute, blend, and store SAF.[13] This project will leverage Marquis' existing logistics resources to support the expansion of SAF production and distribution in the Midwest.

- **Saffire Renewables** was acquired by Southwest Airlines in March 2024.[71] Saffire is part of a project supported by the DOE to develop and

Photo courtesy Port of Seattle

produce sustainable ethanol that can be upgraded into SAF using LanzaJet technology. Saffire expects to use technology developed by the NREL to convert corn stover into renewable ethanol. The company broke ground on a pilot plant in September 2024 at Conestoga Energy's Arkalon Energy facility in Liberal, Kansas.[72] The pilot plant will be capable of processing 10 tons of corn stover per day into cellulosic ethanol that can then be upgraded to SAF.

- **World Energy LLC** was selected in August for a FAST-SAF, Tier 2 grant for up to $22 million to install and integrate multiple components of a SAF pipeline transportation system originating at World Energy LLC Paramount, CA, SAF production facility and delivering Jet A/SAF blended fuel directly to Los Angeles International Airport (LAX).[13,73]

- **Arcadia eFuels** was selected in August for a FAST-SAF, Tier 2 grant for up to $14.6 million to develop a front-end engineering design for Project Arc, an initiative to build a new SAF plant in Gregory, TX.[13,73] Upon completion, the new SAF plant is projected to produce 23.2 million gallons of eSAF per year starting in 2028.

- **Martinez Renewables LLC** was selected in August for a FAST-SAF, Tier 2 grant for up to $50 million to update its existing facility in Contra Costa County, California, to enable SAF production as synthetic paraffinic kerosene (SPK).[13,75] The facility is projected to produce 100-350 million gallons of SAF annually starting in 2027.

- **Equilion Enterprises LLC** was selected in August for a FAST-SAF, Tier 2 grant for up to $18 million to install infrastructure for receiving and blending neat SAF into the jet fuel distribution network at the Shell Carson terminal in Southern California.[13,76] The project will enable the blending, storage, and distribution of up to 151 million gallons of SAF per year.

Photo credit: Washington State University

Policy Developments in Other Countries

Canada, British Columbia

The provincial government of British Columbia updated its Low Carbon Fuels Act in 2023 and mandated the use of low carbon jet fuel.[19] The new rules stipulate that renewable fuel constitutes a minimum of 1% of jet fuel starting in 2028, escalating to 2% in 2029 and 3% in 2030 and subsequent compliance periods. In addition, the regulations include a Carbon Intensity (CI) reduction requirement for jet fuel, starting at 2% in 2026 and progressively increasing to 10% in 2030 and subsequent compliance periods.

European Union

In October 2023, the European Union (EU) adopted the ReFuel EU[20] aviation initiative which mandates the use of SAFs that have lower CO_2 emissions that fossil kerosene. The new regulation includes:

1. The obligation for aviation fuel suppliers to ensure that all fuel made available to aircraft operators at EU airports contains a minimum share of SAF from 2025 and, from 2030, a minimum share of synthetic fuels, with both shares increasing progressively until 2050. Fuel suppliers will have to incorporate 2% SAF in 2025, 6% in 2030, and 70% in 2050. From 2030, 1.2% of fuels must also be synthetic fuels, rising to 35% in 2050.
2. Aircraft operators are required to ensure that the yearly quantity of aviation fuel uplifted at a given EU airport is at least 90% of the yearly aviation fuel required. This provision was implemented to avoid tankering practices, which would bring additional emissions from extra weight. Tankering is the practice of uploading excess fuel at one airport to cover the return trip, in addition to the fuel required for the outbound journey. It is typically employed as a cost savings measure when fuel is cheaper at the departure airport than the arrival airport.
3. Eligible SAFs and synthetic aviation fuels includes certified biofuels, renewable fuels of non-biological origin (including renewable hydrogen) and recycled carbon aviation fuels complying with the Renewable Energy Directive (RED) sustainability and emissions saving criteria, up to a maximum of 70% with the exception of biofuels from food and feed crops, as well as low-carbon aviation fuels (including low-carbon hydrogen), which can be used to reach the minimum shares in the respective part of the regulation.

United Kingdom

The United Kingdom (UK) Government proposed a SAF mandate in April 2024 that set progressive targets for aviation fuel suppliers to provide increasing amounts of SAF from 2025-2040.[21] On January 1, 2025, the UK Government will begin implementing its SAF mandate. Initially 2% of jet fuel supplied in 2025 must be SAF, increasing to 10% in 2030, and 22% in 2040. The UK also imposed a cap on the amount of SAF produced by the Hydrotreated Esters and Fatty Acids (HEFA) Method (e.g., refining used cooking oils, waste fats and greases) beginning at 92% in 2027, 70% in 2030, and reducing to 35% by 2040. It also obligates that a portion of the of the total jet fuel supplied in the UK must be SAF produced from Power-to Liquid (PtL) pathway, with a target of 0.5% by 2030 and 3.5% by 2040.

