



Project
SkyPower

e-SAF Project Delivery Risk Management

The Role of EU Public
Financial Institutions

October 2025

project-skypower.org



Project SkyPower

Project SkyPower's mission is to pave the way for the first large-scale e-SAF plants in Europe to reach Final Investment Decision (FID) by the end of 2025. Our goal is not only to drive progress towards 2030 regulatory targets (ReFuelEU Aviation and UK SAF Mandate), but also towards e-SAF market tipping points in the 2030s and exponential scale thereafter. The vision is to make e-SAF a commercial reality this decade, bringing the European aviation industry a vital step closer to a lower emissions future.

Delivery partners:



Supported by:



Project SkyPower

Our vision

Making e-SAF a commercial reality this decade, bringing the European aviation industry a vital step closer to a lower emissions future

Our mission

Paving the way for the first large-scale¹ e-SAF plants in Europe to reach Final Investment Decision by end of 2025

Accelerating the take-off for e-SAF in Europe

Note: 1. Large-scale e-SAF plants are defined here as plants with an annual capacity of more than 25,000 tonnes e-SAF.



Foreword

Electro-sustainable aviation fuel (e-SAF) is central to decarbonising aviation, but its success depends on developing new, investable projects at scale.

The first commercial facilities face the familiar headwinds of any first-of-a-kind (FOAK) technology: integration complexity, construction risk, and the challenge of translating promising engineering into bankable cash flows.

This report sets out a practical blueprint to bridge that gap. Its core message is clear: targeted public finance, deployed alongside private capital and insurance, can unlock the first wave of e-SAF projects and, following that, scale the wider market. With ReFuelEU mandates taking effect from 2030, projects need to reach final investment decision (FID) within the next 18 months to meet typical construction and ramp-up timelines. That makes early, risk-tolerant capital, particularly senior debt from public financial institutions, mission-critical.

In this report, we set out how to de-risk delivery without displacing private expertise: direct lending to anchor project debt; enhancements to technology performance insurance; contingent credit facilities to manage overruns after contingencies are exhausted; matched funding for comprehensive FEED studies; and targeted

backstops where supplier guarantees are insufficient. Together, these tools align risk with those best placed to manage it: developers, EPCs, OEMs, insurers, and lenders, while protecting taxpayers and accelerating development. Crucially, such support should taper off as private risk appetite deepens as it becomes more informed.

Although focused on e-SAF, the principles outlined in this report extend across FOAK climate technologies. Europe now has an opportunity to convert industrial ambition into delivery, strengthening energy security, building green supply chains, and creating quality jobs, while signalling global leadership in climate innovation.

Project Skypower and the Green Finance Institute are now working with public financial institutions, investors, and industry to move from plans to projects. The runway to 2030 is short. With the right financial architecture, it is still just enough.

Dr. Rhian-Mari Thomas
CEO of the Green Finance Institute



Executive Summary



This report explores the critical aspects of project delivery risk management for e-SAF (electro-Sustainable Aviation Fuel) projects, emphasising the role of public financial institutions¹ (PFIs) in mitigating project delivery risk.

The primary focus is on the construction, commissioning and operational phase, where risks such as technology maturity, integration, and delivery partner reliability are the most pronounced. Given the First-of-a-Kind (FOAK) nature of e-SAF facilities, these projects face elevated technical and commercial risks, making traditional project financing structures challenging without targeted support.

The report highlights the necessity of government intervention to provide long-term, risk-tolerant capital that complements the technical expertise already present in the market. To address this need, we propose a suite of financial instruments designed to deliver critical capital and credit enhancements, ensuring project financing feasibility while underpinning investor confidence. These instruments are tailored to varying risk appetites of PFIs and are evaluated using a financial exposure vs. impact on cost of capital framework, at the individual project level and across the broader funding envelope required to advance the first wave of e-SAF projects through Final Investment Decision (FID). While more intensive support will be necessary for the earliest projects, we expect PFI involvement to decline as market momentum grows, and early proof points increase private sector risk appetite.

We evaluate the role of private market participants including project developers, sponsors, construction contractors, OEMs and technology licensors, in taking appropriate allocations of risk across the project lifecycle. This is critical to ensure risk and responsibility are assigned to the parties best positioned to manage them. The report also explores the role of private insurance, highlighting existing market products that can protect lenders from technology risk through mechanisms such as technology performance wraps.

