

F R O S T & S U L L I V A N

2024 TECHNOLOGY INNOVATION LEADER

*IN THE GLOBAL BOOK
AND CLAIM SAF SYSTEMS
INDUSTRY*

F R O S T & S U L L I V A N

BEST
2024 PRACTICES
AWARD



Shell Low Carbon Solutions

Best Practices Criteria for World-Class Performance

Frost & Sullivan applies a rigorous analytical process to evaluate multiple nominees for each award category before determining the final award recipient. The process involves a detailed evaluation of best practices criteria across two dimensions for each nominated company. Shell Aviation excels in many of the criteria in the book and claim SAF systems space.

| AWARD CRITERIA | |
|----------------------------|------------------------|
| <i>Technology Leverage</i> | <i>Business Impact</i> |
| Commitment to Innovation | Financial Performance |
| Commitment to Creativity | Customer Acquisition |
| Stage Gate Efficiency | Operational Efficiency |
| Commercialization Success | Growth Potential |
| Application Diversity | Human Capital |

Global Decarbonization Efforts and Scalability Are Driving Growth in the SAF Space

Global private and public stakeholders' concerns about carbon emissions are escalating, emphasizing its

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- Riana Barnard
Best Practices Research Analyst

dire impact on climate change and global warming. As such, policymakers focus sharply on the highly polluting aviation industry, which contributes 2% to global carbon dioxide (CO₂) emissions, to reduce its environmental impact. The industry has initiated the decarbonization process and seeks to incorporate sustainable aviation fuel (SAF) to offset its emissions. SAF is an alternative fuel produced from a wide range of non-petroleum feedstock with a lower environmental impact of greenhouse gas (GHG) emissions than regular jet fuel. These feedstocks include waste oil and fat, solid waste, crops,

waste gas, and algae. To date, ASTM International (the standards body that regulates the industry) has approved 11 SAF production pathways and is also examining many other alternatives.

While currently SAF achieves an average 80% reduction of GHG emissions over the entire production and implementation lifecycle, it has the potential to reach a reduction of up to 94%¹, with results varying based

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- Julieta Paez
Industry Analyst: Sustainability and Circular Economy
Practice Area

on production pathways and feedstock. However, the high price of SAF, which is approximately two and a half times higher than conventional jet fuel, is a major obstacle to decarbonization. Also, the lack of specialized SAF infrastructure, including storage and distribution systems, restrains widespread adoption in minor airports, limiting the uptake to specific facilities.

SAF expansion relies on developing more cost-effective and sustainable pathways to address long-term feedstock limitations. Economies of scale and technology maturity will reduce the challenges associated with some of these pathways, making widespread adoption feasible. Frost & Sullivan expects that high production costs will decrease as technology matures and producers incorporate innovative methods to drive widespread adoption. In addition, SAF implementation can provide environmental benefits in the form of emission reduction and repurposing of waste, which producers can divert from landfills and use as feedstock. Importantly, tax incentives, grants, and financial support can help de-risk investments and accelerate the transition, assisting SAF producers to scale and meet the demand. In particular, book and claim models can help increase the demand for SAF by allowing more stakeholders in the aviation value chain to contribute and benefit from this solution. It allows carriers and corporations to benefit from the environmental attributes of SAF and leverage them for their own emission reduction disclosure purposes, even if SAF is not available at the physical location they are flying from.

Frost & Sullivan predicts that the SAF industry in North America will grow from \$1,044.6 million to over \$16,851.0 million by the end of the decade, with a compound annual growth rate of 48.8% from 2023 to 2030. Additionally, analysts at Frost & Sullivan expect a significant increase in production volume between 2026 and 2028, reaching 11,946.6 million liters of SAF annually based on the current announced capacity. Looking ahead, Frost & Sullivan projects the demand for SAF to exceed 500 billion liters by 2050, positioning the global aviation industry as a high-growth area.²

Needs-based Innovation Strategy

Shell Aviation, with a rich heritage spanning more than a century, continues to rely on its innovative spirit, problem-solving skills, and, most importantly, its collaborative approach as it progresses on its journey to

¹ <https://www.sciencedirect.com/science/article/pii/S1364032121006833?via%3Dihub> (Accessed in November 2024). Actual life cycle GHG emissions intensity of neat SAF and baseline comparator might vary per region/feedstock.