Singapore

The Civil Aviation Authority of Singapore (CAAS) has developed the Singapore Sustainable Air Hub Blueprint as Singapore's action plan for decarbonization of its aviation sector.[77] Specifically, CAAS will work with aviation stakeholders to reduce domestic aviation emissions from airport operations which includes vehicles, facilities, and buildings for aircraft, passengers, baggage and cargo handling at Changi Airport and Seletar Airport by 20% from 2019 levels (404 kt CO_2) in 2030. By 2050 CAAS aspires to achieve net zero domestic and international aviation emissions.

Photo credit: muhammad, stock.adobe.com

Flights departing Singapore will be required to use SAF, with a target of 1% SAF from 2026 onwards, and 3-5% SAF by 2030, subject to global developments and the availability and adoption of SAF. To manage the cost of SAF, CAAS proposes central SAF procurement to reap the benefits of the economies of scale. CAAS are planning to introduce a SAF levy for the purchase of SAF while introducing cost certainty to airlines and travelers. CAAS and the Singapore Government will work closely with industrial partners to increase SAF production capacity in Singapore and the region.

Other Countries

Other governments around the globe are considering SAF mandates. The SkyNRG Sustainable Aviation Fuel Market Outlook Report, June 2024 Update, provides a summary of SAF activities in Japan, India, Singapore, Brazil, Malaysia, Indonesia, Turkey, United Arab Emirates, South Korea, China, Australia, and New Zealand.[78] GreenAir News summarized the report in June 2024: "Globally announced SAF production capacity significantly increased last year, driven by regulatory developments such as ReFuelEU, the new UK SAF mandate and incentives to support SAF uptake in the U.S. Additionally, other countries, particularly in Asia, are looking to introduce mandates and targets for production, leading SAF to increasingly be seen as a global tradeable commodity with emerging trade corridors involving the U.S., SE Asia, Europe and South America, says SkyNRG's latest annual SAF Market Outlook. Voluntary demand signals have also continued to strengthen, with multiple airlines, cargo companies and corporates setting ambitious SAF targets. However, says the report, most announced facilities still face the challenges of raising capital, construction and commissioning, and this year will be critical for projects targeting operations before 2030."[79]

Property/Leasehold Tax Exemption for AJF facilities (high consensus that this is a priority)

- All property/leasehold interests in buildings, machinery, equipment, and other personal property which are used substantially for the manufacturing or blending of AJFs (as defined in RCW 70A.535.010), the land upon which this property is located, and land that is reasonably necessary in the manufacturing or blending of AJF, but not land necessary for producing feedstocks, which together comprise a new manufacturing or blending facility or an addition to an existing manufacturing or blending facility, are exempt from State leasehold taxes for a period of ten years from the date on which the new facility or the addition to the existing facility becomes "operational".[22] Suggested definition of "operational":
  - The facility achieves 3rd party certification that the facility has passed a performance test as required by project financing or the facility has demonstrated continuous operations at least 90% of projected capacity for 30 days or more.
- The tax exemptions only apply to facilities that produce AJF which has at least a 50 percent less carbon dioxide equivalent emissions than conventional petroleum jet fuel.
- Exception: This exemption applies only to those property/leasehold taxes levied by the state of Washington and provisions do not apply to property or leasehold taxes levied by local jurisdictions including, county, city, and regional authorities. Local governments may choose to extend this exemption if it is beneficial to their jurisdiction.

Climate Commitment Act (CCA) Infrastructure Grant Program (high consensus of support)

In SB5447, Section 1 (2023), the legislature indicated that it intends to use Climate Commitment Act (CCA) Funds to promote research, development, and demonstration projects, engineering designs, the production, blending, and use of AJF thereby growing the clean energy sector, addressing greenhouse gas emissions, and creating family wage manufacturing jobs in Washington.[3] To help achieve these goals, the AJF Work Group recommends that the legislature use CCA Funding to fund AJF Infrastructure projects, administered by an appropriate state agency. Grant funding would be allocated through a competitive bid process. For additional flexibility the annual funds for AJF infrastructure projects could be allowed to accumulate to hold a competition over 2-4 years with larger amounts of funding for projects in Washington state.

Background

Infrastructure has been identified as a significant barrier to AJF project development. When evaluating AJF projects, investors consider both the viability of a proposed production facility and the ability to transport fuel from the facility to airports. AJF facilities tend to be located close to feedstock supplies and at a distance from fuel distribution infrastructure such as pipelines, deep water ports or rail lines. This creates an infrastructure challenge for the "last mile" of fuel delivery.

