Guidance for Selling Alternative Fuels to Airlines

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Commercial Aviation Alternative Fuels Initiative® (CAAFI) Business Team and
the Airlines for America (A4A) Energy Council and SAF Committee

Introduction

The purpose of this paper is to communicate the basic information and technical requirements for airlines to contemplate purchase agreements with suppliers for conventional aviation fuel containing a synthetic blend component (SBC), also called sustainable aviation fuel (SAF) I. In addition, it describes actions that airlines can take to accelerate the commercialization of alternatives at scale.

To help orient potential producers – and other supply-chain participants – with respect to how and when to engage with airlines, we have laid out a generalized process that describes key steps toward entering into a purchase agreement. This process cross-references other CAAFI documents, including the Path to Alternative Jet Fuel Readiness, which provides information on how to become involved with the aviation community, the testing and environmental evaluations required to show the fuel's suitability for aviation use, and how to best facilitate ASTM International certification for a new fuel. It also refers to several CAAFI communication tools designed to aid in the communication of both the necessary steps to be taken and the progress of SAF projects:

- Fuel Readiness Level (FRL) provides guidance on fuel technical development and certification
- FRL Exit Criteria is a checklist detailing what is performed at each FRL level
- Feedstock Readiness Level (FSRL), developed in collaboration with the U.S. Department of Agriculture (USDA), tracks development and availability of the raw materials (or feedstocks) required to make alternative jet fuels
- Environmental Progression provides guidance on environmental analyses; Environmental Sustainability Overview provides background on the environmental sustainability issues to be considered in the production and deployment of alternative jet fuels

A description of these documents and tools resides at http://caafi.org/information/fuelreadinesstools.html.

The International Air Transport Association (IATA) has also developed an "Aviation Fuel Supply Model Agreement (Incorporating Supply of SAF Blend)," a generic model agreement that airlines and suppliers may consider using to streamline the process of purchasing and selling jet fuel.

Why are airlines interested in commercial-scale alternative jet fuel production?

The commercial aviation industry is interested in fostering the development and deployment of alternative fuels for the following reasons:

- **Emissions Reductions and Climate Goals:** The aviation industry has set an aspirational goal of achieving net zero carbon emissions by 2050, which will require today's limited commercial technologies to scale and be deployed globally. It will also require a significant transition in aviation fuels, from fossil-based supply (conventional jet fuel) to alternative supply sources with better environmental and climate attributes. Airlines have begun procuring SAF, but given the nascency of the market, the procurement across industry is not always consistent.
- **Supply Diversification:** The generally limited ability to adequately pass through high and volatile prices of petroleum-derived jet fuel poses key business challenges to airlines, especially because fuel is one of the industry's highest operating costs. Once SAF reach commercial scale, they may offer an opportunity to buffer price exposure to global crude oil and conventional jet refining margins, diversifying sources of jet fuel available to airlines and reinventing aspects of the fuel supply chain. Expanding the available jet fuel slate in this way may help enhance market stability. In addition, SAF could be essential to accommodate future demand growth for air transport services, especially as overall demand for ground transportation fuels and associated refining capacity declines

- **Operational Reliability:** Commercial-scale production of SAF can bolster the supply of liquid fuel to the airline industry. Given current technology and average age of fleets, there are no practical options to power aircraft engines other than with liquid fuels in the near-term, especially for medium and long-haul flights

- As competition for petroleum-based products intensifies due to increased demand from other industry sectors across the globe and the possible scarcity of this non-renewable resource in future decades, there are concerns that aviation may find it difficult to meet its energy needs over time.

- Furthermore, SAF production facilities need not be situated in the same locations as conventional refineries. This would allow the geographic diversification of production away from sites prone to natural disasters, such as the U.S. Gulf Coast or West Coast.

- **Regional Economic Expansion:** Commercial-scale production of SAF has the potential to generate jobs and spur economic activity, especially in rural areas where bio-based feedstocks can be cultivated. In addition, the growth of a domestic SAF industry would help reduce dependence on U.S. imports of various grades of foreign crude oil and refined products, freeing up resources to be invested domestically. SAF can also obviate the need for carbon taxes, emissions trading schemes or other measures under consideration for conventional jet fuel that could have anti-growth consequences.

