

Aerospace & Defense Practice

# How the aviation industry could help scale sustainable fuel production

Demand for sustainable aviation fuel could outpace supply by 2030 without a significant increase in capacity. Forward-leaning aviation players use a combination of strategies to source SAF, including equity investments, to help scale the ecosystem.

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with Geert Mulder*



**Airlines around the world** are committing to ambitious decarbonization goals to reach the industry target of net-zero emissions by 2050. Among potential decarbonization measures, sustainable aviation fuel (SAF) will make the biggest contributions—up to 50 percent of abatement, depending on the airline.<sup>1</sup> Sustainable fuels, which are already certified for use in today’s jet engines, produce about 80 percent less greenhouse gas emissions than fossil kerosene.<sup>2</sup>

The SAF industry is still in its infancy: in 2024, production capacity will not exceed 1.5 million metric tons (Mt),<sup>3</sup> barely 0.5 percent of total jet fuel needs, according to International Air Transport Association estimates.<sup>4</sup> We expect demand to rise, however, due to regulation and voluntary airline commitments. The estimated global demand from mandated SAF is around 4.5 million Mt in 2030. Considering mandated and target demand, this number increases by 2 million Mt from Asia and 10 million Mt from North America to a total of 16 million Mt or more. Airlines have voluntarily pledged to use even more: announcements of the largest airlines

would accumulate to more than 20 million Mt in 2030.<sup>5</sup>

SAF policies are key for supporting market growth, of which mandates are relatively certain because of penalties for noncompliance. But in an industry known for volatility, intense global competition, and slim margins, some airlines might miss their voluntary decarbonization targets if SAF remains expensive and in short supply—for example, SAF currently costs around 3 times more than fossil fuel kerosene.<sup>6</sup>

With jet fuel historically accounting for 20 to 30 percent of operational costs,<sup>7</sup> airlines voluntarily adopting SAF blend-rate targets of 10 percent by 2030 would need to pass on 4 to 6 percent of total cost increases to customers via green premiums, depending on where airlines are based on and what support mechanisms are in place. Lufthansa Group, for example, introduced an environmental cost surcharge in June 2024, applying it to all departures from EU-27 countries.<sup>8</sup>

## Among potential decarbonization measures, sustainable aviation fuel (SAF) will make the biggest contributions—up to 50 percent of abatement, depending on the airline.

<sup>1</sup> “Decarbonizing aviation: Executing on net-zero goals,” McKinsey, June 16, 2023.

<sup>2</sup> “Net zero 2050: Sustainable aviation fuels,” International Air Transport Association (IATA), accessed July 15, 2024.

<sup>3</sup> “SAF production to triple in 2024 but more opportunities for diversification needed,” International Air Transport Association (IATA), June 2, 2024.

<sup>4</sup> “SAF production to triple in 2024 but more opportunities for diversification needed,” IATA, June 2, 2024.

<sup>5</sup> McKinsey SAF supply and demand analysis, 2024.

<sup>6</sup> Argus Media, accessed July 17, 2024.

<sup>7</sup> Alex Dichter, Kimberly Henderson, Robin Riedel, and Daniel Riefer, “How airlines can chart a path to zero-carbon flying,” McKinsey, May 13, 2020.

<sup>8</sup> “Lufthansa Group introduces Environmental Cost Surcharge,” Lufthansa Group, June 25, 2024.