An additional challenge is that, per fuel specifications, pure (known as neat) AJF is required to be blended with traditional fossil jet before it is supplied to an airport, which may require additional tankage, piping, etc. Capital investments will be required to build new blending facilities or upgrade existing facilities to accommodate blending. As an illustrative example, the 2016 Port of Seattle, Aviation Biofuels Infrastructure Feasibility Study[80] summarizes various infrastructure investments necessary to supply AJF to SEA.

Photo credit: Washington State University

Recommendations

- Designate funding for an AJF program to include research, development, demonstration, engineering designs, production facility, blending and use of AJF infrastructure under CCA grant funding.
    - Qualifying infrastructure includes rail spurs, barging infrastructure, fuel loading and offloading racks, installation of blending facilities which include, but are not limited to, tanks, pipes, pumps, mixing equipment, etc.
    - Grant funds may be used for planning, engineering, design, research, development, demonstration, and construction.
    - Grant funds shall not be used for land acquisition or permitting costs.
    - Infrastructure built with grant funding is intended to be for the public good. Grant recipients shall not restrict access to infrastructure. Excessive fees for use may be considered a restricted access.
    - The infrastructure grants will need the support of the continued work on responsible streamlining of permitting.
    - To increase flexibility the funds could be used to contribute to matching funds for federal/state/local calls for AJF proposals.

Construction Sales Tax Deferrals

The AJF Work Group supports modification of the existing construction tax deferral: Sales, and Use Tax Deferral Program for Clean Energy Investment Projects. The AJF Work Group would like this to apply to the construction of AJF facilities for not only production, but also add language for the installation of blending, storage, and fueling infrastructure of AJF, in addition to storage and fueling infrastructure for Zero Emission Vehicles (ZEVs), hydrogen, and electricity currently in RCW 82.98.01.0[23] In the existing Sales and Use Tax Deferral Program for Clean Energy Investment Project, the tax is a deferral but may be forgiven under certain conditions.

Sales and Use Tax Deferral Program for Clean Energy Investment Projects

- Available to: Manufacturers constructing eligible "clean technology" investment projects.
- Deferral Limits: The eligible investment project must invest at least $2 million in qualified buildings, machinery, or equipment for new, renovated, or expanded:
    - Clean technology manufacturing operations
    - Facilities for renewable energy storage
    - Production facilities for clean fuel, renewable hydrogen, green electrolytic hydrogen, or green hydrogen carriers
- Repayment of Taxes: The deferred taxes must be repaid beginning the second year after the project is operationally complete. The deferral recipient may receive a reduction of the state portion of deferred sales and use taxes based on labor standards utilized to construct the project. The Department of Labor and Industries must certify labor standards.
- Statute: Chapter 82.89 RCW[81]

Permitting

- In 2023, SB 5290 made several changes to RCW 36.70B that place increased emphasis on local development project review.[82,83] Recommended by the Growth Management Act (GMA) Collaborative Road Map Task Force, these new requirements apply to local governments planning under the GMA and are intended to increase the timeliness and predictability of local development project review and decision-making.
- The AJF Work Group is appreciative of the work previously done on the Clean Energy Coordinated Permit Process and supports the continued work on responsible streamlining of permitting of low carbon intensity energy.
- The AJF Work Group suggests to direct and fund the Department of Ecology to complete a study that would inform one or more Programmatic Environmental Impact Statement(s) (PEIS) for AJF production pathways. A PEIS is a document that helps developers consider environmental impacts when designing a project. The PEIS(s) framework should be consistent with that used in developing of existing PEISs for utility-scale solar energy, utility-scale onshore wind energy and green hydrogen.
- The AJF Work Group wishes to acknowledge that flexibility with permitting processes is encouraged for potential AJF facilities in Washington state to choose the optimal permitting process for their scenario.

Federal Policy Engagement (high consensus of support)

- Direct the state departments of agriculture, natural resources, commerce, ecology, transportation, and other related entities to engage with their federal counterparts as appropriate and provide input/responses to federal RFIs related to SAF supply chain development and deployment.
- Create a formal mechanism to report to the Washington congressional delegation on policy that will encourage/support AJF production and align with the state legislature's goals.
- The Washington congressional delegation should encourage the federal government to extend the time frame on federal tax credits for SAFs, preferably for a timeframe more consistent with construction of facility and investor requirements.
- The Washington congressional delegation thanks the FAA for the four Fueling Aviation's Sustainable Transition (FAST) grant program awards in Washington State (bp America, ZeroAvia, APiJET, and The Boeing Company). The Washington congressional delegation should encourage and support additional funding for the FAA to expand the FAST grant program.

