In collaboration with
Oliver Wyman

Scaling Clean Technology Offtakes: A Corporate Playbook for Net Zero

WHITE PAPER

MAY 2024

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Foreword

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Amid the intensifying climate crisis, the urgency to pivot towards a sustainable global economy has never been more pressing. The collective ambition to achieve net-zero emissions by 2050 depends critically on the transformation of heavy industries, historically entrenched in high carbon footprints and responsible for 30% of greenhouse gas emissions.

The transition towards low-carbon technologies is emerging as the most significant economic realignment in recent history, affecting billions of lives and livelihoods. This energy shift presents a unique opportunity, rendering breakthrough zero-carbon industrial products the most valuable assets of the future. Yet, the need to mobilize capital and the imperative to unlock demand by mitigating the green premium, remain among the biggest hurdles in meeting net-zero targets by mid-century.

At the leading edge of this transformation is the First Movers Coalition (FMC), an initiative that aims to connect its members with suppliers of first-in-market technologies, thus creating offtake agreements while enabling members to achieve green procurement commitments. In the two years since its inception, FMC has become the world's largest generator of private-sector clean demand signal.

This report aims to support FMC with valuable insights for influencing market demand, by focusing on overcoming the initial challenge of demonstrating established demand for offtake agreements of clean energy technologies. The insights presented in this paper are derived from a comprehensive series of interviews with industry front-runners, including FMC members, financiers and project developers involved in pioneering offtake agreements. These interviews shed light on the critical challenge of securing adequate demand, and form the foundation for the recommendations in this paper.

These recommendations aim to guide corporations on how to bolster demand through various kinds of commercial engagements, thereby reducing their Scope 3 emissions and decarbonizing their supply chains.

The report zeroes in on two pivotal energy vectors: sustainable aviation fuel (SAF) and green hydrogen (GH_2), identifying them as central to corporate sustainability efforts with significant potential for demand growth in the near future. It emphasizes the strategic importance of these fuels, not just as tools for reducing carbon emissions, but as opportunities for corporate innovation and leadership in the transition to a greener economy. To capitalize on these opportunities, the report suggests a three-fold approach: first, adept navigation through the complex policy landscape to leverage incentives and mitigate risks; second, development of compelling business cases that underscore the economic viability and environmental benefits of SAF and GH_2 investments; and third, the exploration and establishment of robust commercial models for offtake agreements, ensuring stable and scalable market demand. This multifaceted strategy is portrayed as essential for corporations aiming to position themselves at the vanguard of sectoral transformation, marrying their carbon reduction goals with strategic business development and innovation.

As the critical deadline for achieving the Paris Agreement objectives draws closer, the transition to a net-zero future emerges as a shared responsibility that requires steadfast dedication across countries and societies. This paper acts as a strategic guide for forward-thinking businesses poised to make a decisive move towards decarbonization. These businesses can help pivot the global economy towards a sustainable future, safeguarding the planet for future generations.

Executive summary

As much as 40% of the emissions reduction necessary to transition the global economy to net-zero emissions by 2050 relies on the development of breakthrough technologies such as bioenergy, renewable-sourced and hydrogen-based fuel, and carbon capture. Among these, commercial-scale deployment of both sustainable aviation fuel (SAF) and green hydrogen (GH_2) plays an essential role in decarbonizing hard-to-abate sectors.

Both fuels are at the critical early deployment stage. In the net-zero scenario of the International Energy Agency (IEA), SAF is expected to contribute up to 65% of aviation emissions reduction, and GH_2 is expected to account for 8% of all final energy consumption by 2050. Yet, the deployment of both technologies currently falls short of the prescribed pathway. The production of both SAF and GH_2 must be ramped up in the remaining decade to ensure the world stays on track for the 1.5°C pathway.

Findings from discussions with more than 20 suppliers, industrial buyers, financiers and public-sector representatives indicate that low-carbon technologies cannot be scaled merely by the mobilization of capital towards producers. The success of early-stage projects in reaching final investment decisions (FID) depends fundamentally on demand. However, the green premium – the additional cost of choosing a clean technology over higher-emitting alternatives – serves as a major barrier to unlocking demand at a larger scale. While the public sectors in Europe and the United States (US) have recently made tremendous headway in reducing this gap, their efforts alone are not sufficient to create the demand acceleration required for a 1.5°C pathway.

In this context, corporate action to adopt and create demand for low-carbon technologies is crucial to shrink the green premium. It is also essential to create a voluntary market in which demand and production grow to achieve 1.5°C targets.

This report outlines the key challenges that businesses face in creating sustained and growing demand for SAF and GH_2. Further, it proposes three key levers for large corporates to better support SAF and GH_2 demand acceleration:

1. **Navigating the policy landscape of SAF and GH_2:** Demystifying varying economic incentives and regulations allows corporate buyers to better leverage the public support available and minimize the cost of offtake where possible.

2. **Articulating the business case for SAF and GH_2 adoption:** The corporate decision to enter into a contractual agreement for offtake is contingent upon the rationale and expected return on investment.

3. **Identifying commercial models for corporate offtake:** Recognizing and assessing the range of options available for SAF and GH_2 offtake enables corporate buyers to select the best model based on business need, decarbonization ambition and risk appetite.

While the route to sustained at-scale demand for these technologies will likely be complex and will not achieve targets overnight, a tangible business case exists for corporate participation by leveraging a range of commercial models. By charting the course, this report seeks to equip companies with the necessary tools to assess their decarbonization options in light of disclosed net-zero commitments, and to mobilize demand for SAF and GH_2 in the race to a net-zero future.

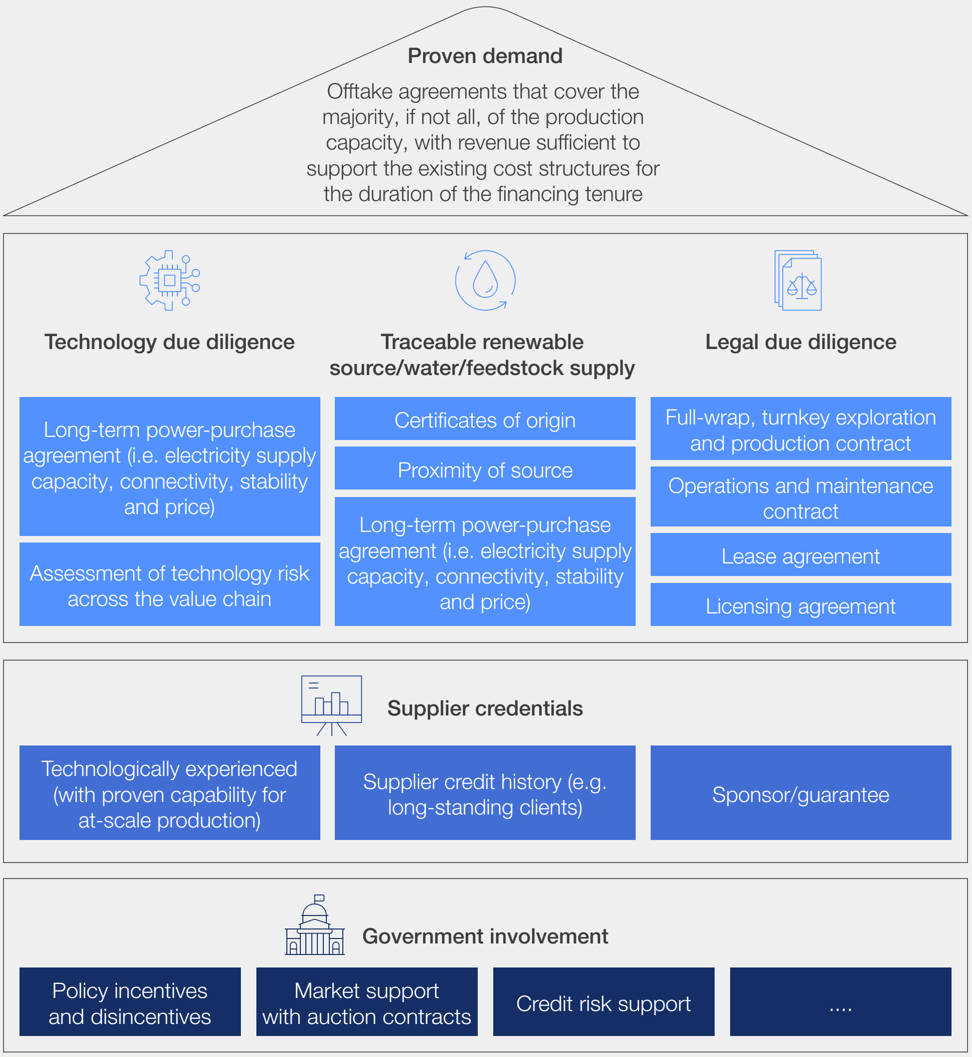
Introduction: The demand acceleration challenge

The 2021-2023 period saw considerable advancement in the development of clean carbon technology, with $1.6 trillion invested in 2022 and over $2.5 trillion in 2023. Yet, the demand for sustainable aviation fuel (SAF) and green hydrogen (GH_2) will likely not be sufficient to reach the volume required to achieve net-zero emissions by 2050.