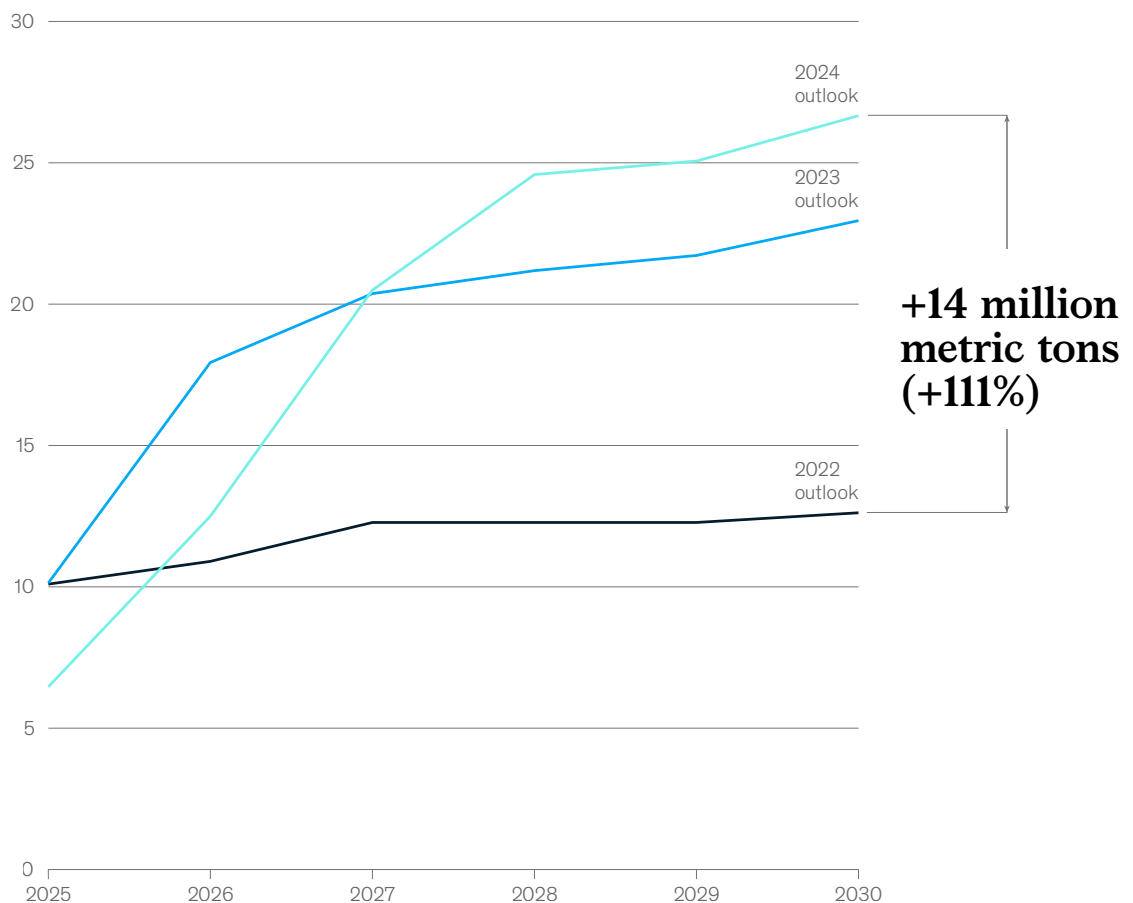
On the supply side, progress is under way around the world: energy majors, airlines, start-ups, and scale-ups are pursuing more than 200 SAF production projects. Some are operational, while others are in development, waiting for final investment decisions (FIDs). Taking into account all announced facilities, we estimate that annual global SAF production capacity would approach 11 million to 25 million Mt by 2030, but those supplies come with significant uncertainty. Not all announced projects will materialize, for example. Expanding

production beyond the use of waste oils will require scaling up new and immature technologies, while relatively high interest rates and risk premiums could discourage investment, especially in immature technologies such as synthetic fuels. Since 2022, announced production capacity expected to be operational by 2030 has increased significantly, while capacity that was expected to become operational in the near future has been delayed (Exhibit 1).