Photo credit: lsannes .istockphoto.com

Proposed Future Work for the Washington Alternative Jet Fuels Work Group

The AJF Work Group would like additional time to develop a deeper understanding of the following potentially complex fields before making recommendations:

- The AJF Work Group is interested in the developing field of unbundled sustainability attributes using book and claim as chain of custody method. Within the nascent systems for SAF accounting, using book and claim the terminology, methodology, and platforms/registries are still being developed.
    - Book and claim is a chain of custody method through which sustainability attributes can be transferred separately from the physical fuel. The trading or transactions are done via a platform/registry that ensures that certificates represent real impact and are accounted for appropriately and correspond to the amount of SAF produced and consumed.
    - The book-and-claim system provides flexibility for AJF suppliers and airlines, and avoids unnecessary logistics, costs, and emissions which might accelerate the aviation industry's decarbonization.
- The AJF Work Group is interested in the developing field of renewable chemicals, sustainable chemicals, and co-products of AJF. When producing AJF, co-products are often produced. In different states and in federal agencies, the definitions of what is meant by a co-product and what is included or excluded is still being developed. However, it is also important to understand how any proposed credits for the co-products would impact the economics of the nascent AJF industry prior to making such recommendations.

Photo credit: Port of Seattle

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Appendix

Response to: EERE T 540.111-02: Request for Information (RFI) DE-FOA-0003157 - Sustainable Aviation Fuel Grand Challenge: Building Supply Chains (as submitted in November 2023)

Point of Contact:
- Washington Alternative Jet Fuel Work Group
- Carol S. Sim
- Washington State University Office of National Partnerships, Washington State University, Pullman, WA, phone number: 503-789-8677, email: carol.sim@wsu.edu

Question 1(a). Are you aware of effective regional supply chain coalitions that have been formed for renewable fuels?

There has been a tremendous amount of SAF-related work in Washington and in the Pacific Northwest since the mid-2000's. Keys to success have been a proactive legislature and a large aviation and aerospace industry committed to sustainable aviation. The information below provides illustrative information on key initiatives and projects done in the region.

Background

Washington state has ranked #1 nationally in aerospace sales, exports, profits, and employment for over a decade.[52] Aerospace is a $70 billion industry in the state and supports more than 130,000 direct aviation and aerospace jobs and 120,000 induced jobs.[53] The industry is anchored by Boeing Commercial Airplanes, which has been a global leader in sustainable aviation fuel (SAF) development since the beginning. Boeing started investigating alternative fuels as early as 2006 and conducted its first demonstration flight in 2008. Their Environmental Strategy Group recognized the potential for SAF production in Washington and along with Alaska Airlines, the Ports of Seattle and Portland, and the Spokane International Airport, convened a broad stakeholder coalition to investigate viable SAF feedstocks in the state. The group published the *Sustainable Aviation Fuels Northwest (SAFN), Powering the Next Generation of Flight*[54] report in 2011. It is a comprehensive review aviation's need to decarbonize, the role of SAF, feedstock supply chain development and feedstock options in the pacific northwest region, as well as a review of hydroprocessing and lignocellulosic biomass processes. The SAFN report includes economic assessment, sustainability evaluation, opportunities, and challenges. To our knowledge, it was the first report in the United States to evaluate SAF supply chains.

The initial SAFN work resulted in the development of numerous SAF-related projects, by various groups, over the past decade plus. For ease of reading, descriptions of these projects are broken into the categories of legislative activities, academia, national laboratory activities, state agency activities, stakeholder activities and project development.

Legislative Activities

Publication of the SAFN report prompted the Washington legislature to establish the Sustainable Aviation Biofuels Work Group in 2012 under HB2422.[3,55] It recognized the potential for Washington to become a leader in the development and commercialization of SAF…" due to its strong tradition of market innovation, a concentrated demand for sustainable aviation fuels, leading expertise and research capacity, an established aviation manufacturing sector, and the availability of a diverse range of feedstocks for the production of biofuels…". The remit of the work group is to facilitate communication and coordination among biofuels stakeholders, provide a forum to discuss, and potentially "resolve barriers related to technology development, production, distribution, supply chain development, and commercialization of aviation biofuels," and make

recommendations to the legislature on policies that will promote a productive SAF industry in Washington.

Work group recommendations adopted by the legislature include: a Washington Clean Fuel Standard[56] which after multiple attempts passed in 2021; a reduced Business and Operations (B&O) tax rate for in-state SAF producers (SB5447)[57]; an alternative jet fuel tax credit of up to $2.00/gallon for production **or** blending **or** use of SAF in Washington (SB5447); streamlined the permitting process for clean energy facilities, including alternative jet fuel producers (HB1216)[58].