This is largely due to a mismatch between the cost of production of green technologies and the willingness to pay for them in the current market. Despite the growth in the planned production of SAF and GH_2, only a small percentage of projects have been funded to date. The International Energy Agency (IEA) estimates that only 4% of proposed GH_2 projects reach a final investment decision (FID), though the Hydrogen Council's estimate is higher at about 10%.[1]

The notably low rate of FID in the private market for these clean technologies is primarily due to the stringent investment criteria that financiers use. Investors, including banks and private equity firms, prioritize projects with a robust business case, characterized by a balanced distribution of risks. This concept, referred to as "bankability", involves sharing risks among producers, sponsors, buyers ("offtakers")

FIGURE 1: **Bankable project framework for sustainable aviation fuel and green hydrogen**



Technology due diligence
Lenders will need to be comfortable with the technology being applied for the project and the interfaces between all relevant technologies to be able to achieve commercial-scale production.

Traceable renewable/water source/feedstock supply
Financiers typically evaluate the proximity of the project to competitively priced renewable electricity generation, which constitutes a key component of the capital and operational cost model and a project's competitiveness.

Legal due diligence
Lenders would need to validate the contracts on the project's land lease or usage agreements, construction and installation agreements, agreements for the provision of feedstock commodities or other inputs, etc.

Supplier credentials
Lenders express preference for suppliers with healthy balance sheets that are experienced in technology and risk management; they are likely to choose from long-standing client relationships, with some flexibility to accommodate newer start-ups.

Government involvement
Government support/financing in some way/shape/form (market- or project-specific) is needed for the business case to be workable for most investors.

and the government, supported by mechanisms such as credit guarantees and policy incentives.

To uncover the challenges associated with a project's "financeability" or investment attractiveness, the Finance team of the World Economic Forum's First Movers Coalition conducted bilateral interviews with more than 10 financial institutions including banks, insurers and private equity investors. The team also facilitated a roundtable dialogue involving these financial institutions and other stakeholders.

The discussions enabled identification of the project characteristics that contribute to a bankable project, including proven demand, technology due diligence, traceable renewables/water/feedstock supply, legal due diligence, supplier credentials and government involvement in the form of financing or de-risking support. Among these criteria, the most crucial is proven demand, often demonstrated through offtake agreements. These agreements between suppliers and buyers commit the buyer to purchasing a specified volume from a plant, whether existing or under development, reinforcing the project's business viability.

Banks said they typically require projects to have offtake agreements that cover the majority, if not all, of the production capacity (more than 75-80%), with sufficient revenue to support the existing costs for the duration of the financing tenure.[2] There are two reasons for this requirement. First, neither SAF nor GH_2 is currently a marketable commodity; as such, projects will find it challenging to raise revenue in the absence of binding purchase agreements. Second, currently, most of the producers' revenue comes from public incentives such as Renewable Identification Numbers and Low Carbon Fuel Standard,[3] which are difficult to hedge against. Ensuring significant, long-term offtake agreements is therefore essential to making the risk acceptable to financiers.

Not only do offtake agreements determine the financeability of a given project, they also collectively contribute to the decreasing green premium over time across projects. As demand reaches commercial scale, production costs decrease due to economics of scale and reduced costs of capital from financiers. Going ahead, the emergence of new producers in response to the surge in offtakes will likely drive down the high margin set by the handful of current players in the market. In the long run, all these factors combined will create a virtuous cycle that will help de-risk low-carbon projects across the value chain.

Despite recent progress around SAF and GH_2 offtake agreements in the past two years, the journey to meet 2030 targets remains long. Aggregating the SAF volume from all the announced offtake agreements signed to date, the committed demand is only around 15% (37 million tonnes (Mt)) of the 242 Mt required by 2030 to be on track for the 1.5°C pathway, according to Mission Possible Partnership.[4] Therefore, the rapid scaling of demand, specifically the rapid increase of high-quality SAF offtakes to fill the remaining 85% SAF volume over the next seven years, will be critical. The progress for GH_2 lags further behind, with merely 5% (7.9 Mt) of the more than 150 Mt5 required by 2030 being accounted for in binding offtakes.

Overcoming the green premium remains a significant barrier for corporate offtakers to commit to additional volume and grow the market for SAF and GH_2 in meaningful ways. Airlines have publicly stated the willingness to buy any SAF produced, as long as it is at jet-fuel price parity. Currently, the green premium is a significant $2-5 per gallon for SAF over jet fuel, and $3-6 per kilogram (kg) for GH_2 over grey or brown alternatives. As such, the key solution lies in finding a commercial way to share the cost of the green premium across public and private market players.

Absorbing these additional costs requires green technology producers, and direct buyers such as airlines, to align with end customers and get public-sector support to absorb these additional costs. Consequently, large corporate clients are emerging as first movers, driving market demand for SAF and GH_2 through their readiness to participate as offtakers in the early market. This proactive involvement is crucial in reducing the green premium in the long run and fostering a market driven by sustainable demand and growth.

This paper aims to equip corporate buyers with a toolkit to effectively navigate and engage in the nascent market for SAF and GH_2, striking a balance between paying a green premium and reducing their environmental impact.

1 Navigating the policy landscape

A select group of early adopters, under the First Movers Coalition led by the World Economic Forum and the US government, have expressed willingness to cover the green premium for limited amounts of SAF and GH_2. This coalition has become a significant demand signal for emerging climate technologies in the private sector, using its collective purchasing power to stimulate the market for these technologies and reduce the green premium for future market participants.

To further spur demand and incentivize supply, corporate buyers are seeking substantial public-sector involvement to bridge the pricing gap between production costs and market readiness to pay. Effective policies at both state and national levels, focused on reducing production costs through financial and economic incentives, are crucial. These include supply-side incentives, regulatory mandates and public support for demand-side offtake. A thorough understanding of these varying policies across different regions is essential for corporate buyers to lead the market transition effectively, purchasing SAF and GH_2 at the most competitive prices.

Sustainable aviation fuel

Since 2020, government support for SAF has expanded rapidly with initiatives such as research and development (R&D) grants, tax incentives and blending requirements. SAF regulations across Europe and the US are generally more advanced than in the rest of the world. However, the types of public support differ for the two regions: the US relies more on supply-side economic incentives, whereas Europe and the United Kingdom (UK) have firmer mandates for airlines and energy players.

In the US, SAF projects can rely on a combination of federal and state incentives. At the federal level, each gallon of SAF produced domestically can receive up to $1.75 under various tax credits (through the Inflation Reduction Act (IRA) SAF Blenders Tax Credit until 2024, and then the Clean Fuel Production Credit until 2027). Producing one gallon of this specific biodiesel and renewable diesel generates 1.6 Renewable Identification Numbers (or credits under the Renewable Fuel Standard (RFS) programme established under the Energy Policy Act of 2005 and expanded under the Energy Independence and Security Act of 2007).

Moreover, depending on the specific scheme, SAF may qualify for carbon intensity (CI) credits under the Low Carbon Fuel Standards (LCFS) in the states of California, Washington and Oregon, and/or state tax credits in Illinois, Washington and Minnesota. Despite its numerous merits, in the absence of mandates and tax credit extension, this supply-side incentive-driven approach will likely concentrate demand on the US West Coast, where these incentives are more prevalent. Furthermore, this situation could introduce uncertainties in the SAF market post-2027, as the future of these incentives and mandates remains unclear, potentially affecting long-term investment and development decisions in the SAF sector.

In the European Union (EU), the Renewable Energy Directive (RED) II applies to all member-states, setting a collective EU-wide target for renewable energy usage and outlining specific sustainability criteria for biofuels, but with variation at the national level. The ReFuelEU Aviation Regulation within the “Fit for 55” package includes new demand mandates of 6% SAF by 2030 and 70% by 2050.[6] Additionally, the EU Emissions Trading System (ETS), a cap-and-trade programme, will incentivize SAF uptake by fully phasing out free emissions allowances for the aviation sector by 2026, allocating €20 million ($21.3 million) in free allowances for fuel technologies that are promising within the short term.[7]

Separately, the UK has set an ambitious SAF production mandate of 10% by 2030 and 75% by 2050 (applicable to all suppliers of aviation turbine fuel in the UK aviation industry), and is supporting this through investments in multiple production facilities. This mandate-driven approach creates a clearer view of expected minimum demand in 2030 and beyond, as well as a set of targets that corporates need to abide by through early offtake. The effectiveness of such mandates hinges on rigorous enforcement by national governments, as evident from actions taken in Germany, Spain and the UK.

While existing mandates and supply-side incentives impact the green premium’s size and trajectory, they are not sufficient to eliminate it for potential corporate buyers. In incentivized markets such as the US West Coast, the SAF premium over jet fuel is currently ~$2-5/gallon and is primarily driven by limited competition. In Europe, a green premium of a similar range exists, averaging over $3/gallon.[8]

For both regions, although current regulations are not sufficient to fully eliminate the green premium in the medium term, an initial downward pressure in the next 1-2 years is likely as suppliers enter the market, resulting in a sustained premium of $1-2/gallon until 2030.[9] The decrease in green premium as a result of supply-side incentives would significantly reduce the economic barrier for corporate buyers. However, direct demand-side public-sector support for SAF in the form of economic incentives remains limited.

Green hydrogen

Public-sector backing of GH_2 has been substantial in both the US and Europe.