Exhibit 1

**The announced capacity for global sustainable fuel in 2030 has doubled since 2022.**

**Sustainable aviation fuel, million metric tons**



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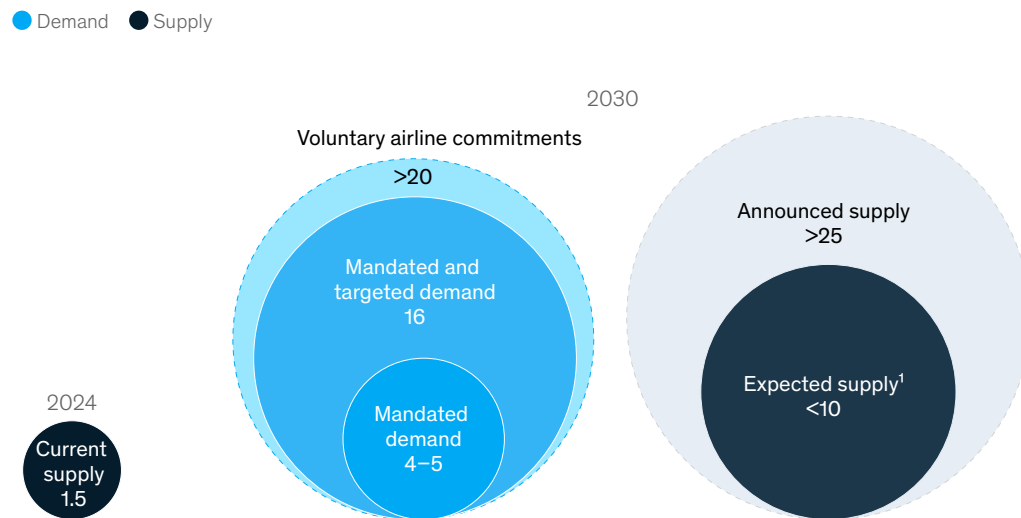
To map development until 2030, we considered different scenarios of demand and supply, including an expected adherence rate for airlines. The result shows that the future is highly uncertain and that

SAF demand could outpace supply if mandated and targeted demand materializes, unless there is a significant increase in additional production volume (Exhibit 2).

Exhibit 2

**Based on our supply and demand projections, SAF shortfalls could arise by 2030.**

**Sustainable aviation fuel supply and demand per annum, million metric tons**



¹This includes the FID and "probable" supply in McKinsey Sustainable Fuel Supply Tracker.

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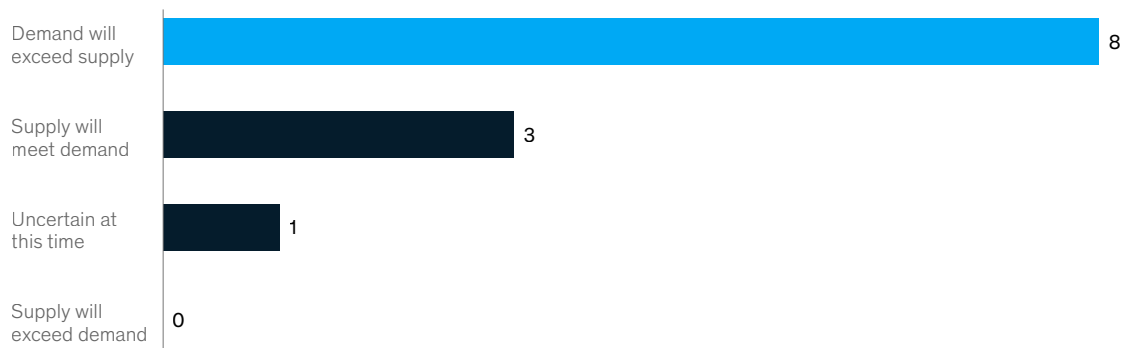
In exchanges with chief sustainability officers across the industry, we learned that about two-thirds expect a shortage by 2030, while a third are uncertain or do not expect a shortage (Exhibit 3).

Participants unanimously agreed that regulatory interventions are the primary motivator to buy SAF, followed by companies' own voluntary targets.

Exhibit 3

### Two-thirds of participating chief sustainability officers believe that demand for sustainable aviation fuel will exceed supply by 2030.