With ReFuelEU e-SAF mandates set to take effect in 2030, the first round of projects must reach FID within the next 18 months to align with the typical 4 to 5 year construction, commissioning and ramp up timelines. For these initial projects, immediate support is essential. Therefore, we highlight that the most impactful role a PFI can play is to lend directly to e-SAF facilities from its existing product suite, by providing a significant portion of the required debt capital. Even at commercial terms, this provides a crucial source of large-scale, risk tolerant capital. This enables insurance to significantly protect the remaining share of commercial debt from technology performance risk. Early capital commitments from PFIs send a clear signal that the EU is committed to building a domestic e-SAF industry in-line with ReFuelEU targets.

¹ A Public Financial Institution (PFI) refers to a government backed financial institution, either at the EU level, such as the European Investment Bank, or at the member state level, such as Export Credit Agencies.



Although the report focuses on e-SAF, the principles outlined are relevant to FOAK climate technologies more broadly. Accelerating the deployment of these technologies will require public-private risk-sharing mechanisms tailored to manage the unique challenges of FOAK project delivery risk. By applying these insights, Europe can not only advance aviation decarbonisation and energy security but also position itself as a global leader in climate innovation.

Note: This report focuses exclusively on project delivery risks and does not address other risks such as offtake, feedstock, or energy supply risks. Offtake risk is the greatest challenge for financing e-SAF projects. However, for the context of this report, it is assumed these other risks will be mitigated through traditional commercial contracts or, for example, the market mechanism Project SkyPower is proposing to address offtake risk.

Key Recommendations

Government-backed instruments can complement private solutions by providing:

- ① **Cornerstone lender to e-SAF projects:** PFIs should be among the first movers to provide senior project finance debt to e-SAF projects to supplement liquidity in the private sector project finance market and build confidence in the bankability of this nascent industry. Where appropriate this finance can be structured to lower risk to commercial lenders, e.g., first loss, subordination and other credit enhancements.
- ② **Enhancements to insurance products,** leveraging best in class risk assessment capabilities, whilst ensuring debt protection is adequate, providing the necessary risk mitigation to ensure debt and equity can invest in e-SAF in line with their internal risk/return requirements.
- ③ **Contingent reserve facilities** that may be accessed after project contingencies are depleted, allowing projects to address essential remediation requirements. These facilities may be hybrid or convertible in nature to provide flexibility.

- ④ **FEED funding:** comprehensive FEED studies are crucial to prepare the financing and construction of multi-contractor projects. PFIs could match private investment into FEED studies against a convertible loan upon FID, repayable during operation.
- ⑤ **Backstopping and enhancement of supplier guarantees** where they are insufficient to cover underperformance or when weaker contractual counterparties would be difficult to accept in a project finance structure.

To discuss the insights of this report, please reach out to the Green Finance Institute at josh.garton@gfi.green or info@gfi.green.



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Note: This report was prepared with input from project developers and sponsors, technology licensors, construction contractors, commercial lenders, project finance lawyers, and technology performance insurance agents. While it may not reflect all perspectives fully, it aims to provide a balanced perspective of key e-SAF project delivery stakeholders.



01

Project Delivery Risk

- First-of-a-Kind (FOAK) technology risk
- Financing structure of an e-SAF project
- Commercial challenges to project delivery risk management
- The need for Public Financial Institution (PFI) support



Project delivery risk for an e-SAF facility refers to the risk that the project will not be completed on time, within budget, or perform to the expected capacity and product specifications.

This report focuses on project delivery risk during these key phases of a project life cycle:

- ① **Construction:** Risks associated with the engineering, procurement, and construction of the plant until mechanical completion.
- ② **Commissioning:** Risks when testing and starting up the technology for the first time and scaling to full production capacity at the expected product specifications.
- ③ **Operation:** Risks around the stability of operations such that the plant does not perform to expected capacity, efficiency, availability or quality levels over time.

Typically, key drivers of project delivery risk revolve around:

- ① **Technology risk:** Risk associated with the performance of individual technology process components.
- ② **Integration risk:** Risk associated with the integration of different technology components, and how they perform together under varying plant production conditions.
- ③ **Delivery partner risk:** Risk that key project partners, such as construction parties or Original Equipment Manufacturers (OEM), fail to meet their technical or financial obligations, which can cause significant delays and loss of revenue.