Similar to SAF, in the case of GH_2, the US relies primarily on commercial mechanisms to incentivize adoption. The IRA provides strong incentives across the GH_2 value chain to help expedite its technical and commercial viability through four key components:

- **Production tax credit:** Includes a tax credit for clean H_2 production worth up to $3 per kg of hydrogen produced, depending on the overall carbon footprint of the product.

- **Investment tax credit (ITC):** Includes a tax credit for clean hydrogen production, which is worth 30% of the cost of investment in clean hydrogen production facilities.

- **Infrastructure funding:** Includes $8 billion for pipelines, $2 billion for storage facilities and $1 billion for refueling stations.

- **Research funding:** Funding of $2 billion is available for R&D for clean hydrogen production and applications.

Collectively, these tax incentives provide up to $3 for every kg of GH_2 produced with emissions intensity less than 0.45 kg CO_2e (kilogram of carbon dioxide equivalent).

GH_2 development in the EU is spurred by ambitious targets and funding. The EU's hydrogen policy framework aims to collectively enhance the competitiveness of the EU's net-zero industry, specifically net-zero manufacturing capacity, to meet European climate targets. This includes an electrolyser capacity target of 6 gigawatts (GW) by 2024 and 40 GW by 2030 (up from 0.06 GW in 2020), which is the equivalent of producing 10 Mt of GH_2 annually. In addition, the RePowerEU plan targets the import of another 10Mt of GH_2 annually by 2030.[10]

Beyond target-setting, the EU and the UK have both invested substantially in subsidy schemes, including demand-side support, to bridge the cost of production and boost the willingness to pay. For example, Germany is providing an initial €900 million ($1.1 billion) to H_2Global, a government scheme to fund double auctions for ~500 megawatts (MW) of electrolyser projects (with plans to extend this scheme with another €1 billion in funding).

The programme tenders 10-year purchase agreements with green hydrogen producers, before holding competitive auctions to sell the output to the highest domestic bidders and covering the difference in price with a grant from the German government. There is also an expansion into the €3 billion European Hydrogen Bank (EHB) programme, with the first auction having been launched in November 2023.[11] Under the EHB scheme, support for every kg of GH_2 produced surpassed that in the US to reach up to €4.5.[12] Similarly, the UK government in 2022 announced the world's first national clean hydrogen Contracts for Difference scheme, promising support for up to 1GW of GH_2 projects to be awarded via two allocation rounds.

Despite the differing approaches across the two regions, both directly affect the price and trajectory of the green premium. Today, the cost of production of GH_2 ranges from $4-7/kg, or ~$5/kg on average, in the absence of tax credits. With up to $3/kg of IRA incentives, the "levelized" cost of production, meaning the average cost per kilogram of green hydrogen over the expected operational life of the production facilities, falls to $2-5/kg (~$3/kg on average for GH_2 vs. $1.5/kg for grey hydrogen).[13] This implies a minimum green premium of $1.5/kg in the US.

Assuming the continuation of existing incentives (including tax credits in the US, and mandates and subsidies in the EU), the levelized cost of GH_2 could gradually fall throughout the remaining decade with the falling cost of renewable energy and electrolyser equipment, potentially reaching $2/kg by 2030.[14] Although public incentives will likely not be sufficient to fully eliminate the green premium, they will diminish the gap meaningfully. This cost reduction will better match the financial risk preferences of private sector investors and companies, setting a foundation for wider engagement from both hydrogen purchasers and financial backers. Additionally, the development of incentive programmes that reward both production and consumption will encourage corporate buyers to actively participate, supporting large-scale market growth.

Corporates looking to decarbonize through green fuel offtake can better identify markets with the lowest green premium by understanding the regulatory incentives and mandates across geographies. Although demand-side policy incentives are still in their infancy, corporate buyers could benefit by becoming early participants of the subsidized auction programmes or subsidy schemes to purchase green technologies close to price parity with their conventional counterparts. Partnerships with SAF or GH_2 producers offer another avenue, leveraging supply-side incentives for the offtake of discounted green fuel.

As corporate engagement in demand offtake at a larger scale is contingent on firmer regulatory mandates and policy incentives, corporates should advocate for expanding demand-side support and investing in programmes offering subsidies on the cost of the green premium or a guaranteed reward on avoided emissions.

2 Articulating the business case

In the ideal scenario, global regulations and incentives will fully close the green premium by 2030, spurring demand for technologies in hard-to-abate sectors. However, this will not be the case in the near term. Corporate stakeholders have limited understanding of the business case for early adoption of SAF and GH_2, and it is crucial to articulate the value proposition for them.

Stand-alone economic analyses of contractual offtakes might yield uneconomical outcomes, as many deals are expected to generate considerable expenses. Nonetheless, the compelling rationale for early SAF and GH_2 offtake lies in its numerous benefits in a more holistic context, including regulatory compliance, progress along net-zero commitments, and potential operational and commercial advantages.

2.1 Regulatory compliance

In developed economies with national or state-level mandates, SAF and GH_2 offtake can help corporates meet regulatory requirements or mandates effectively. This is particularly true for producers such as oil refineries, where the production of fuel with a lower life cycle CO_2 content is required for suppliers to meet the Low Carbon Fuel Standards (LCFS) in states such as California, Oregon and Washington in the US, or REDII and Fuel Quality Directives (FQD) in the EU, where the fuel mix produced is evaluated against a declining carbon intensity benchmark.

Further, sector-specific regulations, such as the SAF blending mandate in the EU, have impacts beyond the aviation industry and, in effect, set a floor for clean fuel offtake, especially for businesses with significant travel needs. Failure to comply with those mandates can result in fines, potentially exceeding the costs associated with the green premium in offtake agreements.

Progress along net-zero commitments

Since the establishment of the Science Based Targets initiative (SBTi) in 2015, more and more corporations have set net-zero and interim targets. Large companies committing to achieving net-zero emissions will reach a critical mass in Europe, with nearly 63% of global Fortune 500 companies committing to be SBTi-aligned by 2030 and as many as 68% setting a net-zero target for 2050. North America shows a similar trend with some 43% of the Fortune 500 pledging to be net zero by 2050.[15]

Entering long-term SAF and GH_2 offtake agreements prior to 2030 is a strategic way for companies to demonstrate progress against disclosed corporate commitments (e.g. Scope 1 and 2 for GH_2, and Scope 3 business travel for SAF). As a matter of fact, sustainability leaders have already embarked on their offtake journey to meet their Scope 3 targets.

For example, Microsoft has signed a long-term agreement with SAF producer World Energy to replace 43.7 million gallons of petroleum jet fuel with SAF (amounting to about 0.5 Mt of expected CO_2 emissions reduction) and a separate deal with the International Airlines Group (IAG) – the parent company of several airlines including Aer Lingus, British Airways, Iberia and Vueling – to purchase 14,700 tons of SAF produced by the Phillips 66 Humber Refinery in the UK.

Similarly, Bank of America has set a 2030 target of 20% SAF usage for its corporate and commercial jets. It has committed to a 10-year partnership with SkyNRG to support the production of 1.2 million gallons of SAF per year beginning in 2025. Additionally, under a three-year deal with American Airlines starting 2021, Bank of America supports the procurement of 1 million gallons of SAF per annum.

Not only do offtake agreements offer a way to signal corporate transition efforts, they are arguably among the most preferred decarbonization approaches as they align with existing environmental standards and are economically favourable.

SAF and GH_2 are consistent with science-based guidance

Purchasing SAF and GH_2 aligns with the SBTi guidance for corporates to prioritize direct emissions reduction in their value chains. This approach is favoured over other mitigation strategies outside of the value chain, or "neutralization", such as through carbon removal technologies. While cheaper options such as purchasing carbon credits ("offsets") are also available and encouraged, it is clearly stated that these investments cannot serve as replacements for value chain emissions reduction against companies' near- or long-term science-based targets.[16]

SAF and GH_2 offer lower cost of offtake vs. alternative decarbonization options

Purchasing SAF and GH_2, even with the voluntary premium, is more cost-effective (in terms of CO_2 abatement – i.e. it costs less per ton of CO_2 abatement) compared to viable alternatives, such as direct air capture and carbon mineralization. This cost advantage is expected to continue until at least 2030.

In the case of SAF 85 – which is SAF with the potential to reduce greenhouse gas (GHG) emissions by at least 85% over its life cycle compared to traditional fossil-based jet fuel – the current green premium of $2-5/gallon corresponds to a carbon credit price of $240-560 per ton of avoided emissions,[17] which is considerably lower than the price of direct air capture and other advanced engineered solutions as things stand (ranging from $600-$1,000).

Climeworks, for instance, has been selling carbon removal credits to companies such as Audi, Microsoft and Shopify at a price as high as €1,000 ($1,048) per ton.[18] Granted that as technology matures, the future carbon capture cost is expected to stabilize at ~$200 per ton of CO_2 (tCO_2) towards the latter half of the decade and will be critical in the decarbonization of hard-to-abate sectors, it will nevertheless be costlier than SAF 85 at ~$115-230/$tCO_2$ abatement (which amounts to $1-2/gallon of green premium).

In the case of GH_2, the cost advantages of early offtake also hold. Corporates can secure large volumes at lower rates and with greater flexibility through strategic partnerships or joint ventures with other players along the value chain. This approach allows them to take advantage of supply-side subsidies and policy incentives, capitalize on the downward trend in production cost, and benefit from economies of scale.