What are the airlines' requirements for contemplating the purchase of SAF?

SAF **must** meet the following requirements in order to be acceptable for use by airlines:

- **Fuel compatibility and performance**
  - **Fuel certification**: Compliance with the relevant ASTM International qualification under to ASTM D7566 (for synthetic blendstocks from non-fossil sources and coal) or D1655 from other fossil resources) (or equivalents).
    - ATSM certifications should apply to the neat SAF prior to blending and the final blended product.
    - Respective Certificate of Analysis (COA) documents should be provided for the neat SAF and blended product upon transfer to a reseller or end user such as an airline.
  - **Drop-in**: Complete compatibility with existing storage, transportation, pumping and distribution infrastructure, and existing engine, aircraft and other equipment without need for segregation of SAF from various production pathways, customized conventional blendstocks, onerous testing protocols along the supply chain, or materially additional infrastructure either upstream of at the airport. The goal is to move towards 100% fully drop-in SAF (no blending required with conventional jet fuel) similar to renewable diesel.
- **Environmental benefit**
  - Compliance with accepted sustainability criteria, in particular resulting in a reduced life-cycle GHG emissions profile, as demonstrated by:
    - Robust third-party certification of the neat SAF and blended product by an established certification scheme (SCS)—preferably one that is approved by an international standard such as ICAO or the Science Based Targets Initiative (SBTi).
    - The ability of a fuel to meet environmental and sustainability criteria under recognized crediting programs is increasingly important to airlines seeking to reduce their carbon footprint and comply with emerging mandates. Programs such as the U.S. Renewable Fuel Standard (RFS), California's Low Carbon Fuel Standard (LCFS) and other similar programs in Oregon and other states, and the federal Clean Fuel Production Credit under Section 45Z of the Inflation Reduction Act offer financial

incentives for fuels with lower lifecycle greenhouse gas emissions. International frameworks like the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) under ICAO and the ReFuelEU Aviation initiative further reinforce the value of Sustainable Aviation Fuel (SAF) that meets rigorous sustainability benchmarks. Demonstrating eligibility under these programs can enhance the marketability of SAF and align with airline goals.

  - Reductions in local air quality emissions, such as particulate matter and sulfur compounds, compared to conventional fuel may be of interest in some locations.

- Compliance with environmental laws and regulations and avoidance of environmental problems that would call into question the airlines' use of the fuels. One means of reflecting this may be through a demonstration that the fuel was produced in a manner consistent with recognized sustainability criteria as described in the CAAFI Environmental Sustainability Overview document.
- Documentation of environmental benefit
  - Airlines must account for the reduced lifecycle GHG emissions profile of any SAF it is using, both for the benefit of its environmental accounting but also as it may have an obligation to report emissions reductions to its own customers. SAF producers must provide product transfer documentation (PTDs) in addition to the above sustainability certification documentation (e.g., Proof of Sustainability (PoS) or Proof of Compliance (PoC) to ensure airlines can credibly account for the reductions associated with their use of procured SAF.
  - Registration in a recognized SAF registry; such as the Civil Aviation Decarbonization Organization (CADO) SAF Registry, SAFc Registry, ISCC Registry, RSB Book and Claim Registry) will facilitate the use of the sustainability attributes of the fuel by airlines.

➢ **Economic viability**: Every airline will have its own procurement strategy and will ultimately enter its own individual contract with a fuel producer with a unique set of conditions, including price; accordingly, any final decisions on price will be the product of direct engagement between the airline and the fuel supplier. However, the following points generally reflect the widely shared views of jet-fuel buyers:

- **Price competitiveness:** Airlines are interested in alternative fuels that offer price competitiveness versus conventional fuel. In general, this means that the net price of alternative fuels, including any tax or other credits as well as adjustments for additional logistics and blending, should be, on average, comparable to the price of conventional fuel. For alternative fuels still in development, the basis of comparison typically would be the forward curve[1] of conventional jet fuel for the future periods in which the alternative fuels may become available.
- **Flexibility in pricing mechanism**: Airlines are open to different pricing mechanisms. For example, they can consider indexing to the price of conventional jet fuel (current or forward curve) and indexing to the price of conventional fuel accompanied by a price collar. They are also open to considering indexing to various commodities other than crude oil (e.g. input feedstocks, or closely related renewable diesel).
- **Valuation of environmental or other credits**: Because of regulatory or policy frameworks, some alternative fuels could earn environmental, tax, or other types of credit, such as a RIN

[1] Forward price curves for jet fuel represent market expectations for future prices and are derived from futures market data (e.g., NYMEX Jet Fuel Futures), price assessments by agencies like Platts or Argus, and key market fundamentals such as crude oil prices, refinery margins, and seasonal demand. These curves are used for hedging, pricing contracts, and gauging market sentiment, and they may slope upward (contango) or downward (backwardation) depending on supply-demand dynamics. platts-forward-curve-oil.pdf.

credit under the U.S. RFS2 program[2] or the emerging ICAO CORSIA system.[3] While it is recognized that these credits can help reduce the purchase price of alternative jet fuel, airlines find it difficult to evaluate those credits over the long run given uncertainties in the market for those credits and lack of visibility into the stability of those regulatory or policy frameworks and associated markets. Thus, the airlines are likely to take the risk associated with such credits into account when discussing their potential role and value in a purchase agreement, particularly if contracts span over multiple years.

- **Alternative fuels currently do not appear to provide value as a hedge instrument**: It is possible that alternative jet fuel may provide price diversification to an airline with respect to conventional fuel. However, given the nascent nature of the commercial alternative jet fuel industry and associated price history, airlines are unable to quantify the value of a potential hedge. A viable hedge requires market liquidity (i.e., a high volume of bids and asks), which is highly unlikely for renewable jet fuel both based on the scarcity of volume and based on experience that even the market for conventional jet fuel is illiquid. This is evidenced by the fact that airlines rarely hedge jet fuel; instead, those that opt to hedge typically hedge crude oil, heating oil or comparable liquid commodities. In addition, it is helpful to keep in mind that airline attitudes with respect to hedging are very different, with some airlines having extensive hedging portfolios and others not hedging at all.
- **Small premiums combined with cooperative purchases**: Airlines are generally willing to explore the possibility of purchasing small amounts of alternative fuel as a group. In such a scenario, they may be willing to pay a small premium for the alternative fuel provided that it would be a meaningful step toward commercialization. A cooperative purchase agreement with a "step-up" clause would allow airlines to spread the risk amongst them while assuring producers that the contracted volumes collectively would be purchased by the group.

➢ **Reliability of supply and on-time delivery**: Airlines put special emphasis in the reliability of supply and on-time, on-specification delivery of the fuel; any supplier of jet fuel to the airlines, be it conventional or alternative, must meet the stringent requirements for delivery and availability of the product that airlines require to be able to operate their flights on a daily, year-round basis.

➢ **Commercial viability:** Airlines are acutely aware of the risks associated with investing in this sector, including via purchase agreements. Accordingly, airlines are interested only in those commercial entities that adequately address the following types of risk:

1. Construction – what is the cost and time to complete?
2. Technology – what is the technology maturity (first-of-a-kind vs. already commercially viable)? What if the technology does not work, or fails to yield the promised production? If licensing, is the technology going to be available and delivered on time?
3. Feedstock – will it be available and at what cost?
4. Policy – if the project's viability depends on government policy/assistance, will that policy remain

[2] The expanded Renewable Fuel Standard, commonly known as" RFS2," establishes mandates of renewable and advanced fuels for the U.S. transportation fuel supply. In a 2013 ruling, the U.S. Environmental Protection Agency (EPA) allowed for jet fuel pathways to qualify under RFS2. Several jet fuel pathways have been approved under RFS2, with more under consideration.
Renewable Identification Numbers (RINs) are generated for each gallon of qualifying renewable fuel under RFS2. Obligated parties (e.g., refineries and other fuel suppliers) can use RINs to meet their renewable volume obligations and can trade or bank them for future compliance periods. Thus, RFS2 creates a market for RINs, which can be used to offset the cost of renewable fuel. For more information, see: https://www.epa.gov/renewable-fuel-standard.