Supply vs demand for sustainable aviation fuel by 2030, number of respondents (n = 12)



Source: McKinsey chief sustainability officer surveys and interviews, 2024

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**Participants unanimously agreed that regulatory interventions are the primary motivator to buy SAF, followed by companies' own voluntary targets.**

## Airlines can use a range of procurement strategies to manage uncertainty and access to SAF

Scaling SAF requires significant funding, from venture capital (VC) to infrastructure investment for building SAF facilities. Investors, however, are hesitant because of uncertainty around future demand and technology readiness. Aviation stakeholders can play a key role by helping create momentum for the further expansion of SAF production capacity.

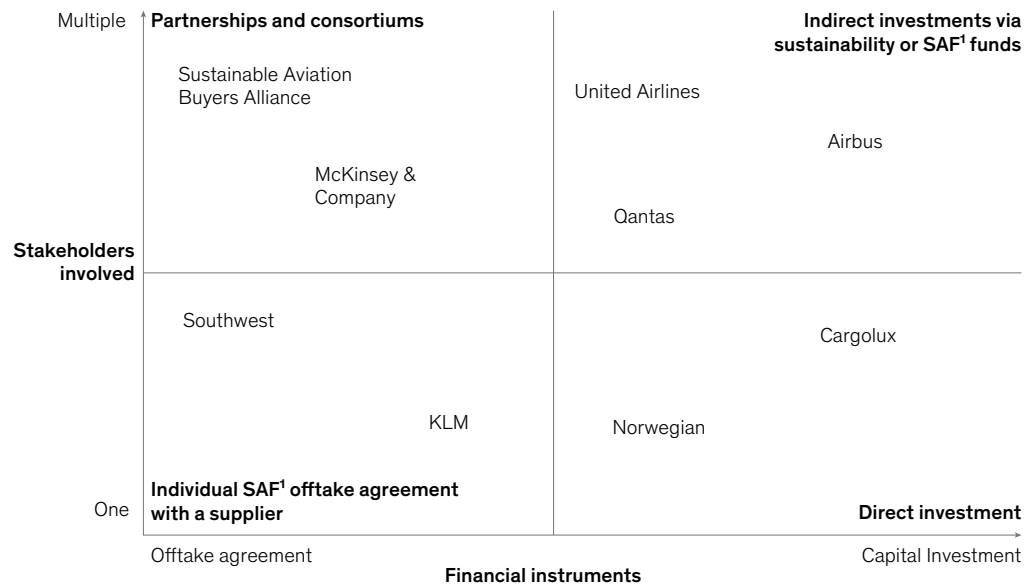
Theye Veen, chief commercial officer at SkyNRG, a Dutch SAF player active across the value chain, explains that “every innovation needs this ‘explosive money’—venture capital. Just \$100 million to \$200 million could accelerate four to eight pre-final-investment-decision projects, marking a substantial step forward in sustainable aviation.”<sup>9</sup>

Apart from airlines that are counting on a future SAF spot market and plan to “wait and see,” forward-leaning aviation players are using a range of strategies to source SAF, from pure offtake agreements to equity investments in suppliers or production (Exhibit 4).

Exhibit 4

## Airlines are using a range of approaches to secure sustainable aviation fuel—often in combination.

### Example companies for different approaches



<sup>1</sup>Sustainable aviation fuel.

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<sup>9</sup> Theye Veen, interview with author, June 4, 2024.

Industry action follows four main archetypes:

- *Individual offtake agreements.* Individual offtake agreements are the predominant approach to SAF procurement; most airline leaders tell us they intend to use such agreements. For mature airlines, direct procurement is similar to today's process for procuring airline jet fuel. Although the required up-front capital is minimal, offtakes can create balance sheet risks. The recent 980-million-liter deal between IAG International Airlines Group and Twelve exemplifies the industry's readiness for substantial agreements.<sup>10</sup> A long-term "bankable" offtake agreement with an anchor customer, such as Southwest Airlines' 20-year arrangement with USA BioEnergy,<sup>11</sup> can mitigate risk and help suppliers attract investors. That said, long-term offtake agreements can pose financial risks, especially since the SAF industry is in its infancy and few suppliers have proven track records.
- *Partnerships and consortiums.* Partnerships and consortiums such as the Sustainable Aviation Buyers Alliance (SABA) illustrate how industry stakeholders can collaborate to pool demand or create other synergies. This option is comparable to offtake agreements of individual airlines but involves multiple stakeholders, sometimes including end customers such as corporations seeking to decarbonize their air travel. SABA's April 2024 announcement involves offtake agreements with four fuel providers, three airlines, and 20 corporate aviation customers, including McKinsey.<sup>12</sup>
- *Direct investments.* Direct investments of individual airlines into suppliers or selected projects are another option. Norwegian Airlines and Cargolux, for example, invested in Norsk e-Fuel's power-to-liquid plant in Norway.<sup>13</sup>