Early work group reports are not available online, the 2020 and 2022 reports are available at the links below.

- 2018-2020- Sustainable Aviation Fuels- Opportunities for Washington, https://s3.wp.wsu.edu/uploads/sites/2180/2020/11/SABWG-Final-Report-November-2020-compressed.pdf
- 2020-2022- SAF Updates and Recommendations (Opportunities for Washington), https://s3.wp.wsu.edu/uploads/sites/2180/2022/12/2022-12-01-SABWG-REPORT.pdf

National Laboratory Activities

Pacific Northwest National Laboratory (PNNL) made a strategic transition to focus on difficult to electrify transportation sectors in 2010. The lab partnered with Imperium Renewables at this time to explore supply chains and conversion approaches that would result in HEFA-like SAF. The approach was focused, with assistance from LanzaTech personnel having experience with ASTM qualification. Together, PNNL and LanzaTech developed the catalyst system and compiled the tremendous amount of data required for ASTM evaluation. PNNL produced the first five gallons of SAF. LanzaTech produced 4,000 gallons of ethanol-derived ATJ-SPK and ASTM qualification was achieved on April 1, 2018.

PNNL continues to work on SAF via upgrading of light oxygenates, butenes, and hydrothermal liquefaction. The lab also has efforts in process intensification and is making investments in direct synthesis gas to olefins – which may be oligomerized to SAF with the goals of maximizing carbon conversion efficiency to the SAF pool and minimized hydrogen requirements.

Academia

Northwest Advanced Renewables Alliance (NARA)

The NARA project was funded by a $40M grant from the USDA National Institute of Food and Agriculture, Agriculture and Food Research Initiative, Coordinated Agricultural Project (NIFA AFRI CAP). Led by Washington State University (WSU), NARA featured a broad alliance of private industry and educational institutions, which took a holistic approach to building a supply chain within Washington, Oregon, Idaho, and Montana, based on using forest harvest residuals to make aviation biofuel and co-products. The alliance was tasked with empowering rural economies, increasing America's energy security, and reducing aviation's environmental impact. To do that, NARA sought to improve the efficiency for each supply chain step from forestry operations to conversion processes; create new bio-based products; provide economic, environmental, and social sustainability analyses; engage stakeholder groups; and improve bioenergy literacy for students, educators, professionals, and the public. The NARA project culminated in the production of 1,000 gallons of SAF, which was used in a 20% blend, to power an Alaska Airlines flight from Seattle-Tacoma International Airport to Washington Reagan National Airport in November 2016. [59]

Aviation Sustainability Center (ASCENT)

FAA Center of Excellence for Alternative Jet Fuel and the Environment, commonly known as the Aviation Sustainability Center or ASCENT[60]. ASCENT is co-directed by WSU and the Massachusetts Institute of Technology (MIT). ASCENT provides science-based solutions for many of the aviation industry's environmental challenges. It is a collaborative of aviation-based research organizations, bringing together 16 leading U.S. universities, federal agencies, and 70+ industry partners that all support the mission and goals of the FAA's

Office of Environment and Energy. ASCENT's research in SAF includes domestic and international supply chain analyses (including the pacific northwest), techno-economic analyses, lifecycle analyses, direct and induced land use change, policy analysis, and fuel certification and qualification. ASCENT researchers participate on the state Alternative Jet Fuel Work Group and have conducted specific regional feedstock assessments for local stakeholders. ASCENT was originally awarded in September 2013 and is ongoing.

WSU – Pacific Northwest National Laboratory (PNNL) Bioproducts Institute (Bio-In)
The WSU-PNNL Bioproducts Institute (Bio-In) was established in 2018 with the purpose to advance methodologies that reduce environmental impact and retain carbon used in the economy. A key focus area of Bio-In has been sustainable aviation fuels with recognition of Bio-In members for their contribution to the U.S. government wide SAF Grand Challenge Roadmap in 2022. Additionally, Bio-In members have been recognized for leadership and contributions to SAF by the Commercial Aviation Alternative Fuels Initiative (CAAFI) in 2022.

Stakeholder Activities

Seattle Tacoma International Airport
The Seattle Tacoma International Airport (SEA) set a goal to power every flight fueled at SEA with at least a 10% blend of SAF by 2028 which, at the time, equated to approximately 50 million gallons per year. SEA has taken several steps toward meeting its goal.

- It recognized that new SAF storage and blending facilities would be required to support the import of such large volumes of fuel. The Port of Seattle, Alaska Airlines and Boeing Commercial Airplanes, partnered to investigate infrastructure requirements. The findings are published the Aviation Biofuel Infrastructure Feasibility Study (2016)[61]. The report examined available land, land use compatibility and zoning, types of infrastructure required by location, including final delivery to the airport.