[3] CORSIA is a carbon offsetting system that is being developed under ICAO, the United Nations body that sets standards and recommended practices for international civil aviation. The CORSIA framework, which calls for certain carbon offsetting provisions to become effective beginning in 2021, contemplates that the lifecycle GHG emissions savings from an aircraft operator's purchase of alternative jet fuel may be credited against the operator's carbon offset obligation, if the fuel meets the environmental, sustainability and tracking criteria. Those criteria are currently under development at ICAO. For more information, see: https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx.

constant throughout the facility's economic life?

5. Financial – have the economic assumptions (e.g., cost of debt and equity, cost of production, selling price of all of the fuel products) been realized?
6. Engineering – is the engineering and design of the plant appropriate?
7. Management – what experience does management have and what happens if it proves inadequate for the task?
8. Supply chain – will the project be able to bear delays in supplies, materials, and ensure redundancy in parts for the project to be completed and started up on time?
9. Scalability – is the project able to scale up and generate meaningful quantities of fuel to provide reliable supply and help lower fuel price over time through economies of scale?
10. Blending infrastructure – is there blending infrastructure available or does it need to be built?
11. Sustainability criteria – does the product incorporate corporate sustainability accounting best practices? Is the process third-party sustainability certified?

What are airlines willing to do to help commercialize alternative jet fuel?

Airlines are interested in accelerating the commercialization of alternative fuels provided that the airline industry's competitiveness is not negatively affected. Airlines are open to creative ideas that can lead to meaningful progress, provided the commercial viability considerations are met. Supportive action may include:

- **Long-term off-take agreements:** Airlines are willing to consider entering into long-term off-take agreements, defined as agreements of three years or more. Throughout the term of the agreement, there may be flexibility with respect to some of the key conditions (e.g., price, volume, products). Generally, airlines are unable to consider agreements exceeding 10 years. (Note: Most term contracts for conventional jet fuel range from 12 to 24 months.) **Spot market purchases:** Airlines may also consider purchasing SAF on the spot market, particularly when such transactions offer short-term flexibility, price advantages, or opportunities to meet sustainability targets without long-term contractual commitments. These purchases can complement broader procurement strategies and provide a responsive mechanism to evolving market conditions.
- **Book & Claim purchases:** While the premium for alternate jet fuels pose a financial burden for airlines, if born alone, they can be managed by agreements airlines hold with their corporate and/or cargo sales customers, many of whom are large corporations with emissions reductions goals of their own that are looking to reduce particularly their travel footprint. Under these procurement structures, airlines contract within their value chain with customers who are looking to mitigate their travel carbon footprint and apply the funds collected by those customers to pay down the alternate jet fuel premium. After the fuel has been used, the calculated emissions reductions associated with the use is allocated specifically to those customers, lowering the emissions across the value chain. As indicated above, this use is facilitated by the SAF registration in a relevant SAF registry.
- **Flexibility in product delivery:** While airlines are primarily interested in alternative fuels for use on aircraft, they also acknowledge that a) most processes for alternative jet fuel production also generate alternative fuels for surface use, and b) the economics of many processes may favor production of alternative fuels for surface use. Therefore, airlines are open to considering the entire production slate of alternative fuel facilities as part of an off-take agreement. This may include airlines purchasing alternative fuels for surface use to meet their own demands (e.g., for use in ground support equipment). In addition, airlines may be responsive to producer proposals to change the production slate depending on market conditions for both aviation and surface alternative fuels.
- **Cooperative/joint purchases:** As mentioned above, airlines are open to considering joint purchases as a group, including cooperative purchase agreements with the military.
- **Equity stake investments:** Airlines are open to considering becoming upstream investors in

alternative fuel projects, especially in circumstances when their participation can help a producer reach meaningful milestones and accelerate commercialization.

- **Policy advocacy:** Airlines generally are willing to support policy advocacy that could help level the playing field for alternative fuels with respect to conventional fuel – without raising the cost of conventional fuel or other financially negative consequences, particularly for tax credits and subsidies.