In January 2024, LanzaJet Freedom Pines Fuels opened the world's first ethanol-to-SAF production facility with investments from multiple stakeholders, including IAG and All Nippon Airways.<sup>14</sup> Many of these investments are bundled with offtake agreements with lower SAF-sourcing costs and preferred access to future supplies. Another novel direct-investment approach is the strategic partnership of Airbus and Qantas, which are co-investing \$200 million in SAF production projects to foster a local SAF ecosystem in Australia. The companies are blending their expertise in the global SAF market from both OEM and airline perspectives, and combining their knowledge of the Australian market.<sup>15</sup>

- *SAF funds.* SAF funds are typically set up by partners with a common interest in scaling production. Potential partners include investors and financiers, scaled players in the SAF supply chain, other airlines and airports, engine and aircraft manufacturers, and corporate customers seeking to mitigate Scope 3 emissions. Partners investing together can raise more funds and impact by enabling larger ticket sizes. Given their typical size of less than €0.5 billion, SAF funds initiated by the aviation sector will be able to provide the first rounds of financing to promising projects.

Such a setup unlocks a number of benefits: a synergistic consortium of investors provides the portfolio company with expertise and support along the value chain, and the fund structure mitigates risks for each participant while maximizing the overall investment budget. Some investors may seek carbon credits for offtakes generated by the SAF that is produced and sold. Co-investors, such as other airlines, can also secure more-flexible terms and lower prices.

<sup>10</sup> "IAG reaches one-third of 2030 SAF target with major e-SAF deal with Twelve," IAG, February 29, 2024.

<sup>11</sup> "Southwest Airlines signs agreement with USA Bioenergy to purchase up to 680 million gallons of sustainable aviation fuel," Southwest Airlines, November 2, 2023.

<sup>12</sup> "SABA announces historic agreements to purchase sustainable aviation fuel certificates to grow investment in clean fuel technologies," SABA, April 17, 2024.

<sup>13</sup> "Norwegian becomes co-owner of Norsk e-Fuel," Norwegian, January 17, 2024.

<sup>14</sup> "LanzaJet celebrates grand opening of Freedom Pines Fuels Plant, the world's first ethanol to sustainable aviation fuel production facility," LanzaJet, January 24, 2024.

<sup>15</sup> "Qantas and Airbus joint investment to kickstart Australian biofuels industry," Airbus, June 19, 2022.

For example, United Airlines' investment vehicle—known as the Sustainable Flight Fund—has grown quickly since launching in February 2023.<sup>16</sup> More than \$200 million is now committed with more than 20 corporate partners, including Air Canada, Boeing, Embraer, GE Aerospace, Honeywell, and JPMorgan Chase.<sup>17</sup> The fund's dual mission is to secure a consistent supply of SAF and expand the overall SAF supply chain, thereby accelerating research, development, and production. Since its inception, the fund has invested in Svante, a carbon capture company, and Dimensional Energy, a company that can make low-carbon products from CO2 and hydrogen.

Scott Kirby, CEO of United Airlines, put it plainly: the challenge “is not that supply is limited,” he says; “the issue is creating supply. The reason we have double the commitment of anyone else is that we have helped build companies that are creating [SAF]. The only way to get SAF is to fund and build the companies that are creating SAF. It is not an option to just go there and buy it.”<sup>18</sup>

Orchestrating funds and managing investments are not among the core competencies of most airlines,

but advanced instruments can provide advantages. On the capital allocation side, funds can reduce risk through diversification compared to direct investment, but airlines can find it difficult to secure capital, especially in times of financial uncertainty without the promise of immediate returns.