- It further explored potential funding mechanisms to support infrastructure development. It contracted RMI-Carbon War Room and SkyNRG to produce a report on Innovative Funding for Sustainable Aviation Fuel at U.S. Airports- Explored at Seattle Tacoma International (2017).[62]

- It contracted the WSU ASCENT researchers to evaluate the availability of regional feedstocks to support the Port's SAF goals. The SAFN report, mentioned earlier, examined the types of feedstocks in the pacific northwest region, without consideration of availability. *The Potential Northwest Feedstock and Production of Sustainable Aviation Fuel*[63] *Report* quantifies available regional feedstocks suitable for ASTM-approved pathways for producing SAF and provides techno-economic analyses for various pathways and feedstocks.

Boeing
- In 2022, Boeing committed to providing SAF, as a blend component, for all its delivery flights in the Puget Sound region. Boeing's procurement and use of commercial volumes of SAF, at its Puget Sound sites, has allowed its strategic partner, Epic Fuels, to develop a SAF commercial logistical supply chain, establish additional customers in the region, and pursue strategic opportunities with aviation industry stakeholders including SeaTac airport and its airline operators.

Stakeholder Forums

2019- A two-day *Sustainable Aviation Fuels Summit*[64] hosted by the Port of Seattle, brought together Washington Governor Inslee, former Secretary of the U.S. Navy, Ray Mabus, and industry to focus on opportunities to develop a Washington-based supply chain of clean and sustainable fuels for aviation.

2021-The Port of Seattle hosted the *Use of Sustainable Aviation Fuels Taking Off*[65] study session, which brought together industry partners to facilitate the adoption and local production of SAF. Representatives from Alaska Airlines, Delta Air Lines, United Airlines, Microsoft, and Breakthrough Energy shared their SAF strategies and priorities for climate action.

2023- The Washington Academy of Sciences hosted the *Sustainable Aviation Fuels Symposium*[66], held at the Boeing Museum of Flight, which brought together members of the legislature, academia, aircraft manufactures, airlines, airports, state and national aviation and aerospace industry representatives, state government agencies, NASA, and workforce development specialists.

State Activities

Department of Commerce

1. In 2022, the Washington Department of Commerce provided grant funding for innovation cluster accelerator programs (ICAP) to accelerate development of key industries in the state. One SAF-related grant was funded, the Sustainable Aviation Technologies and Energies (SATE) Innovation Cluster, led by the Aerospace Futures Alliance. SATE's mission is to advance aviation's global fight against climate change by leading the research, development and deployment of sustainable aviation fuels, electric aircraft, and hydrogen-powered aircraft.

2. At the direction of the legislature, the Department of Commerce established the Office of Renewable Fuels in 2022. The original legislation focused largely on hydrogen but was amended in 2023 to include alternative jet fuel (AJF). The office will work with multiple stakeholders to support analysis and policy work on AJF topics. **It should be noted that several of the duties respond directly to the questions posed in the SAF RFI**. Duties of the Office of Renewable Fuels are specified in **RCW 43.330.570** and a few illustrative examples are shown below.

(1) The office shall:
(a) Coordinate with federally recognized tribes, local government, state agencies, federal agencies, private entities, the state's public four-year institutions of higher education, labor unions, and others to facilitate and promote multi-institution collaborations to drive research, development, and deployment efforts in the production, distribution, and use of alternative jet fuels and renewable fuels including, but not limited to, green electrolytic hydrogen;
(b) Review existing renewable fuels, alternative jet fuels, and green electrolytic hydrogen initiatives, policies, and public and private investments, and tax and regulatory incentives, including assessment of adequacy of feedstock supply and in-state feedstock, renewable fuels, and alternative jet fuels production; …
(d) Assess opportunities for and barriers to deployment of renewable fuels, alternative jet fuels, and green electrolytic hydrogen in hard to decarbonize sectors of the state economy; …
(f) By December 1, 2023, develop a plan and recommendations for consideration by the legislature and governor on renewable fuels and green electrolytic hydrogen policy and public funding including, but not limited to, project permitting, state procurement, and pilot projects; and …

Snohomish County SAF Research and Development Center

The Washington state legislature, as part of the 2023-2025 transportation budget, allocated $6.5 million for a Research and Development (R&D) Center for sustainable aviation fuels at Snohomish County's Paine Field Airport (PAE). The Center at Paine Field is a partnership between Snohomish County and Washington State University (WSU) and leverages the presence of campuses in Everett, Tri-Cities, and Pullman.