What does a "term sheet" look like?

Airline alternative jet fuel supply agreements should consider scope of term materials that are overarching (i.e., can be placed in a master agreement) and those that are delivery and location-specific; for the latter, consider a location agreement. Although the "term sheet" for a commercial agreement will vary depending on the specifics of the arrangement, producers can expect to see many of the following elements:

Item	Example
Product	✓ Alternative jet fuel: neat (certified to ASTM D7566), blended (ratio defined) certified to ASTM D1655 Annex [X] or equivalent ✓ Other alternative fuel (e.g., diesel): neat, blended (ratio) certified to relevant specification. Blended SAF shall be required to conform with any specifications set forth by pipeline or terminal operators that meet or exceed ASTM Standard Specification D1655 ✓ Any affiliated producer or reseller (many times alternative jet fuel is produced by one entity but marketed and sold by another – this should be transparent in the changing of hands)

Item	Example
Feedstock	✓ Source of biomass, CO_2, etc. ✓ No palm, palm derivatives
Delivery point	✓ Refinery gate ✓ Product terminal or pipeline ✓ Airport storage ✓ Into wing
Volume	✓ Typically expressed in annual quantities but could vary seasonally
Term	✓ Typical airline jet fuel term contracts extend from one to two years ✓ Alternative fuel deals may span the same or longer
Target Commercial Operation Date	✓ [X]
Pricing	✓ The pricing mechanism will depend on many factors and will be negotiated directly between buyer(s) and seller(s) ✓ Airline jet-fuel buyers will seek mechanisms that involve risk-sharing by the supplier and investors; for example, if the supplier wants a price floor, a price cap should also be offered
Government policies	✓ Any applicable governing law under which the contracted fuel received an incentive or met a compliance obligation
Credits	✓ Credits to accrue to producer or to buyer ✓ Any additional attestation/documentation required for any incentive credits realized by the airline
Environment/ Sustainability	✓ [X%] reduction of lifecycle GHG emissions relative to conventional fuel according to [Y] methodology (i.e., expected carbon intensity) ✓ Sustainability declaration or certification according to [Z] framework(s) by [X] sustainability certification scheme ✓ Participation in [X] registry
Environmental Attributes	✓ Credits to accrue to producer or to buyer ✓ Any additional attestation/documentation required for any environmental attribute credits realized by the airline

More detail on agreement requirements and considerations are available through the Aivation Fuel Supply Model Agreement (Incorporating Supply of SAF Blend) developed by the International Air Transport Association.

What is the best way to engage with airlines?

CAAFI can be the first point of entry for an interested jet- fuel supplier or marketer. CAAFI is willing and able to help make the necessary introductions for producers to engage with airlines and other end users. When and how to engage with airlines depends to a great extent on how far a given producer is along the commercialization curve.

As mentioned in the introduction, CAAFI has developed a number of “readiness” tools to create a common language and understanding of the development stage of production pathways. The primary tools – the Fuel Readiness Level (FRL), the Feedstock Readiness Level (FSRL) and the Environmental Progression, help facilitate communication with potential end users. Appendix A shows how these three tools relate to one another. In addition, the rightmost column provides guidance as to how and when to approach airlines and other end users through CAAFI according to maturity of the technology. These include:

- For production pathways that are early in the maturity curve (FRL < 3),see "Path to Alternative Jet Fuel Readiness" for more information.
- For production pathways that don't fall within one of the existing ASTM fuel certifications nor within one of the task forces for pathways currently in the certification process, CAAFI can help potential producers, for example, by serving as an interface to the ASTM process, reviewing producer and OEM work plans and research reports, and guiding the work flow through the ASTM annex ballot process.
- For production pathways that have reached the preliminary technical evaluation (FRL 4) or production system validation (FRL 5) stages.
- For production pathways in full-scale technical evaluation (FRL 6) or fuel certification (FRL 7), CAAFI would facilitate the assignment of an airline sponsor to help the producer understand the airlines' requirements and, at the same time, afford the producer the opportunity to start building a business proposition.
- For production pathways in commercialization (FRL 8) or with production capacity established (FRL 9), CAAFI would facilitate direct contacts with interested airline sponsors to engage in commercial discussions.