SAF has minimal impact on the corporate bottom line

Although the premium for SAF may not be economically viable for airlines to fully absorb due to the industry's thin profit margins, the expense associated with carbon offsetting for Scope 3 business travel typically has a minimal impact on corporate budgets. Among Fortune 500 companies, the expected cost to replace 2022 jet-fuel consumption with 100% SAF to decarbonize Scope 3 business travel represents merely <0.1% of corporate revenue, assuming a $5 SAF premium. Therefore, the cost of large-scale SAF offtake to cover half or even all of Scope 3 business travel is reasonably affordable for large corporates and should be considered as part of the rationale for voluntary SAF offtake.

FIGURE 2: **Estimated cost of replacing 100% jet fuel used in Scope 3 business travel with SAF**

	2022 Scope 3 business travel (tCO_2)	2022 Scope 3 emissions from air travel (tCO_2)	2022 indirect jet-fuel consumption (gallon)	2022 additional cost from SAF replacement	2022 corporate revenue	SAF cost as % of corporate revenue
Microsoft	139,083	125,175	10.7 million	$55.4 million	$198 billion	0.03%
Meta	251,807	226,626	20.1 million	$100.3 million	$116 billion	0.09%
Bank of America	80,171	72,154	6.4 million	$32.0 million	$95 billion	0.03%

Sources: Microsoft 2022 Environmental Sustainability Report; Bank of America 2022 Performance Data Summary; and Global Reporting Initiative Index.

2.2 Commercial opportunities, process optimization and capacity development

The advantages of offtaking GH_2 could extend beyond decarbonization. Currently, volume commitments are often structured as self-offtakes by project partners – where offtakers invest in projects in exchange for the SAF or GH_2 produced – rather than purchase contracts with buyers. This presents a unique commercial opportunity for early adopters (such as the major players in oil and gas, industrial and transport sectors) to venture beyond offtake activities and capture a larger share of the value chain through joint ventures with GH_2 producers and other stakeholders. In addition, by leveraging partner resources, gaining broader value-chain access, and diversifying into low-carbon products, offtakers might attract new clients and further grow their businesses.

Furthermore, GH_2 offtakes in the form of joint ventures could help corporates reduce the current cost of production and, therefore, the price of offtakes through enhanced understanding of existing production processes and additional capability development. Corporates also have the option to expand partnerships beyond GH_2 offtake to provide value-add in other aspects of their businesses (e.g. the circular economy and related fields).

Making the business case might not be sufficient if the corporates do not have any relevant competency or internal incentives for SAF/GH_2 offtake. For example, a company without externally disclosed Scope 3 emissions might find it more difficult to justify the purchase of SAF carbon credits; conversely, a member of SBTi with explicit targets along with an internal price of carbon is more incentivized to enter a binding offtake agreement.

Thus, fostering comprehensive, enterprise-wide climate-related expertise can significantly boost corporates' overall decarbonization efforts, particularly in advocating for SAF and GH_2 offtake. This can take the form of building capacity for climate-related disclosures and target-setting, as well as integrating climate considerations into operational decision-making and corporate strategic assessments for Scope 3 reporting, internal carbon tax and climate scenario planning.

3 Identifying the commercial model

Corporate buyers can choose from a set of commercial models. While an offtake agreement provides the most direct demand support to ensure project bankability, corporates can utilize other ways to create an impact in low-carbon technology development, ranging from supporting book-and-claim development (see 3.2) to becoming an equity partner to clean-energy producers. Careful strategic planning is necessary to identify the modality of offtake that is aligned with the company's level of ambition and risk appetite.

FIGURE 3: **Types of corporate offtake agreement**

Types	Description	Considerations
Individual offtake agreement	Enter binding long-term offtake agreement with a clean technology producer and/or airline through the commercial models available today	Currently widely adopted for SAF and relatively mature; limited for GH_2 but expected to grow Secures future volume while directly backing technology producer(s) of choice without upfront capital commitment
Book-and-claim system	Participate in book-and-claim programmes or pilots to purchase carbon attributes to offset corporate Scope 3 business travel emissions	Less mature currently and available for SAF only Offers higher flexibility on geography and terms of offtake (e.g. lower volume commitment) Provides lower delivery risk due to diversification of suppliers vs. direct contract with a single party
Joint venture	Participate in joint ventures or strategic partnerships with other players along the value chain to secure offtake volume at a lower cost and on more flexible terms	Available for GH_2 primarily, and for energy players in the case of SAF Requires risk-sharing with producers and other players along the value chain in exchange for lower cost of offtake and other commercial opportunities

3.1 Individual offtake

Commercial models

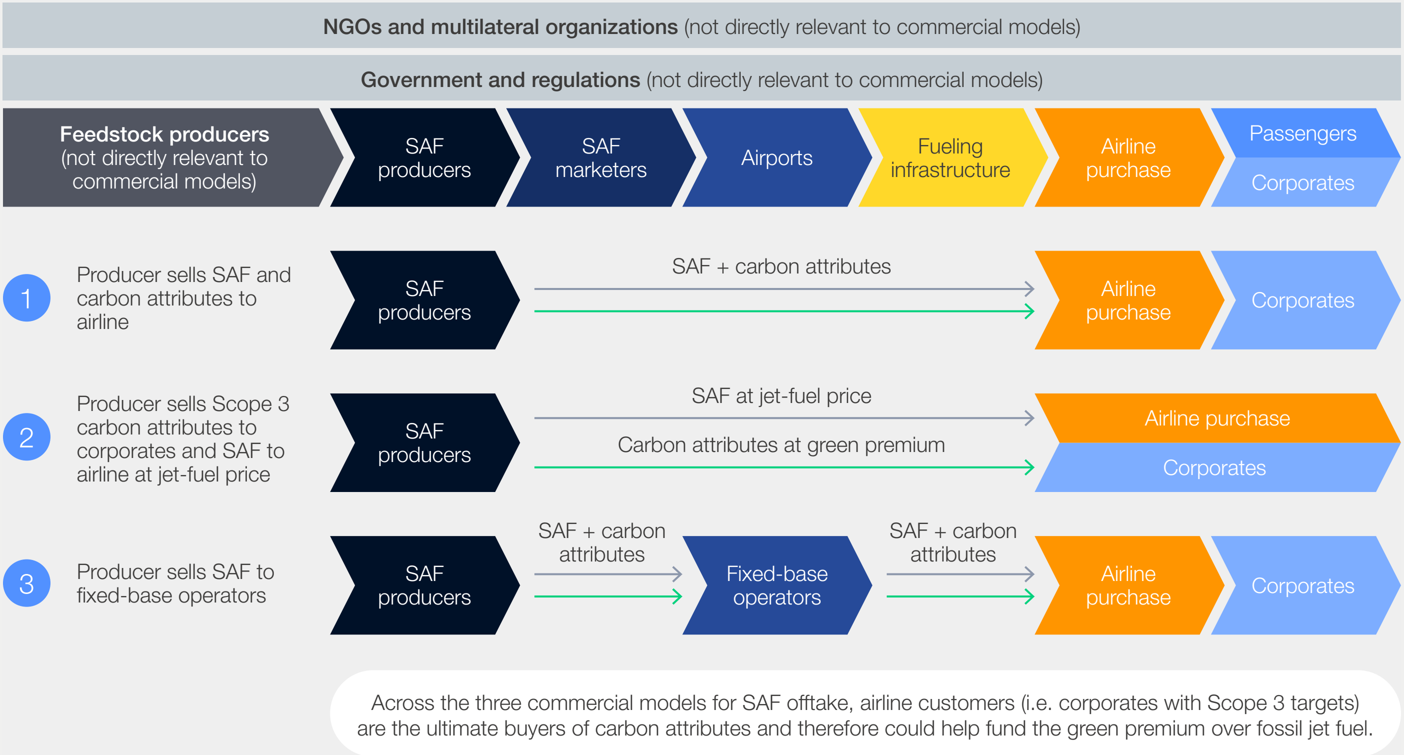
Individual offtake is the direct contractual arrangement between a producer and a buyer to purchase or sell (with or without intermediaries) portions of the producer's expected SAF or GH_2 volume, similar to a power purchase agreement.

Currently, individual offtake agreements are more common with SAF than GH_2, but this dynamic is expected to shift as the market matures. Hydrogen project developers around the world have planned for 47 Mt of annual clean hydrogen capacity by 2030, but only about 1 Mt (~2%) is covered by binding contracts with offtakers.[19] Moreover, the majority of the volume committed is through self-offtake, where project developers or partners consume the hydrogen they have produced.

On the other hand, SAF offtake has started to gain momentum in the past few years with ~13.6 billion gallons (51.3 billion litres) contracted, over 82% of which were announced during 2021-2023.[20] However, a vast majority of offtake agreements to date involve major airlines as buyers of the low-carbon fuels. Corporate actions around SAF offtake have been limited to less than a handful of sustainability leaders. Microsoft and Meta, for instance, have committed to ~116 kilo barrels and ~44 kilo barrels of SAF, respectively. Major corporations (e.g. Bank of America, Boom Supersonic, Boston Consulting Group, JPMorgan Chase & Co. and Meta) have also started to experiment with collective offtake at a smaller scale through the Sustainable Aviation Buyers Alliance (SABA) to purchase 0.8 million gallons (3.2 million litres) of SAF (~0.0036% of jet-fuel consumption worldwide) from SAF producer World Energy, to be used to power JetBlue flights.[21]

To enable demand acceleration at a larger scale, corporates would need to familiarize themselves with the commercial models for SAF offtake in today's market. Broadly, three types of contractual arrangements exist, which individual corporates or a consortium of corporates can engage in.

