SUSTAINABLE ALTERNATIVE FUELS: AN OPPORTUNITY FOR AIRPORT LEADERSHIP

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Low-carbon alternative fuels are critical for reducing aviation greenhouse gas emissions. Production and uptake of Sustainable Alternative Fuels (SAF) have progressed steadily since the first-ever biofuel flight in a commercial aircraft in 2008, and more than 1,500 commercial flights have used SAF since 2011[1]. Airlines, OEMs, and governments have played key roles in spurring this advancement, but true commercial scale remains elusive under the current paradigm.

Commercializing SAF is a new frontier, which requires a bold and creative new approach. We at the Carbon War Room are proposing a paradigm shift for the industry, engaging airports to act as key players in catalyzing commercial-scale uptake. The airport-led business model we have developed will establish SAF demand centers, providing a strong market signal to producers and supporting robust supply chains. While we recognize that most airports today are not directly involved in aviation fuels, this innovative, airport-led model, with buy-in from airlines and other airport stakeholders, can overcome the last barriers to commercial-scale SAF use.

Carbon War Room, a business unit of the independent non-profit organization Rocky Mountain Institute, is tackling this challenge directly by working with airports to implement the SAF program described here.

Introduction

The aviation sector has adopted ambitious goals to address its contribution to climate change, with alternative low-carbon fuels as a key element to achieve these goals. Recognizing the importance of alternative fuels in the future of aviation, governments, multi-stakeholder initiatives, and individual airlines have set SAF adoption targets: the European Commission set a target for the European Union of 3% to 4% SAF penetration by 2020, and 40% by 2050, and for the United States, the FAA's goal is 5% SAF market share by 2018[2].

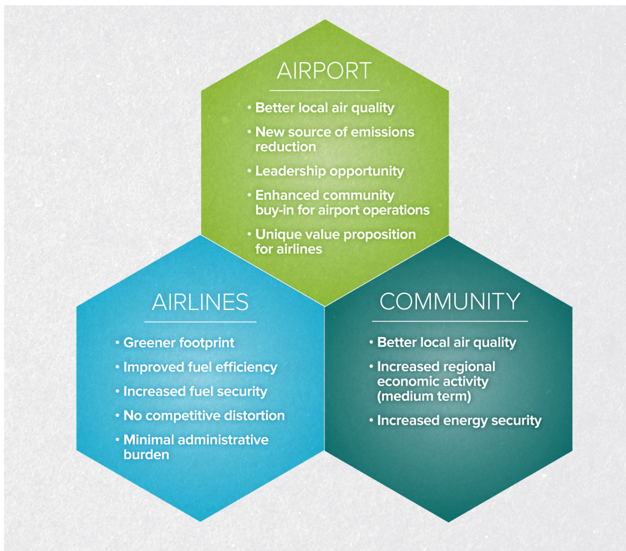
We have a long way to go to reach these targets. Far from being an integrated part of the global aviation fuel mix, SAF today is primarily distributed via boutique supply chains with high associated transaction costs and logistical burdens. The volume of SAF in the market is increasing, but market penetration is still close to zero. Substantial industry shift is required in order to realize a mature SAF industry that is fully integrated into global aviation fuel markets and that can meet stated penetration targets.

Carbon War Room envisions this shift occurring at the individual airport level, with the airport itself playing a key role. Integrating SAF directly into the on-airport fueling infrastructure, at an airport-wide blend ratio, will transition SAF from an alternative product used by some airlines on a project basis, to a standard product that is used for business-as-usual. This standardization would send a strong and consistent demand signal to the SAF industry, which boosts investor confidence and catalyzes industry growth. Individual breakthroughs driven by airlines, such as United's leadership at Los Angeles International with AltAir Fuels, are difficult to replicate given the associated administrative burden and costs for the carrier. We believe that airports are thus key to unlocking this new paradigm.

Why Airports?

Airports can leverage their unique position at the intersection of airlines, fuel suppliers, fuel operators, governments, and communities to support SAF's transition from isolated procurement transactions to use in regular operations. Because

FIGURE 1. ADVANTAGES OF AIRPORT- BASED APPROACH



an airport can aggregate fuel demand across all airlines, and also plays an integral role in the regional economy where it is located, an airport-led approach will benefit airlines, communities, and the airport itself. **Figure 1** illustrates key advantages to each of these stakeholders.