How else can CAAFI help?

CAAFI can help make introductions to other potential partners that may be interested in supporting an alternative jet fuel project. CAAFI facilitates or advises a number of "state and regional initiatives" in which different stakeholders – including airports, feedstock producers, fuel producers, state and local agencies and airlines – may participate to assemble a proposal for a regional supply-chain solution. CAAFI continues to expand this work and invites the participation of potential fuel producers who have clear goals with respect to supply chain needs.

CAAFI can also assist in identifying funding opportunities through USDA, the Department of Energy (DOE), the Federal Aviation Administration (FAA) or other agencies and coordinate joint reviews with Defense Logistics Agency (DLA) Energy, as well as representatives of the United States Armed Forces.

CAAFI can advise fuel producers as to potential beneficial uses of process co-products for use in aviation (i.e., pavement and aircraft deicers from alcohol-to-jet and biodiesel production, respectively).

For additional information, please visit www.caafi.org.

Appendix A: CAAFI Readiness Tools and Recommended Avenues for Commercial Engagement

Scale	Feedstock Readiness Level (FSRL)	Environmental Progression	Fuel Readiness Level (FRL)				Commercial Engagement
			Description	Fuel Testing and Certification	Tollgate	Fuel Quantity*	
FRL 1	Basic Principles	Basic Principles	Basic Principles		Feedstock and process basic principles identified		"Path to Alternative Jet Fuel Readiness"
FRL 2	Concept Formulated	Concept Formulated	Concept Formulated		Feedstock and complete process identified		"Path to Alternative Jet Fuel Readiness"
FRL 3	Proof of Concept	Proof of Concept	Proof of Concept		Small fuel sample available from lab - basic fuel properties validated	0.13 US gallons (500ml)	"Path to Alternative Jet Fuel Readiness"
FRL 4.1	Preliminary Technical Evaluation	Preliminary Technical Evaluation	Preliminary Technical Evaluation	Preliminary Specification of Properties	System performance and integration studies	10 US gallons (37.8L)	CAAFI facilitates engagement with ASTM for pathways not yet qualified
FRL 4.2					Entry criteria/specification properties evaluated		
FRL 5.1	Production System Validation	Scale up Validation of Initial Assessments	Process Validation		Laboratory production development	80-225,000 US gallons (300-850,000L)	CAAFI facilitates engagement with ASTM for pathways not yet qualified
FRL 5.2					Subscale production demonstrated		
FRL 5.3					Scalability of production demonstrated		
FRL 5.4					Pilot plant capability enabled		
FRL 6.1	Full-Scale Production Initiation	Full-Scale Feedstock Impact Evaluation	Full-Scale Technical Evaluation	Fit-for-Purpose Properties - ASTM Balloting Process	Fit for purpose properties evaluated	80-225,000 US gallons (300-850,000L)	CAAFI facilitates engagement with ASTM for pathways not yet qualified, facilitates preliminary airline engagement
FRL 6.2				Component/Rig Testing - OEM Review and Approval	Turbine hot section testing		
FRL 6.3					Component/rig/emissions testing		
FRL 6.4				Engine/APU Testing - ASTM Research Report	Engine/APU testing		
FRL 7	Feedstock Availability	Full-Scale Fuel Producer Impact Evaluation	Certification/Fuel Approval	Fuel Class Listed in International Fuel Specifications	Fuel class/type listed in international fuel standards		CAAFI facilitates engagement with ASTM for pathways not yet qualified, facilitates preliminary airline engagement
FRL 8	Commercialization	Commercialization	Commercialization		Business model validated for production go-ahead - airline/military purchase agreements secured		CAAFI facilitates engagement with potential airline sponsors
FRL 9	Sustainable Feedstock Production Capacity Established	Sustainable Feedstock and Fuel Supply Established	Production Capacity Established		Full-scale plant operational		CAAFI facilitates engagement with potential airline sponsors

* Quantities required for risk mitigation reference