First-of-a-Kind (FOAK) technology risk

With no commercial-scale e-SAF² facilities yet operational, the first deployment of a specific e-SAF technology pathway would by definition be FOAK, grappling with elevated levels of technical, integration, and commercial uncertainty. These projects must navigate complex engineering interfaces, such as renewably powered hydrogen electrolysis, CO₂ capture, reverse water gas shift reactor, and Fischer-Tropsch synthesis, without the benefit of operational benchmarks, serial learnings, or learning-curve effects. This lack of precedent translates into greater uncertainty across technology performance, construction delivery, and market uptake.

2 For the purpose of this report, a commercial scale e-SAF facility is one that produces +25kt of e-SAF.



Financing structure of an e-SAF project

FOAK commercial-scale plants are typically developed by large strategic investors using on-balance-sheet financing. For e-SAF, this would likely involve major energy or oil companies, but in Europe, these firms are not yet active in e-SAF commercialisation. Instead, smaller companies supported by financial or institutional investors are driving projects. While some of these investors may have the means to ensure completion and operational performance, when considering e-SAF projects total installed cost (TIC) of €1-1.5 billion,³ they seek to limit their liabilities and prefer to partner with debt providers during both construction and operation using project financing structures. These typically involve structuring in “non-recourse” Special Purpose Vehicles (SPVs) with funding based on anticipated cash flow from bankable contracts covering off take,

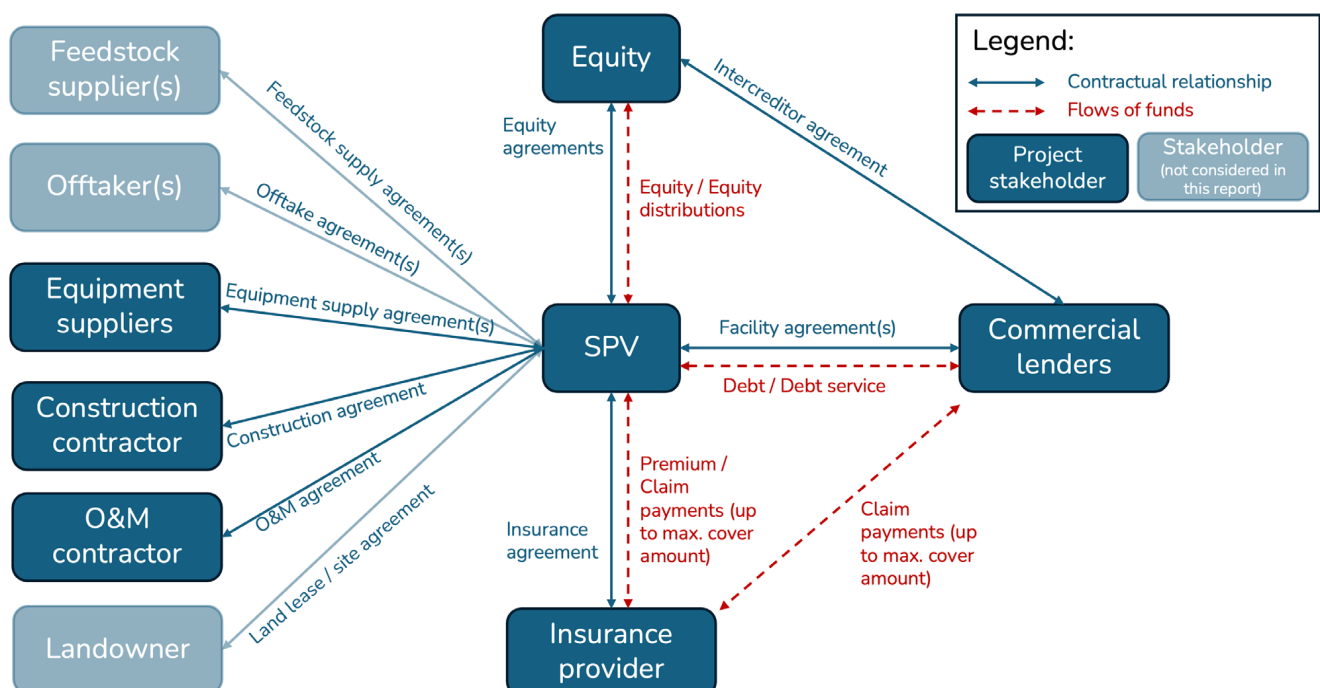
feedstock supply, technology, construction, and O&M agreements. This approach relies on the ability to provide predictable cash flow, allowing investors to evaluate risk-adjusted returns.