The Center at Paine Field will host a 'bank' of SAF samples from commercial and experimental SAF production methods. Large and small volumes of these samples will be stored, blended, and processed for tests performed

at Paine Field, other WSU research sites, and worldwide. The sample bank at Paine Field, when combined with other WSU assets, will form a SAF repository with data management, storage, and distribution. This repository will be the first facility in the U.S. of this type for advancing sustainable aviation fuel technologies and serve the global need for reference samples to support research. In effect, the repository will do for SAF development what seedbanks do for agricultural research. In addition, potentially a new combustion test facility at Paine Field will be used to research and qualify new fuels to decarbonize locally produced aircraft worldwide. Experimental fuels will be tested there for safe aircraft operability at relevant conditions and scales.[67]

Project Development

Twelve

Twelve, a carbon transformation company, broke ground in July 2023 on an E-Jet® fuel production facility in Moses Lake, WA.[68]

bp Americas, Cherry Point

In March 2023, bp announced that its Cherry Point facility, in Whatcom County, WA, is on a list of five refineries around the world that it is considering for conversion to future hubs for sustainable aviation fuel and green hydrogen facilities.[69]

SkyNRG Americas

SkyNRG Americas has a goal to produce 30 million gallons per year of SAF by 2029. According to its website, Sky NRG Americas are standing up a Pacific Northwest project that is supported by The Boeing Company and other partners with offtake agreements to purchase SAF produced in the U.S. by SkyNRG.[70]

The Washington Department of Natural Resources (DNR) has been approached by several smaller businesses (startups) around the supply chain of biomass/woody biomass, that are planning for installations in 2-6 years. Biomass and waste streams being a potential source for SAF, the DNR is looking into how it can support (within its' current authority) reducing fuel loads, primarily slash piles/biomass, by partnering with third parties to remove and utilize this wood product. The barriers are primarily on the third party/external parties to have sizeable capital to create the type of building and transportation infrastructure to support biomass removal and processing. Using biomass from sources including pre-commercial thinning, forest health treatments, and timber harvest could produce a supplemental source of SAF but would require secondary support systems outside of state agency authority or resource capacity.

Question 2. What modeling and simulation tools would enable participants along SAF supply chains to be more effective at maturing functional, integrated supply chains?

The nascent SAF industry can be understood as a system of systems; as such, its development will require bottom-up and top-down modeling approaches for individual systems, as well as the integration of cross-system relationships. Such models allow the identification and understanding of critical elements as well as their advantages, gaps, and implications. Essential elements of SAF supply chains include demand, supply, technology (including maturation), as well as social, environmental, methodological, and political aspects.

Foundational, harmonized models are required to provide a modeling baseline and to identify integration opportunities. Models required include land availability and suitability, land use change (direct and indirect), hydroclimatic variability and projections, biomass supply and logistics assessment, siting optimization, techno-economic analyses, and life cycle assessment. Implementing of these models requires assumptions about the nature of the supply chain they intend to study, often when the implications are poorly understood. Feedstock availability and density are critical. To prevent carbon intensity increases in fuels, crop rotations focusing on the potential for double cropping could provide increased volume without increasing cropland.

When evaluating materials that are categorized as waste, it is important to consider the impact of waste removal and current and future expected competition.

At the conversion stage, model users need the ability to consider all applicable conversion technologies for the chosen feedstock and understand how site type (greenfield, retrofitted, co-located, or co-processing) may influence their results.

Regional models are crucial providing spatiotemporal details on: 1) the heterogeneity of feedstock quality, supply, cost, and availability over time; 2) surplus land availability, quality, and suitability; 3) supply logistics; 4) infrastructure availability, limitations, and competitiveness; 5) evolution of the value chains. Regional-scale studies are also key for engaging with stakeholders, as they present a perspective of supply chains that can be directly related to their day-to-day operations.

Systemic regional models that can implement multiple options simultaneously, including technological learning, various products and services, investment competition, and path dependency for short-, medium-, and long-term investment, provide a dynamic evolution of the value chains and their competition with other value chains. Full system models include topic-specific models that shall be harmonized to produce clear results.

Question 3. What are the most critical gaps in demonstration (pre commercial validation) of supply chain elements and how can these be overcome?

The most critical gaps in the successful demonstration of supply chain elements and their potential for commercial viability are the compound risk of the investment and the lack of funding required to scale SAF supply. Many promising SAF technologies fail to make an impact because they cannot scale up from the early stages of commercial development. Often, issues such as limited sustainable feedstock availability, food for fuel debates, technology readiness, lack of dedicated SAF infrastructure, and high capital costs prevent meaningful expansion and successful deployment at scale.