Leading sustainability funds have discipline and skills in sourcing deals; assessing

risks and opportunities based on deep expertise in SAF pathways, economics, and production technologies; driving portfolio strategy; managing funds; and convening a wide range of investment partners in early stages. Few airlines or OEMs have these capabilities in-house at the required scale, and building them could require significant expense and efforts that could distract teams and leaders from their core roles.

### **Best practices based on research and experience**

In recent years, SAF funds have emerged as a new category of sustainability-related investment vehicles in aviation. They can take different shapes and forms; for example, they can be independent entities such as VC funds or, closer to airlines, corporate venture capital funds (CVCs).

A typical CVC managed by a corporate holding company aims to drive innovation in a legacy organization. The CVC JetBlue Ventures, for example, is investing in early-stage start-ups improving travel and hospitality, “next-gen aviation operations and enterprise tech,” “seamless customer journeys,” and “sustainable travel.”<sup>19</sup> JetBlue Ventures is a proprietary JetBlue investment vehicle, while United Airlines' Sustainable Flight Fund includes a broad set of investment partners, but both are incorporated as CVCs.

SAF funds also differ from broader environmental, social, and governance funds, which typically have wide-ranging mandates and partners from a range of industries. KLM's investment in SHIFT Invest, for example, includes partners in transportation, infrastructure, and finance that are investing in a broad agenda of climate and biodiversity. The airline contributes its name but otherwise acts as a hands-off investor.<sup>20</sup>

## **The first offtaker can guarantee a significant base volume at an attractive price in a cost-plus model and has a lot of flexibility in the contract.**

—Former executive at an operator in the cargo industry

<sup>16</sup> “United adds new corporate partners to sustainable flight fund that now exceeds \$200 million,” PR Newswire, February 14, 2024.

<sup>17</sup> “United Airlines Ventures,” United Airlines, accessed July 15, 2024.

<sup>18</sup> “How Scott Kirby is making United Airlines a global leader in sustainability,” Sustainability in the Air, podcast, May 5, 2022.

<sup>19</sup> “About,” JetBlue Ventures, accessed July 15, 2024.

<sup>20</sup> “Investor SHIFT Invest expands fund to €110 million to make mobility and logistics more sustainable,” SHIFT Invest, January 6, 2022.



Based on our research and experience serving clients in aviation, investment, and other industries, we've identified three best practices in designing and setting up SAF funds.

## 1. Set clear investment objectives and targets

Management teams are more effective when they're aligned on what success looks like. For example, getting access to sustainable fuel isn't the only reason why airlines drive such funds. Airlines typically also aim to build internal capabilities and demonstrate their commitment to sustainability to the public, including customers, legislators, and regulators. Leaders within the airline need to be in alignment, of course, but the entire consortium

of stakeholders and potential target companies should also agree on overarching goals and success metrics. These companies need to understand the extent to which the consortium supports and accelerates the business. Management teams can help improve clarity and drive alignment by making early decisions on objectives, expectations, and governance. A well-designed decision grid can guide their choices (Exhibit 5).

Although most aviation players consider the fund to be strategic, they do negotiate hard-to-get financial benefits from them. Some even have clear IRR targets—often around market rates of around 12 to 16 percent—and want general partner status and board seats where they believe their expertise can help advance projects.