Due to the FOAK status of e-SAF projects, equity providers expect high returns, while debt providers seek stricter assurances of sufficient cash flow for debt servicing, a requirement heightened by regulatory rules like the Basel frameworks. Lacking the necessary assurances, debt providers find it very difficult to finance e-SAF projects in the current market, which means the most likely financing pathway would be full equity, which, with a significantly higher cost of capital, would exacerbate already high Levelised Costs of Production (LCOP) and raise minimum sale prices. This makes securing long-term offtake agreements, essential for bankability and investor confidence, more challenging.

3 Estimated total installed cost for a 50ktpa e-SAF facility based on market engagement.

Exhibit 1

SPV diagram including key contractual parties





Commercial challenges to project delivery risk management

A core principle of project finance is to shield the SPV by transferring risks to those best able to manage it, from equity sponsors to construction contractors, technology licensors, and OEMs. Sponsors assume market and strategic risks, contractors cover construction and integration, and licensors and OEMs provide performance warranties. Yet each party faces acute FOAK challenges: sponsors often lack balance-sheet depth for cost overruns, contractors confront new integration challenges, and licensors and OEMs cap liabilities on processes. These constraints drive conservative contract structures, inflate financing costs, and hamper the bankability of FOAK projects (see section: [Commercial Risk Management & Residual Risk](#)).

The need for Public Financial Institution (PFI) support

With ReFuelEU supply mandates approaching in 2030, and construction and commissioning timelines for e-SAF projects of 4–5 years, targeted PFI intervention is essential to help the initial FOAK projects reach Final Investment Decision (FID) as quickly as possible. Without such support, there is a risk of missing critical delivery windows, jeopardising mandate compliance and delaying the scale-up of a commercially viable, long-term e-SAF industry.

However, any PFI support should be targeted, temporary, and designed to (i) complement or share, not replace, private sector accountability and/or (ii) enhance the credit profile of the SPV. Item (i) is important for two key reasons:

- ① PFIs are not best placed to carry project delivery risk – the operational expertise required to resolve production issues resides with the stakeholders mentioned above.
- ② Extended PFI support can distort market dynamics, such as a lack of motivation to resolve issues or excessive risk taking i.e. moral hazard.

The successful delivery of the first wave of FOAK e-SAF projects hinges on a carefully balanced allocation of risk between public and private actors. Private sector stakeholders, including developers, sponsors, licensors, contractors, and insurers, should assume the maximum level of risk they can reasonably carry, based on their expertise and financial capacity. To complement this, PFIs should step in with targeted interventions, with options including development-stage funding, first lender to FOAK projects, credit enhancements, or guarantees. This shared-risk model is essential to de-risk emerging e-SAF technology pathways and unlock the investment needed to bring these projects to Final Investment Decision.



02

Technology & Integration Risk Analysis

- Technology Pathway: Reverse Water Gas Shift + Fischer-Tropsch synthesis (RWGS + FT)
- Technology Pathway: E-Methanol to Jet (e-MTJ)
- Technology, Integration & Delivery Partner Risk



The Green Finance Institute commissioned **ERM⁴ to assess several technology pathways for e-SAF projects**. Two production pathways were considered, reflecting the predominant e-SAF technology pathways currently under development across Europe.

- Reverse Water Gas Shift + Fischer-Tropsch synthesis (RWGS + FT)
- E-Methanol to Jet (e-MTJ)

The purpose of this analysis was to understand the distribution of risks across an e-SAF production process, both on an individual component and integrated system level. To assess these risks systematically, ERM applied a Technology Readiness Level (TRL) methodology, as defined in section 1.1 of the [Appendix](#), to evaluate the maturity of individual technology blocks and the integration implications of combining them into a new configuration. While many components are commercially proven in other applications, their integration, particularly alongside less mature technologies, increases integration risk. These risks are often difficult to manage, as they cannot easily be allocated through standard contractual arrangements among project stakeholders.

In its research, ERM highlights that it does not view the risks identified to be significant barriers to the ultimate production of e-SAF. Instead, the concerns mainly relate to the economic performance of the plant as a whole, i.e. affecting total capital expenditure, the consumption of key inputs (e.g. renewable energy), the product specification and yield, and plant utilisation rates.

The likelihood and severity of the identified risks are higher for process steps and interfaces with lower TRLs. However, as these technologies mature and are proven at commercial scale, the associated risks will reduce. At present, the relatively low TRLs present financing challenges due to uncertainty in plant economics, which directly impacts the project's bankability.