² *North American Sustainable Aviation Fuel Growth Opportunities, 2024 – 2030: Global Decarbonization Efforts and Scalability Concerns are Driving Growth in this High-potential Industry* (Frost & Sullivan, September 2024)

net-zero emissions. The company has been active in the renewable energy sector for many years. In 2009, it developed a certified synthetic fuel from natural gas, which a Qatar Airways Airbus A340-600 used for the world's first commercial passenger flight. This fuel, a 50:50 blend of synthetic gas to liquid kerosene (GTL) and traditional oil-based kerosene, was produced at Shell's GTL plant in Bintulu, Malaysia.³

In 2021, Shell made 500 liters of synthetic power-to-liquid kerosene, known as e-fuel, in The Netherlands. KLM then used this e-fuel for a commercial flight from Amsterdam to Madrid. This e-fuel, a blend of captured carbon and green hydrogen made from water and renewable power, is a result of the collaborative efforts of Shell Aviation and its partners.⁴ Over the years, Shell Aviation has gained a strong understanding of the market landscape and regulatory requirements, recognizing SAF as the only scalable in-sector solution for decarbonizing aviation.

In particular, Shell Aviation has recognized a major challenge in the SAF sector. The cost affordability of SAF has led to a lack of demand, which hinders the expansion of its supply. Without strong demand signals, there is limited incentive for investment in supply expansion. In addition to addressing this complex relationship between supply and demand, Shell Aviation underscores the importance of collaboration in designing an innovative solution to support the decarbonization of the aviation sector.

The company partnered with Accenture, American Express Global Business Travel (Amex GBT) and Energy Web Foundation to launch Avelia, a blockchain-based book and claim platform, in June 2022 at an International Air Transport Association (IATA) annual general meeting in Doha, Qatar. By using the book and claim model, Avelia allows companies in the aviation ecosystem who do not directly use fuels and airlines who do not have access to SAF at their location, the ability to access environmental attributes of SAF to reduce their emissions, without requiring physical access to supply. Thus, Avelia enables more stakeholders in the aviation value chain to use and benefit from SAF, helping to make it a more commercially viable decarbonization solution.

The partnership is a prime example of cross-value chain collaboration. Amex GBT leverages its customer base and insights to make SAF's environmental benefits available to more parties, helping Avelia connect corporate travel demand with SAF supply. As Avelia's business and technology partner, Accenture has driven the technical design and build of the platform and continues to play a pivotal role in its ongoing evolution and growth, while Energy Web Foundation serves as technical advisor.

A Proven Track Record

Avelia's value proposition focuses on helping to scale the demand and use of SAF by allowing more players in the aviation value chain to contribute to and benefit from SAF usage, accelerating the industry's transition to cleaner energy.

Avelia stands out in the SAF space due to its unwavering commitment to transparent and credible practices. Avelia also uses blockchain, a tamper-proof digital database, to securely track both the delivery of the fuel into the aviation fueling network and the allocation of the associated environmental attributes,

³ <https://www.shell.com/business-customers/aviation/100years/flying-together/paving-saf.html> (Accessed in September 2024)

⁴ <https://www.shell.com/business-customers/aviation/100years/flying-together/paving-saf.html> (Accessed in September 2024)

while avoiding issues such as double counting. This provides customers with confidence in the source of the data and allows them the option to authenticate and record the associated Declarations of Environmental Attributes (DEAs) in their climate disclosures.

Avelia has received independent verification from external auditor LRQA which proves the accuracy of Avelia's SAF carbon accounting methodology and its environmental attributes allocation. Furthermore, Avelia has set a benchmark by being among the first SAF book and claim solutions to publish a verified GHG progress statement, demonstrating its dedication to creating more impact through information transparency.

As an industry pioneer, Shell Aviation has a proven track record. From its launch to September 16th 2024, the Avelia platform has introduced over 18 million gallons of SAF into the existing fuel network, abating⁵ more than 165,000 tons of CO₂e. Additionally, Shell Aviation signed agreements with carriers and leading companies to supply 49 million gallons of SAF up to 2026⁶. Participants are Alaska Airlines, Aon, Bank of America, Cathay Pacific Airways, Delta Air Lines, Emirates, Google LLC, Kintetsu World Express, Japan Airlines, JetBlue Airways, Rolls-Royce, British Cycling and Yokogawa, among others. The potential impact of these contracts could bring the total abated⁷ CO₂e to 450,000 tCO₂e (or the equivalent of nearly 800,000 passengers flying from London to New York⁸). Since it was launched and up to the 16th of September 2024, over 35 airlines and corporations⁹ have purchased environmental attributes through Avelia, with over 650 Declarations of Environmental Attributes retirements transacted, demonstrating impact and support for eco-friendly practices within the aviation industry.

Frost & Sullivan foresees that the Avelia book and claim platform will significantly accelerate SAF adoption. Shell Aviation's collaborative approach has advanced the platform's first-mover status, strengthening its position to capitalize on emerging opportunities.