The SAF industry has developed a robust variety of SAF feedstocks and technologies, often with the support of public research and development (R&D) funding from the public sector. While we must continue to research various feedstocks and continue to optimize SAF production technologies, it is time to put words into action so the industry can scale up and meet the aviation industry's intended goals. We are at a critical point in fighting the climate crisis where we need to scale up solutions for aviation quickly. Federal governments might consider shifting the focus of their funding for SAF from R&D to commercial scale up and deployment.

Eventually, the private sector will be willing to provide more funding for SAF commercial deployment, but those investments are limited right now. Airlines and SAF producers have been in a holding pattern for more than a decade given the nascent nature of the SAF industry. Without long-term government support, the cost of SAF will continue to be at least double the price of conventional jet fuel, which means airlines are buying too little SAF for the industry to scale up. Sustained public funding for SAF commercialization and consistent policy support are essential to enable large investments across the SAF supply chain.

One example of how the federal government is already helping to close the supply chain gap for SAF is the inclusion of a DoD pilot program for SAF under the FY 2023 National Defense Authorization Act (NDAA). This pilot program is helping the test and demonstrate successful use of SAF in its operations. This strategy can and should be used across the federal government because it reduces the operational risk of agencies transitioning to SAF while helping the SAF industry increase production and build economies of scale.

Question 4. What are the most significant barriers to scaling and commercial build out of SAF supply chain elements and how should these be addressed?

Barriers	Alternatives to be addressed
High cost of SAF	-Tax reduction or incentives for environmental and/or social services provided
	-Incentives stacking (federal, state, local, etc.)
Concrete demand	-Offtake agreements with defined terms
	-Governmental procurement with defined terms
	-Consumer willingness to pay portion of green premium
Capital Investment for commercial facilities	-Building investor confidence in SAF production
	-Patient capital/green bonds/low interest loans
	-Leverage existing infrastructure/facilities
	-Policies that can be bankable, reducing the risk assumed by financial entities, enhancing the willingness of banks to loan for low TRL technologies
Time to Permit/Timeline to Build	-Streamlined permitting with successful examples
	-Decrease timeline for final investment decision by providing information on sites, feedstock, infrastructure
	-Community engagement/education
Feedstock availability/price assurance	-Risk sharing across supply chain
	-Low CI feedstock price premium
	-Feedstock availability and accessibility within proximity of conversion facility, especially for low yield processes
	-Treating feedstocks equally such as, SAF made from RNG on a book-and-claim basis being treated equally to other feedstocks that are eligible for federal and state tax incentives
Community Acceptance	-Quantitative assessment of possible sites for project acceptance and success like Community Assets and Attributes Model (CAAM)
	-Early stakeholder engagement/education
	-Tribal information as applicable
Lack of existing infrastructure to blend/deliver SAF	-Siting of central blending locations with pipeline access
	-Blending and/or co-processing at existing refineries
	-Evaluation of pipeline capacity
	-Rail connected off-airport terminals and tankage which are subsequently connected to the airport via pipeline
Regional off road transportation costs	-Rail and barge costs for modeling efforts
Renewable electricity supply and transmission infrastructure to support economic lower carbon intensity hydrogen	-Modeling the levels of renewable power needed for both renewable hydrogen for initially lower carbon intensity SAF via hydrotreatment and later transitioning to Power-to-Liquid (PtL) pathways for SAF production
	-Opportunity for greater alignment of policies in the U.S. and Europe regarding SAF production from CO_2 and H_2
Access to workforce	-SAF projects are typically developed in areas that have limited work forces and limited construction firm representation

We respectfully encourage the DOE to coordinate with the U.S. Department of Treasury to be explicit in forthcoming guidance that SAF produced from RNG on a book and-claim basis is eligible for the Clean Fuel Production Credit, § 45Z, and the Sustainable Aviation Fuel Credit, § 40B, so long as such SAF meets the greenhouse gas emissions threshold and other criteria outlined in 26 U.S.C. § 45Z and 26 U.S. Code § 40B, respectively. Without clear guidance from the federal government to this effect, it will inhibit the U.S. to be able to meet its SAF production goal of 3 billion gallons of SAF per year by 2030 set out in the SAF Grand Challenge.

Question 5. Is there a beneficial role that DOE and other U.S. Government agencies could serve in informing potential SAF producers about the wide range of potential investors and financial contractual structures in the SAF ecosystem?

Education and outreach around SAF including co-benefits to using biomass or wood biomass as risk reducing actions around fuel loads reduction for fires would be beneficial. Communications to establish life cycle assessments around using feedstocks from source to consumption with minimal increase to waste processing and ultimately GHG emissions may increase interest of industrial and commercial operations wanting to reduce carbon emissions or support Environmental, Social, and Governance (ESG) reporting. SAF should be highlighted as another tool to enhance a company's sustainability portfolio and its ESG reporting.