FIGURE 4: **Commercial models for individual SAF offtake**



	Commercial model description	Considerations for corporates
1	Producer sells SAF and carbon attributes to an airline, and the airline sells to corporates to cover the green premium	– Most common model adopted today – Supports financing of SAF offtake agreements for corporate airline partner(s)
2	Producer sells SAF to airlines at jet fuel (or close to jet fuel) price and Scope 3 carbon attributes to corporates at a premium in the form of carbon credits	– Allows for greater flexibility for participation as the model separates the procurement of sustainable fuel from the environmental attributes
3	Producer sells SAF and carbon attributes to fixed-based operators (such as airports or fueling services), who either sell SAF and carbon attributes to a group of airline purchasers, who ultimately sell to corporate buyers, or sell SAF to airlines at jet-fuel price and carbon attributes to corporates at a premium	– Unlocks slightly lower rate of green premium for corporates due to bulk purchases with airports as demand aggregators – Otherwise similar to model 1 or 2

Major corporations are the ultimate purchasers of carbon attributes in the three prevalent commercial models of SAF offtake (see in Figure 4). To effectively distribute the technology risk of SAF offtake, the best practice for corporates is to diversify their offtake activities across different technology pathways, producers and airline partners.

Elements of bankable offtake agreements

In addition to recognizing the various commercial models used for offtake agreements, it is essential for corporates to grasp the key components that constitute a long-term contract. While the exact arrangement of each offtake agreement and the stakeholders involved can differ, certain essential elements must be addressed in the agreement to qualify as bankable for project financing:

Offtaker credibility

Banks emphasize that the critical factor in assessing the viability of a purchase agreement for project financing is who the offtaker is. An ideal candidate would be a company with a long-standing credit history, a healthy profit and loss (P&L) statement, relevant technological experience, and plans to use the committed volume towards the production of a relatively mature technology (e.g. replacing grey hydrogen with GH_2).

For example, if the GH_2 produced is to fuel Amazon hydrogen trucks or to replace grey hydrogen usage in Shell's refinery, the business case would be strong despite the much higher offtake price. This is due to the low likelihood of large corporations of the likes of Amazon and Shell of breaching a binding contract, given that the contracted amount would have a minimal impact on the company's P&L. For this reason, these contracts are viewed as "proven demand" by financiers when assessing project bankability. As such, the responsibility of demand signaling through offtake falls primarily on large corporate buyers.

Offtake terms and conditions

The majority of the offtake to date is covered by non-binding memoranda of understanding (MoUs) or unspecific agreements with vague terms. While entering an MoU signals a step in the right direction, what is essential for these projects to reach an FID are contractually binding offtake agreements. Hence, securing such agreements should be a primary focus for large corporations.

Furthermore, the degree to which an agreement is "binding" can often be discerned from the severity of the termination clauses. Since neither SAF nor GH_2 currently functions as a marketable commodity, banks looking at an offtake agreement are particularly interested in termination terms that ensure the project can be debt-free at a minimum, with the potential inclusion of a full equity refund and loss-of-profit refund. These terms provide the financial security and assurances that banks and financiers require to confidently invest in and support these innovative clean energy projects.

Offtake volume

Regarding offtake volume, the goal is to get as much of the revenue hedged as possible through purchase agreements, aiming for nearly 100% coverage. However, financiers recognize the challenges associated with offtakes in the first handful of projects and allow for a minimum threshold of 75-80% of contracted volume across all bankable offtakes. Hence, large corporations that commit to higher offtake volumes would significantly contribute to projects achieving FID and may face lower project financing and delivery risk.

Offtake duration

Offtake agreements would need to cover the tenure of debt financing. Since the duration of project financing for clean technology typically ranges from 8-14 years, corporates looking to commit should consider long-term offtake agreements of 10 years or longer to provide the project with sufficient revenue certainty. However, few offtake agreements to date extend beyond 2030, primarily due to the lack of regulatory certainty on current incentives. The extension of tax credits and a more predictable regulatory landscape would further de-risk corporate offtake. Thus, as the regulatory landscape evolves to include longer-term commitment of existing support, corporates can consider committing to longer-term offtakes.

Offtake pricing and pricing structures

When entering a purchase agreement, one of the key considerations for corporations is the price structure as well as the price point of such offtake. Ideally, the offtake agreement falls within a competitive green premium range in line with other similar arrangements. This is because a higher price point signals a higher likelihood of a contract breach from offtakers, whereas a lower price point signals a higher probability of a contract breach from the supplier as input costs fluctuate.

In the case of SAF, the structure of offtake pricing matters just as much as the current price point. Figure 5 illustrates the range of options from the least to the most risk shared by offtakers. Although the "fossil-index plus" pricing model is common, it is anticipated to face increasing difficulties due to the widening gap between feedstock and jet fuel prices, due to demand and supply dynamics and feedstock price volatility (given the ongoing changes in feedstock availability and regulations).

Generally, financiers favour pricing structures that distribute the project risk between the various parties involved in a balanced way, as this approach mitigates risk for producers and provides greater certainty of supplier revenue in the absence of other de-risking solutions in the market, such as insurance or guarantees. Large corporates looking to support market acceleration can hence adopt a cost-plus pricing model that includes a price cap. This means that the price of SAF would be based on the production cost plus a mark-up (to cover costs like administration and R&D), but it would also have a maximum limit or cap.

This cap ensures that the price does not escalate beyond a certain point, which can be crucial for budgeting and financial planning for both the supplier and the purchaser. This model can be beneficial in the case of SAF at the infancy of production by providing some level of cost predictability and stability. From a risk perspective, this pricing structure is best positioned to take input-related risks. From an economic perspective, input costs (including feedstock, hydrogen, fixed and variable tolling fees levied by processing facilities, etc.) are expected to drop over the remaining decade as the technology matures and the cost of production decreases.

FIGURE 5: Pricing structure types for SAF offtake agreement

In use for offtake agreements today (Flat/fixed pricing, Fossil index-plus, Cost-plus)

Input costs include feedstock cost, hydrogen cost, variable tolling fee, fixed tolling fee and other fees (Cost-plus)

Pricing structure	Flat/fixed pricing	Fossil index-plus	Cost-plus	Take-or-pay	Ownership
Description	Contracts where price of SAF is locked in for the agreed-upon quantities, regardless of change in jet-fuel market price or cost of inputs.	Offtakers take the agreed-upon quantities, at the price based on the market index of fossil Jet A (LA spot[1], Argus[2] or OPIS[3]), with a green premium.	– Offtakers take the agreed-upon quantities, at the price of input costs at the time of production, with a margin (i.e. tolling agreement with margin). – Might be subject to price cap.	Offtakers pay for the products on a regular basis, whether or not they actually take delivery of the products.	Offtakers take any quantity at the cost of production, in exchange for investment capital and risks (typically through joint-venture partnerships).
Risks shared by offtakers					
Security of supply	■	■	■	■	■
Feedstock risk			■	■	■
Hydrogen risk			■	■	■
Technology risk				■	■
Operational risk				■	■
Construction risk					■
Return on investment					■
Considerations	– Uncommon – Risky for producer	– Most common – Expected to grow more challenging as gap widens between HEFA[4] feedstock and Jet A indices	– Adopted by some SAF producers (e.g. SkyNRG) and common among energy players – Less risky for producers with feedstock constraints (especially given policy restrictions in the EU)	– Too inflexible/ high-risk currently for most offtakers, but will likely emerge stronger as the market for SAF matures	– Adopted by a few large energy players – Unlikely to be adopted by other players at scale (e.g. airports and airlines) due to the capital investment required

1. Los Angeles Spot Market, a regional market for commodities including jet fuel. Prices on the spot market fluctuate based on supply and demand dynamics in the region. **2.** Argus Media provides price assessments and analysis for international energy and other commodity markets, which are widely used as price benchmarks. In the context of jet fuel, an 'Argus index' would provide the market price for jet fuel as assessed by Argus Media. **3.** Oil Price Information Service (OPIS) provides pricing and news information for petroleum pricing, news and analytics. It offers a jet-fuel price index that is used as a benchmark for pricing in various markets, including the Los Angeles market. **4.** Hydroprocessed Esters and Fatty Acids are used to produce renewable jet fuel and diesel from various types of oils and fats, including: vegetable oils, used cooking oil, animal fats, algal oils and non-edible oils.

3.2 Book and claim

Book and claim is a chain-of-custody model that allows clean fuel producers to “book” the emissions savings of a good they’ve produced in one place, and customers to “claim” the emissions benefit from these goods for climate disclosures in a different place. It decouples the physical fuel from its environmental attributes (i.e. GHG emissions). The system aggregates and registers carbon reduction through the production of physical SAF from producers while allowing corporate buyers to purchase carbon attribute certificates to be used towards corporate emissions reporting.