4 ERM (Environmental Resources Management): <https://www.erm.com/>



Technology Pathway: RWGS + FT

Relies on green hydrogen and carbon dioxide as feedstocks to produce a hydrocarbon mix, including e-SAF, e-diesel, and e-naphtha.

In this pathway:

- Hydrogen and CO₂ are fed into an RWGS unit to produce syngas, which is then processed through FT synthesis to yield a tuneable mix of straight-chain hydrocarbons.
- The hydrocarbons are then fed into a hydrocracking/isomerisation unit, which produces a jet fuel component for blending at up to 50% with fossil jet.

The configuration typically includes one or more recycle loops to improve carbon efficiency:

- Unreacted carbon monoxide is recycled back into the FT reactor.
- Light components from FT are reformed and fed back into the RWGS unit.

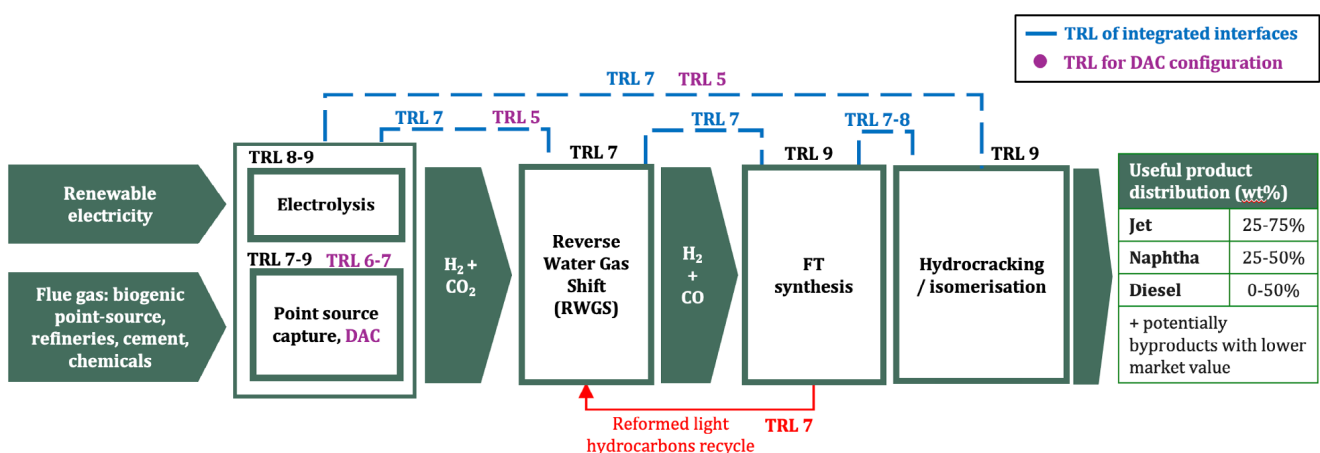
ERM has assigned a **TRL 7** to the integrated process based on the demonstration of the integrated technology by Ineratec and Infinium. It should be noted that there are several other credible technology developers active in this pathway, developing their own permutations of key process components e.g. RWGS, FT. The TRL of individual components and of the integrated pathway will vary depending on the developer.

Many of the individual technology components of this pathway have had some level of commercial application, most notably in Gas-to Liquids (GTL) projects operated at large industrial scale. However, the full RWGS + FT pathway has not yet been demonstrated at commercial scale. This pathway has received ASTM certification for the production of e-SAF.

For specific risks surrounding individual components and their integration, please refer to section 1.2 in the [Appendix](#).

Exhibit 2

ERM Analysis: RWGS-FT – Technology Process Flow Diagram



Note: DAC stands for Direct Air Capture, which refers to a technology for extracting CO₂ directly from the ambient air.

Source: ERM proprietary analysis.



Technology Pathway: e-MTJ

Also relies on green hydrogen and CO₂ but uses methanol as an intermediate.

The process involves:

- Methanol synthesis via catalytic hydrogenation of CO₂.
- Upgrading methanol through two steps:
 - Methanol-to-Olefins (MTO), producing light olefins.
 - Oligomerisation, converting olefins into longer-chain hydrocarbons.
- Final upgrading (e.g., hydroprocessing) is required for jet fuel compliance.