Exhibit 5

### Aviation players can shape their investment funds using this example decision grid.

Key dimension	Key question	Possible choice			
<b>Objective</b>	What are the objectives of the fund?	Secure supply	Increase feedstock capacity	Influence sector	Decarbonization targets
<b>Scope</b>	What type of decarbonization levers will the fund focus on?	ESG <sup>1</sup>	Environmental focus (decarbonization)	Selected decarbonization option (eg, SAF <sup>2</sup> )	
	Where across the value chain will the fund focus?	Company or project	Facility or infrastructure	Strategic control point within SAF <sup>2</sup> production	
<b>Size or volume</b>	What is the overall size of the fund?	<\$100 million	\$100 million–\$300 million	>\$300 million	
	What is the acceptable ticket size?	<\$5 million	\$5 million–\$15 million	>\$15 million	
<b>Geography</b>	What are the investable geographies of the fund?	National	Regional	Global	
<b>Time horizon</b>	What is the investment horizon of the fund?	<5 years	5–10 years	>10 years	>Evergreen
<b>Maturity of assets or technology</b>	What type of asset will the fund invest in?	New or unproven business	Venture capital or growing asset	Proven entity or private equity	Established assets or large public entity
<b>Returns</b>	What are the target returns of the fund?	Internal rate of return (IRR) <5%	IRR 5%–10%	IRR >10%	
<b>Partnership and governance</b>	Who would invest in the fund alongside the airline?	No co-investor	Other industry players	Non-industry players	

<sup>1</sup>Environmental, social, and governance.

<sup>2</sup>Sustainable aviation fuel.

## **2. Engage the right partners to enable synergies and support for portfolio companies**

Although some funds are set up by a single company, working across a consortium of partners can provide synergistic benefits beyond scale—such as uniting stakeholders throughout the ecosystem, raising awareness and impact, and allowing partners to jointly advocate for supporting policies.

Some funds bring in partners from across the aviation value chain, including airlines, corporate customers, financiers, OEMs, travel management companies, and airports. Ultimately, the fund should create “pull” from the SAF supplier side, seeking an environment of supportive investors who can enable their effective incubation.

From the start-up perspective, a financial institution might seem to be a more attractive partner than an airline, which may not be able to provide cash as quickly with minimal interference. But an airline can significantly boost a portfolio company’s attractiveness with its name, network, industry insights, and attention from the public and other investors. A collaboration like this can include detailed data exchanges and close cooperation; for example, research teams from the portfolio company can work with operational teams from the airline to gain insights into operational efficiencies to benefit the start-up and investors.

## **3. Shape governance to move quickly, focus on returns, and involve experts**

In a fund incorporated as a CVC, the investment committee typically includes aviation company leadership, and, in some cases, representatives of investment partners. Since these funds compete against faster-moving VC funds that have more flexibility and less overhead, they need an effective independent governance structure that allows for quick decisions. The corporate governance, legal, and procurement processes of airlines may not permit the speed of decision making that VC investments require; an airline may require a three-year profit and loss statement, for example, which new start-ups typically lack.

Best practices for these funds, therefore, include establishing a governance structure similar to those of independent VCs, with independent investment decision making within the agreed mandate of the fund. This independence can speed execution, but it can also create tension with the airline organization—for example, when a sustainability team is the “center of expertise” of SAF.

In addition to the choices outlined in Exhibit 5, some funds seek to attract the right talent by implementing performance-based compensation models and management fees, which differ significantly from traditional airline-employee remuneration.

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## Next steps

Advances are being made in the science and industry of SAF production—but not quickly enough for the aviation industry to meet its ambitious decarbonization goals. As more aviation players start to catalyze the ecosystem through investments in the SAF supply chain, even more capital is needed to meet global demand in the next decades. Beyond the first seed investments to accelerate start-ups and immature projects, trillions of dollars for post-FID capital will be required to build enough capacity to meet global demand by 2050.<sup>21</sup>

Long-term infrastructure investors may need to step in and finance capacity development. This is likely the next challenge for the sector, as demand is uncertain and technology unproven. To reduce this risk, the regulatory environment can be key, particularly when globally coordinated.

In short, beyond fuel and energy suppliers, a wide range of industry stakeholders will need to play much larger roles in expanding and strengthening the SAF ecosystem to help the world reach its climate targets. An airline's SAF fund can drive innovation, but other investors will need to step up to fund the infrastructure that will decarbonize the industry.

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<sup>21</sup> Making net-zero aviation possible: An industry-backed, 1.5°C-aligned transition strategy, Mission Possible Partnership, July 2022.

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