This approach has several key features that set it apart from individual offtake agreements and create the breakthrough needed to unlock SAF demand acceleration, including:

1. **Balancing out demand and supply geographically:** Given the differing regulatory guidelines and incentive schemes across regions, aggregating supply and demand through a global system solves for potential shortages at the regional level due to local regulations and policies, thereby unlocking corporate demand in regions where production is currently limited.

2. **Enabling decoupling between customer and product:** The ability of corporates to offtake carbon attributes directly, regardless of the origin/destination of business travel, removes major logistical barriers associated with SAF distribution and renewable energy infrastructure. This decoupling simplifies the process for corporations seeking to offset their emissions.

3. **Facilitating a global certification system:** The pooling of green fuels across producers in various geographies necessitates the development of standardization and independent quality assurance, accelerating the growth of a global market for sustainable fuels, and ensuring quality and consistency across different producers and regions.

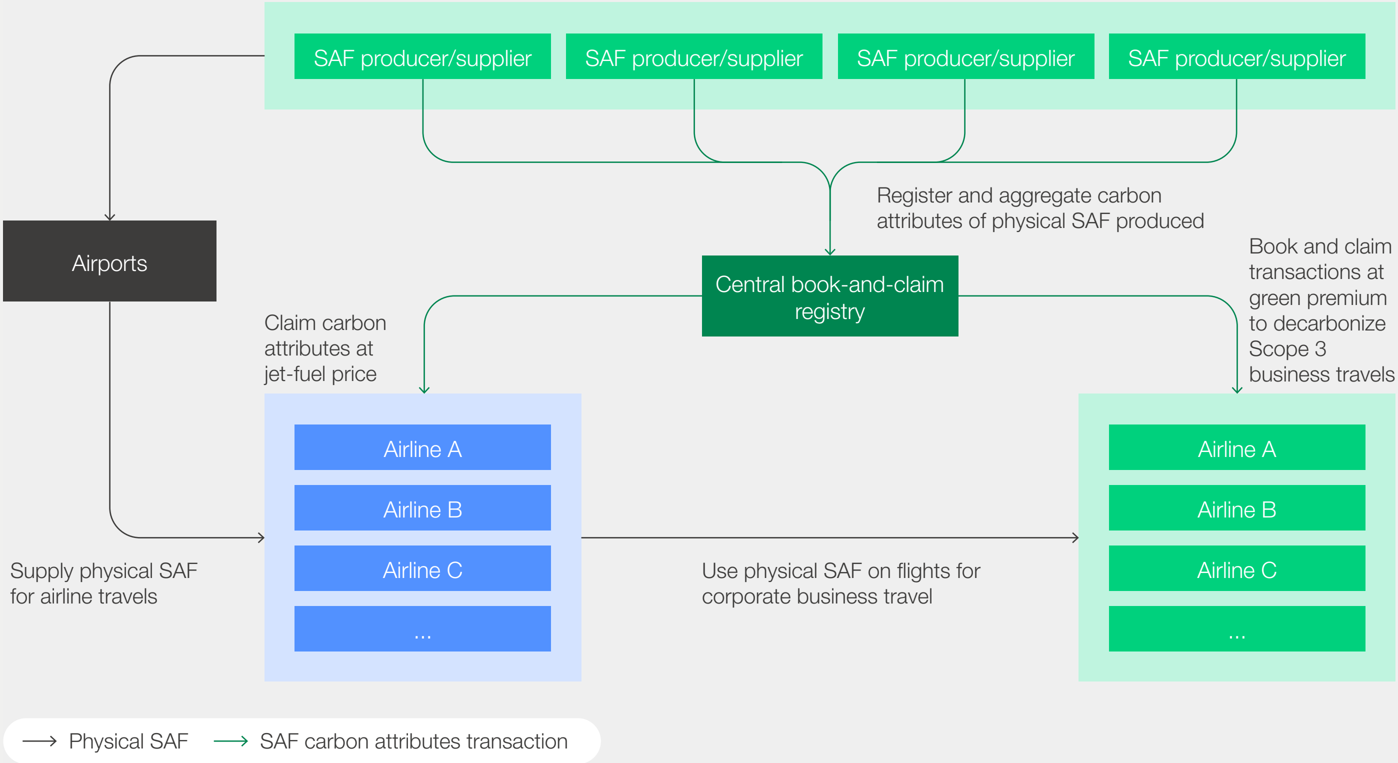
In other words, corporate buyers would be able to purchase the environmental benefits of the SAF produced without physically tracing the fuel through its supply chain, bypassing airlines as the intermediary to absorb the cost premium.

This implies several advantages over long-term individual offtake agreements. First, decoupling the fuel from its carbon-reduction attributes removes the geographical restrictions on production and offtake activities, and allows global access to green fuel at a lower premium, regardless of local policy incentives. Moreover, as the committed carbon attributes will be supplied by multiple producers of SAF, this modality of offtake hedges against the delivery risk of a single producer and provides corporations with greater flexibility around the terms of the offtake as well as the parties involved.

The development of the book-and-claim system is particularly significant for multinational companies, given that aviation-related business travel forms a substantial portion of their Scope 3 emissions. This system benefits not just the individual corporations participating in the initiative, but also stimulates large-scale production in response to growing demand. This demand is largely driven by the recent trend of corporate target-setting for emissions reduction. Implementing book-and-claim allows these companies to contribute to reducing their Scope 3 emissions effectively. By purchasing carbon attribute certificates, they can claim the environmental benefits of using SAF, even if the physical fuel isn’t used directly in their own business travel. This approach can significantly drive the demand for SAF, encouraging producers to ramp up production to meet increasing corporate demand.

The broader impact of this development is two-fold. First, it accelerates the transition towards more sustainable aviation practices by creating a market for SAF, driving down the cost of production and offtake in the long run. Second, it enables corporations to meet their sustainability targets more effectively by providing a feasible, scalable and relatively affordable way to offset a major source of their indirect emissions. This synergy between corporate environmental responsibility and the development of SAF markets is crucial for achieving larger climate goals.

FIGURE 6: **Central book-and-claim structure**



A holistic, auditable and clear book-and-claim system that bypasses airlines and marketers, and allows for credit purchase by corporates around the world, is essential for scaling up global demand. This is especially important for offtakes outside of incentivized markets, which facilitate the connection between suppliers and international buyers.

Despite its numerous merits, the key challenge of this approach currently lies in the presence of multiple book-and-claim systems, each with its own set of SAF suppliers and partnerships. A critical issue with this fragmentation is that the commercial objectives driving individual platforms may lead to a divided market, diminishing the overall effectiveness of the approach. To overcome this fragmentation and scale demand globally, as highlighted in Figure 6, it is crucial to establish a comprehensive, auditable and transparent book-and-claim system.

Such a system should consolidate the SAF supply from various producers and facilitate the purchase of credits by all types of corporations. This unified system is essential for leveraging the purchasing power of companies worldwide, including those located in regions without direct incentives or local SAF suppliers.

What are some ways for corporates to get involved to support the scaling of book-and-claim solutions? Depending on the level of ambition, companies can participate in the book-and-claim pilot programme, commit to carbon credit “bookings” via a platform, become partners in system development, or support the development of standardization and centralization of book-and-claim systems. Case studies 1.1 and 1.2 illustrate a few potential ways to engage by following the example of sustainable leaders.

CASE STUDY 1.1

Air BP, RSB, United and Microsoft

In 2021, **Air BP, RSB, United and Microsoft** announced a **partnership for an SAF book-and-claim pilot.**

- In this pilot, Air BP is to supply 7,000 gallons (26,500 litres) of waste-based SAF to United at UK airports, achieving an 80% reduction of life-cycle GHG emissions in comparison to the fossil fuel it replaces.
- The pilot intends to unlock increased supply for SAF users and their customers:
  - The end-user of carbon credits, **Microsoft is joining the pilot to purchase Scope 3 emissions attributes** of SAF via RSB's book-and-claim system to **reduce the GHG life-cycle emissions associated with its corporate travel.**
  - The transaction will be registered, audited and verified by RSB.
  - The Sustainable Aviation Buyers Alliance (SABA), a joint initiative of Environmental Defense Fund (EDF) and RMI, is advising on the design of the book-and-claim system, and collaborating with RSB on the development of an electronic registry to transparently record SAF life-cycle emissions reduction transactions.
- The feedback and input of RSB's multistakeholder membership – representing industry, civil society, academia and others – on the book-and-claim pilot project will be key to ensuring credibility and broad support for the system going forward and to unlocking the development of book-and-claim at a larger scale.

CASE STUDY 1.2

Avelia: Amex GBT, Shell, Accenture

In 2022, **Amex GBT, Shell and Accenture** announced the launch of their blockchain-based book-and-claim system with 1 million gallons of SAF (delivered by Shell) available for corporate customers – enough to power almost 15,000 business trips from London to New York. Operated on the Avelia platform, the programme is one of the world's first blockchain-powered digital SAF book-and-claim solutions for business travel to provide corporations with fully traceable environmental attributes of SAF to help decarbonize corporate air travel.