Technology Sparked by a Commitment to Make an Impact

Avelia works closely with customers during the purchase journey. Sales professionals onboard clients and support them in closing deals. A dedicated team of specialists manages the platform, ensuring continuous improvement based on customer feedback. Avelia also has in-house greenhouse gas (GHG) experts who have developed an analogy calculator, which allows the platform to convert the CO₂ equivalent value into a visualization that is easier for customers to understand.

Shell Aviation engages with many customers using thought leadership across various marketing channels. As of October 2024, there are over 45,000 subscribers on its official LinkedIn channel, it shares informative videos to raise public awareness about its services. To amplify its message, Avelia selectively participates

⁵ Actual life cycle GHG emissions intensity of neat SAF and baseline comparator might vary per region/feedstock.

⁶ Interview with Frost & Sullivan (4 September 2024). The amount of attributes ultimately delivered under these agreements will depend on the availability/supply of SAF during the relevant contract periods.

⁷ Basis for the projected carbon abatement computation: CORSIA default is of 22.5 gCO₂e/MJ for HEFA SAF with beef tallow, relative to the CORSIA default of 89.0 gCO₂e/MJ for conventional jet fuel. Data can be found in "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels - Second Edition (ICAO int)". Actual life cycle GHG emissions intensity of neat SAF will be known upon delivery.

⁸ The number of one-way long haul average passenger flights has been calculated based on the following assumptions, a flight distance between London and New York of 5541km, and an emissions factor for a long-haul flight of 0.102 kgCO₂e/passenger-km based on UK DEFRA 2022 emissions factors for corporate reporting.

⁹ Airline carriers and corporations who have signed on to Avelia include Alaska Airlines, Amex GBT, Aon, Bank of America, Cathay Pacific Airways, Delta Air Lines, Emirates, Google LLC, Kintetsu World Express, JetBlue Airways, Rolls-Royce, British Cycling and Yokogawa among others.

in events such as SAF Futures and Global Business Travel Association (GBTA). Its active involvement in these events aims to share progress, create awareness, and impart knowledge in the business travel sector.

Shell Aviation partners with Amex GBT to identify major corporations as they play a significant role in the corporate travel market. Furthermore, the Avelia team works with key players in the air cargo forwarding industry to understand their needs and has recently launched a new offering – Avelia Air Freight Solutions – for the air freight sector.

Conclusion

Technology is a critical success factor for the development of the sustainable aviation fuel (SAF) industry. Yet, with many options available, market stakeholders need to leverage the most appropriate and best technology-based solutions to optimize their market impact. With its blockchain-powered book and claim platform Avelia, Shell Aviation overcame issues related to limited SAF access in certain areas, exacerbated by the high costs of transporting and storing SAF. The blockchain technology delivers security and transparency, enabling customers to verify the authenticity of the environmental attributes of SAF they are purchasing. Avelia's proven track record helps to build confidence in SAF as a decarbonization solution, which drives demand to accelerate widespread adoption. The solution stands out from competitors' offerings based on its commitment to innovative, transparent and credible practices, while achieving commercial success. Over a short period, Avelia has injected over 18 million gallons of SAF into the existing fuel network, abating over 165,000 tons of carbon dioxide equivalent¹⁰.

With its strong overall performance, Shell Aviation earns Frost & Sullivan's 2024 Global Technology Innovation Leadership Award in the book and claim SAF systems industry.

¹⁰ Actual life cycle GHG emissions intensity of neat SAF and baseline comparator might vary per region/feedstock.

What You Need to Know about the Technology Innovation Leadership Recognition

Frost & Sullivan's Technology Innovation Leadership Award recognizes the company that has introduced the best underlying technology for achieving remarkable product and customer success while driving future business value.

Best Practices Award Analysis

For the Technology Innovation Leadership Award, Frost & Sullivan analysts independently evaluated the criteria listed below.

Technology Leverage

Commitment to Innovation: Continuous emerging technology adoption and creation enables new product development and enhances product performance

Commitment to Creativity: Company leverages technology advancements to push the limits of form and function in the pursuit of white space innovation

Stage Gate Efficiency: Technology adoption enhances the stage gate process for launching new products and solutions

Commercialization Success: Company displays a proven track record of taking new technologies to market with a high success rate

Application Diversity: Company develops and/or integrates technology that serves multiple applications and multiple environments

Business Impact

Financial Performance: Strong overall financial performance is achieved in terms of revenues, revenue growth, operating margin, and other key financial metrics

Customer Acquisition: Customer-facing processes support efficient and consistent new customer acquisition while enhancing customer retention

Operational Efficiency: Company staff performs assigned tasks productively, quickly, and to a high-quality standard

Growth Potential: Growth is fostered by a strong customer focus that strengthens the brand and reinforces customer loyalty

Human Capital: Commitment to quality and to customers characterize the company culture, which in turn enhances employee morale and retention