ERM has assigned the e-MTJ pathway a **TRL range of 5 to 7**. The lower end (TRL 5) reflects the largest operational plant which is currently below 0.1 kta in scale. However, given that several technology licensors have substantial experience in related process pathways, the upper bound is set at TRL 7. This is particularly applicable if developers have

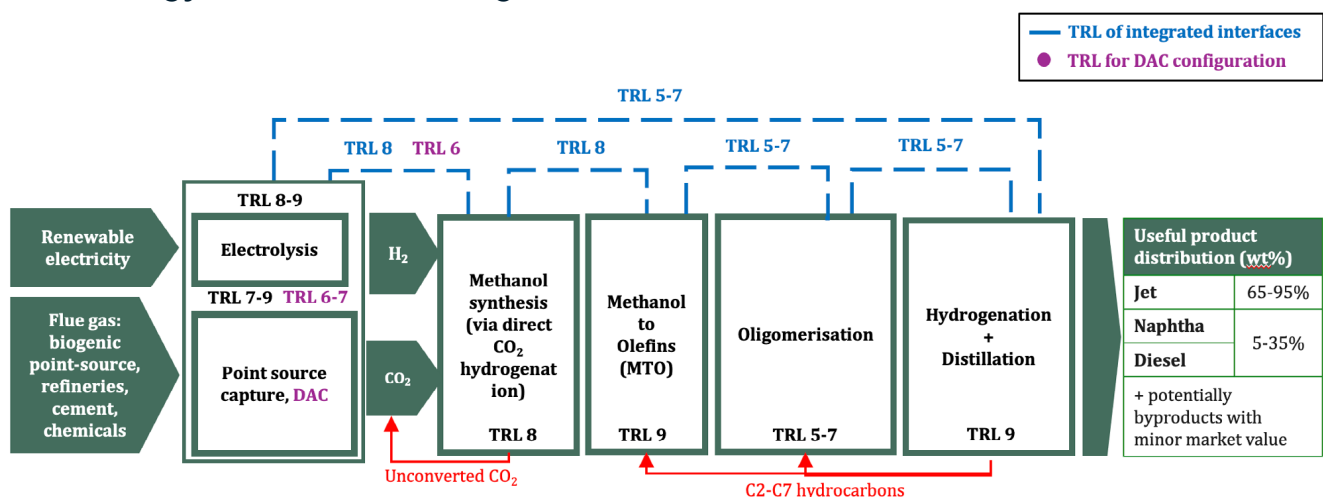
successfully addressed key limitations, most notably within the methanol-to-olefins (MTO) to oligomerisation steps, which are the main challenges in the process.

To date, the full e-MTJ process has not been demonstrated at commercial scale, with only a limited number of pilot projects in operation. Jet fuel produced via the e-MTJ route is not yet certified under ASTM standards meaning fuel specification remains an active area of development. However, industry engagement indicates that the fuel's properties are broadly consistent with those of already certified ASTM fuels. To advance this pathway a dedicated industry task force has been established and the e-MTJ pathway is progressing through the ASTM qualification process, currently under OEM review stage (review by engine and aircraft OEMs). ERM does not foresee major barriers to the approval of this route, though the exact timing of approval is not certain.

For specific risks surrounding individual components and their integration, please refer to section 1.2 in the [Appendix](#).

Exhibit 3

ERM Analysis: e-MTJ – Technology Process Flow Diagram



Source: ERM proprietary analysis.



Technology, Integration & Delivery Partner Risk

The deployment of e-SAF production facilities presents a set of interrelated risks that stem directly from the first-of-a-kind nature of the end-to-end process. This introduces several layers of uncertainty that affect investor confidence and create challenges in securing capital to an e-SAF SPV.

Technology Risk

Some technology blocks (e.g., electrolyzers, Fischer-Tropsch, hydrocrackers) are commercially mature (up to TRL 9) but may still carry risk when used at scales or under conditions that differ from traditional applications. For example, early electrolyser deployments have faced challenges operating efficiently at reduced loads.

Certain components, such as electrified RWGS in RWGS + FT or the oligomerisation step as it is configured in e-MTJ, have limited or no commercial deployment. This creates uncertainty around long-term reliability and operational performance.

Integration Risk

While individual components may be proven, they have not been demonstrated in an integrated, end-to-end e-SAF production system. The integration of less proven components, such as electrified RWGS, raises additional uncertainty around the performance of (otherwise mature) downstream units like FT, reducing overall TRL and increasing the risk of system-level issues.

Delivery Partner Risk

Given the complexity of developing an e-SAF facility, underperformance or default by a critical partner/system can trigger significant delays, cost overruns, loss of revenue, business interruption and technical setbacks.