- The platform aims to benefit players across the value chain:
  - Airlines tap the buying power of corporations by offering greater access to a platform that tracks the ecological impact of their fuel use and a transparent way of tracking the environmental attributes of SAF.
  - Corporates access the opportunity to reduce emissions associated with their business travel to achieve sustainability targets.
  - SAF suppliers get a clear demand signal, gaining confidence to invest in scaling production.
- Bank of America is the first financial institution to join this SAF programme.

Corporates can play a role by joining book-and-claim programmes as well as becoming partners in the development of the system.

Supporting book and claim not only allows large corporates to progress against their sustainability targets with independently authenticated SAF credits but also secures carbon attributes at a lower price than individual SAF offtake agreements, given the minimization of logistical costs. In the medium to long run, scaling demand as a result of platform growth will accelerate production volume and further benefit corporates by rapidly driving down offtake prices.

3.3 Equity investment for committed volume

Lastly, for emerging technologies with limited precedent of individual offtake, such as GH_2, corporates looking to secure these products early on can also share the risk with producers by committing capital financing to the project. This is generally done through a joint venture with one or more clean-energy producers. As an equity partner, the corporate buyer agrees to take on the project's technological, operational and construction risks in exchange for securing SAF or GH_2 offtake volume at potentially lower rates, more flexible terms, and, eventually, a return on investment.

In the case of GH_2, since the end-use market is still nascent, the development of production projects requires collaboration and coordination between different players across the value chain. Initial projects typically involve end-user participation to de-risk the project by securing long-term offtake. This guarantees transparency on operational performance and provides complementary capabilities and resources.

Figure 6 showcases examples of such partnerships, highlighting the collaborative efforts required to develop and scale GH_2 projects and demonstrate the critical role of cross-sector partnerships in driving the transition to a more sustainable energy landscape.

FIGURE 7: **Examples of GH_2 partnerships**

Cross-value chain partnership

Development of hydrogen requires **collaboration and coordination** between different players across the value chain.

First hydrogen projects involve the **participation of end-users to de-risk the project** by securing long-term offtake, providing transparency on operational performance and offering **complementary capabilities and resources**.

Such strategies create advantages beyond GH_2 supply (e.g. value-chain integration, cost advantages and partnership in other aspects) and help develop rules to **shape the future** of the hydrogen ecosystem.

Example of partnership		Description
Hydrogen for green steel brownfield plant	Iberdrola H2greensteel	– A 1,000 megawatt electrolyser is integrated in a brownfield carbon-neutral steel plant. – The electrolyser is operated jointly by Iberdrola and H_2GreenSteel.
Hydrogen production and transmission in northern Spain	DH2 Energy Fertiberia enagas ArcelorMittal	– Hydeal plans to build a 7.4 gigawatt network to provide clean hydrogen to northern Spain. – It plans to expand the consortium to 30 entities.
Circular economy in steel production	Ørsted SALZGITTER AG Stahl und Technologie	– A strategic partnership aims to produce GH_2 to decarbonize steel production. – Salzgitter will deliver low-carbon steel for wind plants and recycle wind turbines.
GET H2 Nukleus's hydrogen infrastructure	RWE OGE bp SALZGITTER AG Stahl und Technologie EVONIK Leading Beyond Chemistry Wir transportieren Gas. nowega	– A 100 megawatt electrolysis unit to be built in an RWE power plant. – Open infrastructure to be extended to expand grid reach and include storage facilities in the future.

The case study below shows that this strategy can create advantages beyond merely securing supply of GH_2. These advantages include value-chain integration, cost efficiencies and additional partnership opportunities. This approach plays a pivotal role in establishing the foundational guidelines that will shape the evolving GH_2 ecosystem. As the industry matures and develops, more independent hydrogen producers are likely to emerge. These producers will likely strike a balance between catering to dedicated offtakes and serving broader wholesale or export markets.

This evolution will be a significant step in the hydrogen industry, as it signifies a shift from initial, more integrated project models to a more diversified and expansive market structure. Such a transition will not only enhance the availability and accessibility of GH_2 but will also stimulate competition and innovation within the sector, further solidifying GH_2's role in the clean-energy landscape.

CASE STUDY 3

The NorthH2 consortium

$NorthH_2$ is a consortium including Eneco, Equinor, RWE, Shell and Groningen Seaports. The project aims to **build the largest GH_2 factory in Europe in the Eemshaven, a significant port area located in the province of Groningen, in the northern part of the Netherlands.**

- The project will have an electrolysis capacity of 1 GW in 2027, **4 GW by 2030** and **10+ GW by 2040** for electrolysis. This equates to **0.4 Mt of GH_2 production in 2030 and 1 Mt GH_2 production by 2040**. (This amounts to ~8-10 Mt of CO_2 emissions abatement, equivalent to the yearly emissions from road traffic in Norway.)
- Nitrogen products manufacturer **OCI NV joined the consortium as a partner** to secure **offtake of 1 GW of green hydrogen** from the project to develop integrated green ammonia and methanol value chains in the Netherlands.
  - Partnership with $NorthH_2$ will help **decarbonize OCI's own production processes** and the downstream food, fuel and consumer goods value chains, as well as reduce the country's dependence on natural gas.
  - Using 1 GW of $NorthH_2$'s green hydrogen, OCI can **help the Netherlands achieve a significant 4% of the 2030 climate targets** set for the Dutch industry, equivalent to taking 450,000 cars off the road.
- Further, this consortium-based partnership across the value chain creates a considerable cost advantage to GH_2 production (benefitting both producers and offtakers):
  - In the first phase of the feasibility study, the study concludes that $NorthH_2$'s integrated approach could lead to a **20% reduction in societal costs** compared to a smaller-scale approach in the period up to 2030.
  - Because the consortium wants to **build the entire chain on a large scale – from offshore wind farms, production, storage and distribution to the eventual end-use of green hydrogen** – this cost reduction is achievable.
  - In this way, **GH_2 can become an economically interesting decarbonization option in the industrial sectors in comparison to alternatives**.

While participation of corporate end-users to de-risk the project by securing long-term offtake, large-scale value chain integration in partnerships creates a cost advantage to green hydrogen production, enhancing the economics of green hydrogen adoption vs. alternatives for corporates.

The offtake market for SAF is relatively more mature than that for GH_2. As such, offtake agreements, book-and-claims or clean energy fund investment might be a better fit for corporate offtakers looking to decarbonize their Scope 3 business travel through SAF carbon credits. This range of options allows corporations to engage at various levels, depending on their specific needs and sustainability strategies.

However, there is an exception to this general trend, particularly for energy companies seeking to develop their SAF production capabilities. For these players, partnering with technologically experienced entities can be invaluable. Such partnerships enable these companies to gain insights and acquire knowledge directly from those already proficient in SAF production. This collaborative approach not only aids in building their own production competencies but also contributes to the overall growth and maturation of the SAF market.

Other enabling corporate actions

In addition to sending demand signals through volume commitments, corporates can take several actions to support the acceleration of SAF and GH_2 development. For instance, they can commit direct capital to investment platforms that help accelerate low-carbon start-ups. Specifically, the mobilization of private capital for investment in lighthouse projects will complement offtake activities by supporting the increase in supply to meet the increase in demand. This section provides two examples of clean-energy funds and describes what their investment portfolios look like.

Apart from investing in independent clean-energy funds, corporations can contribute to the clean-energy investment funds of their business travel partners. For instance, United Airlines has established the Sustainable Flight Fund with 13 corporate partners and an investment pool of approximately $200 million. SAF producers funded by the initiative to date include Alder Fuels, Fulcrum and NEXT Renewable Fuels.

EXAMPLE 1:

Clean H2 Infrastructure Fund, Hy24

- **Objective:** The Clean H_2 Infra Fund managed by Hy24 is a 50-50 joint venture between Ardian, a world-leading private investment house, and FiveT Hydrogen, a clean H_2 producer. The fund is now up and running with €2 billion of allocations aimed at accelerating the development of the hydrogen sector.
- **Portfolio:** Through its infrastructure fund, Hy24 is investing in early-stage and strategic large-scale infrastructure projects for the production, storage and distribution of clean H_2.
- **Direct capital partners:** Air Liquide, Baker Hughes, Chart Industries, Plug Power, TotalEnergies and VINCI Concessions.
- **Investments:**

#	Project	Description
1	**H_2 Green Steel**	H_2 Green Steel has raised about €1.5 billion in equity from an investor group led by Altor, Government of Singapore Investment Corporation (GIC), Hy24 and Just Climate. The round will finance the world's first large-scale green steel plant and Europe's first giga-scale electrolyser.
2	**Elyse Energy**	Founded in 2020, Elyse Energy is a pioneer in the production of low-carbon molecules. Elyse Energy has completed a financing transaction with Hy24 and Mirova to support the development of its e-methanol and SAF projects in France and Spain.
3	**InterContinental Energy**	Using upstream wind and solar, InterContinental Energy delivers GH_2 at scale to accelerate the energy transition. InterContinental Energy enters the next phase of growth thanks to a strategic joint equity investment of $115 million from GIC and Hy24.