These advantages include:

- **Economies of scale.** Aggregating demand across all airlines at the airport increases total volume while reducing transaction costs, logistical complexity, and administrative burden.
- **Reduced risk.** Fuel requirements at an airport level are generally stable, providing a bankable commitment for SAF producers. Additionally, the increased diversification of the fuel pool adds robustness to the fuel supply, decreasing fuel supply risk.
- **Equality.** Refueling all airlines at the same blend ratio enables smaller airlines without the resources to implement a SAF off-take agreement to participate. It also avoids the competitive distortion resulting from a single airline shouldering the SAF procurement burden.
- **Regional economic development.** A proven airport demand center can encourage investment in regional feedstock production and alternative-fuel refinery capacity, and can stimulate increased downstream activities in the region.
- **Reduced CO_2 emissions.** Using SAF can be up to 80% less carbon intensive on a lifecycle basis than conventional jet fuel[3]. As airports increasingly address their carbon footprint (138 airports around the world participate in Airports Council International's successful Carbon Accreditation program),[4] leading airports could consider implementing an SAF program as an innovative carbon reduction initiative.
- **Improved local air quality.** SAF use reduces SOx and particulate matter emissions during takeoff and landing, improving local air quality.
- **License to grow.** The environmental benefits of SAF use can mitigate environmental impact concerns related to proposed future airport activities and/or infrastructure.
- **Unique value proposition.** SAF availability enhances airport attractiveness for air service development opportunities by providing a unique service to interested airlines.
- **World leadership.** The airport-led approach is an opportunity to demonstrate world leadership in a bold, new, green initiative. Early adopter airports will earn public recognition and enjoy a PR advantage.

The specific business model proposed by Carbon War Room can support this innovative new role for airports by enabling these benefits while minimizing changes to existing procedures and processes.

The Carbon War Room Approach

Carbon War Room has developed a unique business model to deliver an airport SAF program. Carbon War Room (CWR) is a business unit of the Rocky Mountain Institute, an independent non-profit that delivers market-based solutions to a decarbonized economy. We further refined the model in cooperation with our partner SkyNRG, a global market leader in the blending, distribution, and sales of sustainable jet fuel. SkyNRG has the capability to orchestrate the logistics of this business model. As a partnership, we bring expertise in both alternative fuels and innovative low-carbon business solutions.

Using sustainable alternative fuels can be up to 80% less carbon intensive on a lifecycle basis than conventional jet fuel.

Our business model centers on the airport as an aggregator of fuel demand and of funds, and as an orchestrator of the procurement and delivery of SAF. SAF would be provided to all jet aircraft refueling at the airport at an airport-wide blend ratio. We envision an initial low blend ratio of 1% to 3%; a ratio which minimizes total costs while laying the groundwork for future volume increases.

The current refueling process would remain unchanged for most stakeholders. Airlines would continue to procure fuel from their current suppliers, at current prices, and refuel at the airport as usual. They would receive fuel that fully meets ASTM and other relevant standards. Additional administrative and logistical requirements for airlines would be minimal. Fuel supply security would be unaffected or improved. Fuel suppliers already operating at the airport would have minimal changes to their operations, if any.

The airport authority would designate an individual or team to manage the aggregation of funds to purchase the SAF (see the Funding and Cost section, below). The funds would be designated for the SAF project, and we recommend a transparent bookkeeping approach that allows all stakeholders to monitor the disbursements of designated funds. The funds cover the price premium of SAF, its blending, and its delivery to the airport fuel farm.

The project also requires an "orchestrator." The airport could assign internal personnel to this role, or contract an expert team. The roles of the orchestrator include: managing the procurement of the pre-blended, or neat, SAF (described as "biocomponent" in Figure 2B), overseeing the blending of the fuel, verifying fuel certification, and ensuring delivery of the final blended fuel. The fueling would be delivered directly to the existing airport fueling infrastructure (i.e., tank farm, hydrant system, etc.), to allow all jet aircraft refueling at the airport to use the blend. It is important to note that once the neat SAF has been blended into the conventional fuel, the resulting blended fuel is fully certified as Jet A or Jet A-1 and can be blended into the rest of the fuel pool, using existing airport infrastructure and standard procedures. **Figures 2A** and **2B** illustrate the current and proposed supply chains in one of our candidate airports.