As highlighted above, these risks are not prohibitive to the eventual production of e-SAF; however, they require careful consideration in the structuring and delivery of early-stage projects. As the underlying technologies mature and are proven at commercial scale, many of these uncertainties will be reduced. In the interim, targeted support mechanisms are needed to complement the existing risk management approaches (as defined in section: [Commercial Risk Management & Residual Risk](#)). Such support is essential to create the conditions necessary for the development of the first projects which will enable the industry to scale.



03

Commercial Risk Management & Residual Risk

- Risk Allocation: Contractual Arrangements During Construction & Operation
- Stakeholder Challenges – Project Owners (inc. sponsors & developers)
- Stakeholder Challenges – Technology Licensing Companies & OEMs
- Stakeholder Challenges – Construction Contractors



Building on this analysis, we have assessed the appetite and capacity of key market participants to take on the identified project delivery risks. This highlights where residual risk remains, and where targeted government support may be needed, whilst ensuring risks are shared with the private sector stakeholders best placed to manage them.

Risk Allocation: Contractual Arrangements During Construction & Operation

Project finance lenders traditionally insist on a Lump Sum Turnkey (LSTK) contract, under which a technically capable, financially strong contractor guarantees both completion and operational performance. This structure, common in gas-fired power plants, international oil & gas projects and road projects, allows the project SPV and its financiers to invoke liquidated damages (LDs) or other contractual penalties for construction delays or performance shortfalls, thereby protecting against financial risk from underperformance.

Currently, EPC (engineering, procurement, & construction) contractors are unlikely to provide LSTK contracts for e-SAF projects due to the integration of multiple new technologies in a first-of-a-kind setting, making it hard to assess and accept all process risks. These facilities combine unproven interdependent units, such as electrolysis, RWGS, Fischer-Tropsch synthesis, and upgrading, that have yet to demonstrate commercial-scale compatibility. This creates several challenges:

- Unclear liability for parties involved in plant delivery and operation
- Technology risks persist even for mature components due to integration issues
- LSTK contracts – if/when they are even available – are costly because they must cover both technology and construction risk premiums

These factors make it complex to structure bankable contractual agreements across multiple contractors.



Conducting comprehensive FEED studies is critical, as they establish the technical and financial basis necessary for effective allocation and management of integration risks, allowing parties to underwrite well-defined performance commitments. In construction, adopting more adaptable execution approaches, such as EPC Management (EPCM) or grouping the contracts into work packages with manageable interfaces, can aid in managing project complexity and enhancing overall bankability.

Early offshore-wind projects showed that capital-intensive, technology-heavy assets can be financed via multi-contracting structures, with licensors, OEMs and construction contractors each taking on discrete risk scopes. By bundling work packages into as few contracts as possible and placing LDs and other penalty obligations with the most creditworthy supplier in each package, developers create clearer accountability and stronger bankability. However, it is worth noting that in the early stages of offshore-wind development, PFIs provided significant support through direct lending and completion guarantees.

Note: Risk accountability table definition: a relative assessment of the amount of risk the stakeholder carries across project life cycle stages. High = stakeholder is carrying a significant amount of the risk. The risk accountability through the project lifecycle will vary with each project and is dependent on the limits of the project contracts. The below is indicative only.





Stakeholder Challenges – Project Owners (inc. sponsors & developers)

With a lack of strategic investor interest in e-SAF projects, developers lack the balance sheet strength to play a major role during construction. Typically, they bring in external investors (sponsors) to provide the equity required for procurement and construction. Given the size of e-SAF projects, these will likely be institutional investors, that are sometimes prevented by fund mandates from investing in projects with TRLs below 8. Even where these funds have appetite for unproven technology themselves, they will require debt leverage to achieve their required equity returns – and as indicated above, project finance lenders are conservative on new technology. A fundamental factor in addressing these challenges is the implementation of a comprehensive, well-resourced Front-End Engineering Design (FEED) study. This process identifies and mitigates primary risks, while collaboratively establishing a sustainable execution model with the construction contractor. Such analysis significantly improves visibility into technical feasibility and cost estimates, serving as the foundation for

assessing risk-adjusted returns for both equity and debt providers.

A FEED study is estimated to cost around 1.5% to 3%⁵ of the total installed cost (TIC). For projects ranging from €1-1.5 billion, a FEED study could cost between €15M and €45M, an amount that presents a real challenge for developers given early-stage funding constraints. Yet this investment is far more than a technical formality: it underpins the ability to unlock capital, allocate risks with confidence, and transform FOAK project ambition into bankable, executable delivery.