EXAMPLE 2:

Breakthrough Energy Catalyst, Breakthrough Energy

- **Objective:** Breakthrough Energy Catalyst is a novel platform that funds and invests in companies utilizing emerging emissions reduction technologies. Catalyst seeks to accelerate the adoption of these technologies worldwide and reduce their green premiums.
- **Portfolio:** With over $1 billion raised in committed capital, Catalyst funds large demonstration projects and invests in first-of-a-kind projects using key emerging climate technologies. Using capital alongside the team's energy infrastructure investing and project development expertise, it collaborates with companies and key stakeholders to efficiently advance projects from development to construction stage.
- **Direct capital partners**

American Airlines, ArcelorMittal, Bank of America, BMO, BlackRock, BCG, Builders Vision, citi, gm, HSBC UK, Microsoft, Mitsubishi Corporation, State Farm

- **Investment:**

Project	Description
LanzaJet Freedom Pines Fuels SAF plant	Breakthrough Energy's first Catalyst project funding will go to LanzaJet's Freedom Pines Fuels SAF plant in Soperton, Georgia, US through a $50 million grant. Projected to be operational in 2023, the Freedom Pines project is the firm's first commercial-scale SAF plant and will be the first in the world to produce alcohol-to-jet SAF. The plant is expected to produce 9 million gallons of SAF and 1 million gallons of renewable diesel annually, roughly doubling current SAF production in the US. Construction of the plant will enable significant scale-up of LanzaJet's technology within the US and globally.

This multifaceted approach described above of both contributing to and benefiting from advancements in the SAF and GH_2 sectors is essential for driving the transition towards more sustainable energy sources in aviation and beyond.

Conclusion

Addressing the challenge of scaling up SAF and GH_2 offtake is a formidable endeavour, necessitating a concerted effort from across the public and private sectors. It calls for a proactive stance from stakeholders to not only mitigate long-term investment risks, but also to initiate action in the face of demand uncertainties.

The call for cross-value chain collaboration to tackle one of the energy sector's most pressing hurdles is well-founded, including but not limited to, suppliers, public and private financiers, and government actors. To support the transition to a net-zero economy, the Finance Pillar of the First Movers Coalition will continue to work jointly with coalition members and government partners to enable effective dialogues between corporations and the financing community, promoting financing and de-risking mechanisms for hard-to-abate sector technologies, and driving climate finance capacity-building for the public sector. Moving beyond mere advocacy for collaboration, the coalition will address the critical need to share actionable strategies, including innovative offtake agreements and financial frameworks, to steer the industry on a sustainable trajectory.

The imperative for decarbonizing hard-to-abate sectors is unequivocal, and the first movers are committed to rapidly advancing these initiatives. The moment has come to ignite the engines of change and propel the industry forward.

Glossary

1.5°C pathway: In May 2021, the International Energy Agency (IEA) published its landmark report, "Net Zero Emissions by 2050: A Roadmap for the Global Energy Sector." The report set out a narrow but feasible pathway for the global energy sector to contribute to the Paris Agreement's goal of limiting the rise in global temperatures to 1.5°C above pre-industrial levels.

Book and claim: This is a chain-of-custody model that allows clean fuel producers to "book" the emissions savings of a good they've produced in one place, and customers to "claim" the emissions benefit from these goods for climate disclosures in a different place.

Carbon attributes: These are the environmental qualities or benefits associated with the reduction, avoidance or sequestration of carbon dioxide (CO_2) emissions. These attributes can be quantified and often become tradable assets in the form of carbon credits or carbon offsets in carbon markets. Each carbon credit typically represents 1 metric ton of CO_2 (or CO_2 equivalent gases) that has been either prevented from being emitted into the atmosphere or removed from it through various means such as renewable energy initiatives, reforestation or carbon capture and storage.

Carbon credits: A carbon credit is a permit that represents a ton of CO_2 or other greenhouse gases that can be emitted or removed from the atmosphere. Carbon credits are used in cap-and-trade programmes that limit the total emissions of a business or a market. They can be bought, sold or traded to compensate for emissions made elsewhere or to generate revenue for low-emitting businesses.

Carbon intensity (CI): This is the backbone of California's Low Carbon Fuel Standard (LCFS) and is measured in grams of carbon dioxide equivalent per megajoule of energy (gCO_2e/MJ). Each year, the California Air Resources Board (CARB) sets a carbon intensity benchmark for all fuels. Fuels with CI scores above the benchmark create deficits that can be met by purchasing LCFS credits generated by fuels with CI scores below the benchmark.

Contract-for-difference subsidy: In the context of Green Hydrogen, contract for difference is a subsidy model in which both positive and negative deviations from a fixed reference price are paid out to the contractual partner.

Emissions Trading System (ETS): The EU ETS was initially established in 2005 as a market-based mechanism to tackle GHG emissions within the European Union. While it primarily targeted energy-intensive sectors like power generation and manufacturing, recent developments have included shipping in the ETS.

European Hydrogen Bank (EHB): This is a group of 33 energy infrastructure operators, united through a shared vision of a climate-neutral Europe enabled by a thriving market for renewables and low-carbon hydrogen. Aims to accelerate Europe's decarbonization journey by defining the critical role of hydrogen infrastructure – based on existing and new pipelines – in enabling the development of a competitive, liquid, pan-European renewables-based and low-carbon hydrogen market.

Final investment decision (FID): This is the final stage of a capital investment decision. This is the point in the capital project planning process when the decision to make major financial commitments is taken. In the energy industry, FID is the point at which the company or companies owning and/or operating the project approve the project's future development.

Fuel Quality Directive (FQD): Refers to a directive that provides technical and environmental specifications for fuels used in positive ignition and compression engines.

Green Hydrogen (GH_2): Refers to hydrogen produced by splitting water into hydrogen and oxygen using renewable electricity, which is a different pathway compared to both grey and blue hydrogen. GH_2 featured in a number of emissions reduction pledges at the UN climate conference COP26, as a means to decarbonize heavy industry, long-haul freight, shipping and aviation.

Green premium: Refers to the difference in price between something made with fossil fuels and something made in a sustainable manner. In other words, it is the additional cost of choosing a clean technology over an alternative that emits more greenhouse gases (GHGs).

H_2Global: This is an instrument developed in response to the mismatch between climate change targets and existing instruments to promote rapid reductions in CO_2 emissions in the industrial, energy, heat and transport sectors. Promotes the production and use of GH_2 and its derivatives through a market-based approach, making an important contribution to the green transition of society and economy.

IRA SAF Blenders tax credit: The Treasury Department and the Internal Revenue Service of the United States (US) have issued guidance regarding an SAF blender's tax credit. The credit is $1.25 for each gallon of SAF in a qualified mixture. To qualify, the SAF must have a minimum reduction of 50% in life-cycle GHG emissions as compared to jet fuel.

Low Carbon Fuel Standards (LCFS): Refers to a regulation that reduces the average carbon intensity of transport fuels. Carbon intensity is the amount of GHG emissions associated with a fuel, from production to combustion. An LCFS requires fuel manufacturers to use lower-carbon fuels or purchase credits to comply. California is the first state in the US to implement an LCFS, as part of its efforts to reduce emissions by 2030 and 2050.

Low-carbon technologies: These are innovative technical solutions that are characterized by a low emissions intensity, compared to alternatives.

Memorandum of understanding (MoU): This is a formal document that expresses an agreement between two or more parties on a common goal or project. An MoU is not necessarily legally binding, but it indicates the willingness and expectations of the parties to cooperate.

Offtake agreement: Refers to a contract between a producer and a buyer to sell or buy a certain amount of the producer's future output. It is usually negotiated before a production facility is built or production begins. It is often used for natural resource development projects that require large capital investment.

Offtakers: These are the buyers of Sustainable Aviation Fuel or GH_2 in an offtake agreement; can be a public company or a private party.

Project bankability/"financeability": A project is bankable, whether from public or private sources, when its risk-return profile meets investors' criteria and can secure financing to implement the project.

RePowerEU: Refers to a European Commission proposal put forward in May 2022. The plan aims to save energy, produce clean energy and diversify European energy supplies. It is backed by financial and legal measures to build the new energy infrastructure and system that Europe needs.

Renewable Identification Numbers (RIN): These are credits used for compliance that are the "currency" of the Renewable Fuel Standard Program (RFS) of the US government. In terms of the life cycle, renewable fuel producers generate RINs, market participants trade RINs, and obligated parties obtain and then ultimately retire RINs for compliance.

Renewable Energy Directives (RED): This is a legal framework for the development of clean energy across all sectors of the EU economy. RED was adopted in 2009 to deliver a minimum 20% share of renewable energy sources (RES) in EU final energy consumption by 2020. It was later updated with the recast Renewable Energy Directive (2018/2001/EU), part of the Clean Energy for All Europeans package, setting a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upward revision by 2023.

Science Based Targets initiative (SBTi): This is a partnership between CDP, the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF). The SBTi drives ambitious climate action in the private sector by enabling companies to set science-based emissions reduction targets.

Scope 3 business travel: Refers to emissions from the transport of employees for business-related activities in vehicles owned or operated by third parties. Roughly 90% of business travel can be accounted for by emissions from air travel.

Sustainable Aviation Buyers Alliance (SABA): This is a group of major corporations spearheaded by RMI and Environmental Defense Fund (EDF), accelerating the path to net-zero aviation by driving investment in, and adoption of, high-integrity SAF. Supports companies, airlines and freight customers in achieving their climate goals.

Sustainable Aviation Fuel (SAF): Sustainable aviation fuel, made from non-petroleum feedstocks, is an alternative to jet fuel that reduces emissions from air transport.

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