FIGURE 2A. CURRENT AIRPORT FUEL SUPPLY CHAIN (ILLUSTRATIVE)

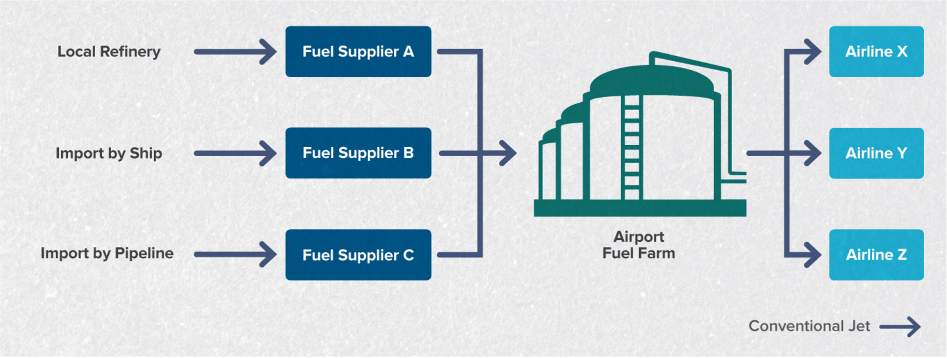
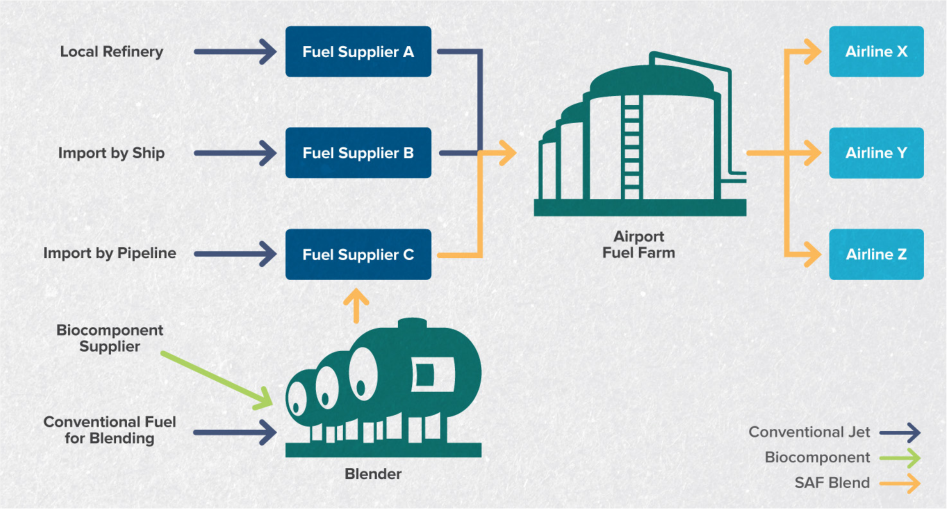


FIGURE 2B. PROPOSED "HYBRID BLENDING" (ILLUSTRATIVE)



The fuel supply chain schematic illustrated above is based on the situation at a specific candidate airport. Supply chain modifications will vary on an airport-by-airport basis. Note that the blender can be a new or existing fuel supplier.

The orchestrator would also ensure the sustainability and traceability of the fuel, manage reporting to airport stakeholders, (e.g. airlines, fuel suppliers, etc.), and coordinate the communication of progress and achievements in the media. As the environmental and social sustainability of feedstocks are key concerns for many aviation stakeholders, including passengers, we recommend the airport procure fuel that adheres to the standards put forth by the Roundtable on Sustainable Biomaterials (RSB). Financial responsibilities of the orchestrator would include budgeting, accounting for any relevant credits or subsidies, insurance and risk management, financial reporting, and any obligations under an offsetting scheme. The orchestrator would procure as much SAF as possible with the available funds (this may vary from year to year).

Assigning these responsibilities to a centralized orchestrator minimizes stakeholder burden while accelerating impact.

Funding and Cost

As indicated above, the airport authority would manage covering the SAF cost premium. The cost of SAF relative to conventional jet fuel has decreased substantially over time, but a price differential remains. The airlines would cover the base jet fuel price as usual, so the airport would only need to cover the difference. Total cost would depend on the fuel volume at the airport, the blend ratio, and the type of SAF procured. **Figure 3**[1] illustrates sample per-passenger cost calculations. Note that the costs in the United States are lower than the costs in Europe due to the incentives provided by the US Renewable Fuel Standard.

The airport, working with its airline partners, would identify the best mechanism for covering the cost premium. This decision should be made on a case-by-case basis, taking into account the financial profile and preferences of the airport. Several potential funding sources to cover these costs are presented below. This list is not meant to be exhaustive, but rather illustrative of the variety of options available to airports interested in pursuing this business model.

Possible sources of revenues to cover the SAF cost premium include:

[1]Costs will vary by airport due to logistics, average fuel usage, and regional incentives. Airport identification has been removed for confidentiality. Per passenger rates are based on total passengers, and all values expressed in USD.

FIGURE 3. SAMPLE ESTIMATED COSTS

	EUROPEAN AIRPORTS		US AIRPORTS	
	Airport 1	Airport 2	Airport 3	Airport 4
Total Passengers	25 million	55 million	34 million	45 million
Per Passenger Cost (2.5% blend)	$0.70	$1.02	$0.33	$0.45

FIGURE 4. IMPACT ON LOCAL AIR QUALITY*

POLLUTANT	REDUCTION (2.5% BLEND)
CO_2 (Life cycle basis)	-1.9%
LTO SO_x	-2.5%
LTO Fine Particles	-2.3%

*Extrapolated from NASA APEX, AAFEX and ACCESS missions. NOx and CO are excluded, as the impact of biofuels use on these emissions is inconsistent across fuel types. Table shows impact on aggregate emissions from total fuel burn.

Non-aeronautical airport revenues, for example from activities such as vehicle parking.

Operational cost savings from sustainable energy infrastructure, cost reductions through capital investments, efficiency subsidies, and renewable energy incentives can be tracked and redirected towards the biofuels program.

Government subsidies, policies and grants could decrease the price differential. For example, in the US, under the Renewable Fuel Standard, blending of alternative fuels generates saleable credits (called RINs), and RIN revenue decreases the price gap. A similar "bioticket" system exists in the Netherlands. If the EU's Renewable Energy Directive could be applied in this way to aviation, it could reduce the premium by almost one-third. Additional possibilities in this category include municipal tax breaks and subsidies for job creation.

Contributions from locally based corporate sponsors/customers (similar to SkyNRG's Fly Green Fund model) would decrease the amount of airport funding required and provide a PR opportunity for the sponsors.

Impact

The primary environmental impact from increased SAF uptake is reduced CO2 emissions. SAF can be up to 80% less carbon intensive, on a lifecycle basis, than conventional jet fuel[5]. The actual emissions reduction achieved depends on many factors, including the fuel volumes at the airport, the blending ratio, the type of feedstock, and refinery process, among other factors. For illustrative purposes, an airport using 25,000 tons of SAF (for example, as a 2.5% blend over 1 million tons of fuel airport-wide) would reduce emissions by 39,000–62,400 tons.

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Because many biofuels are more energy dense than conventional jet fuel,[6] carbon benefits are enhanced by factoring in the energy requirements associated with the liquid weight of the aircraft fuel. On longer routes, significant aircraft energy is required to transport the weight of the fuel itself. So if the fuel is more energy dense, then less fuel is required to travel a given distance, resulting in a beneficial feedback loop that further decreases emissions reductions.

An additional benefit of SAF use is the improvement of local air quality and associated human health benefits. SOx and fine particles are both proven to have negative impacts on human health7. They contribute to air pollution around the airport when emitted during takeoff and landing. Both SOx and fine particles can be reduced with SAF. **Figure 4** provides estimates of these improvements.[7, 8]

Looking Ahead

The airport-led approach described above represents a paradigm shift with the long-term impact of catalyzing rapid increases of SAF usage. As the international aviation sector pursues carbon-neutral growth from 2020, a mature SAF industry will provide valuable emissions reductions. This business model can jumpstart the transition of SAF from intermittent use to become the new business-as-usual.

[7]CO2 calculations in Figure 4 assume a 75% lifecycle carbon reduction over conventional fossil jet fuel. Actual carbon reductions depend on the type of fuel, and in general range between 50-80%.

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