In e-SAF projects, risk allocation is shaped by the contractual framework between the Project SPV and delivery partners. Construction contractors typically assume a portion of the construction-phase risk, which may extend into commissioning based on contract terms. Nevertheless, the ultimate accountability for delivery throughout the entire project lifecycle sits with the project owners. Given balance sheet and risk appetite constraints, absorbing this risk through capital buffers at the SPV level becomes particularly difficult.

⁵ Estimate based on market engagement with industry stakeholders.

Table 1

Project sponsor risk accountability level through the e-SAF project lifecycle

	Construction	Commissioning	Operation
Technology	Medium	High	High
Integration	Medium	High	High
Delivery partner	High	High	High

Note: See note at the beginning of Stakeholder Challenges section on page 16 for an explanation of table definitions.



Stakeholder Challenges – Technology Licensing Companies & OEMs

Technology licensing companies and OEMs play a pivotal role in the development of e-SAF projects by providing access to the core process technologies that enable the conversion of feedstocks into e-SAF. These licensors supply the intellectual property, proprietary designs, operational parameters, and performance guarantees for critical units – such as electrolyzers, RWGS reactors, Fischer-Tropsch synthesis, and product upgrading systems. Their involvement and guarantees ensure that projects can integrate technology and leverage specialised engineering know-how to build viable process flows.

While these suppliers may offer warranties or performance guarantees, the coverage is typically limited and insufficient to address the contractor's liabilities in the event of broader system underperformance. This issue is compounded when the contractor is unable to rectify issues involving equipment or systems that rely on specialised,

proprietary know-how; and further complications arise from the fact that many licensors are specialised firms with limited credit strength, reducing the value of their warranties in project finance terms.

Some of these risks can be partially mitigated by incorporating technology licensors' obligations into broader contractual packages, fronted by more financially robust counterparties, such as OEMs or construction contractors. This approach enhances bankability by strengthening creditworthiness and increasing accountability across key interfaces. However, it does not fully eliminate the residual performance risks inherent in the overall project structure and is likely to add a premium to contract costs, as the risk is effectively transferred to the counterparties responsible for delivering the contractual packages.

Table 2

Technology licensor risk accountability through the e-SAF project lifecycle

	Construction	Commissioning	Operation
Technology	High	Medium	Medium
Integration	Low	Low	Low
Delivery partner	Low	Low	Low

Note: See note at the beginning of Stakeholder Challenges section on page 16 for an explanation of table definitions.



Stakeholder Challenges – Construction Contractors

Construction contractors are pivotal to e-SAF project delivery, managing full facility build-out and integration across complex, interdependent technologies. Yet the lack of commercial precedent makes it difficult for them to confidently estimate costs, timelines, and performance outcomes. As a result, contractors typically avoid assuming end-to-end liability and instead limit exposure through discrete work packages. The high degree of interface and commissioning risk, where the performance of one unit directly affects others, further complicates delivery, making LSTK commercially unviable.

To navigate these uncertainties, contractors often favour cost-reimbursable or target-price models that allow for iterative execution and shared problem-solving. While these structures offer flexibility, the resulting risk transfer to the SPV is generally unacceptable within project finance frameworks. This underscores the need for supplemental de-risking instruments, such as technology performance insurance, contingent equity, or public-backed financing mechanisms, to support bankability and enable credible delivery pathways for early e-SAF projects.

Table 3

Construction contractor risk accountability through the e-SAF project lifecycle

	Construction	Commissioning	Operation
Technology	Medium	Medium	Low
Integration	Medium	Medium	Low
Delivery partner	High	Medium	Low

Note: See note at the beginning of Stakeholder Challenges section on page 16 for an explanation of table definitions.



Structuring around risk constraints

Contract structures will be crucial to achieve project financing for initial e-SAF projects.

① Staged contracting and early-phase continuity

Engaging contractors early in the process enables them to develop a deep understanding of the technical complexities inherent in an e-SAF project. Early involvement, aligned with the selection of technology providers i.e. pre-FEED, followed by a robust FEED and detailed design phase, allows contractors to more accurately identify and price delivery risks, improving confidence in timelines and cost estimates.

To maximise the value of this early engagement, a FEED-to-EPC roll-over mechanism, in which the same contractor continues into the execution phase, can provide essential continuity. This enables the owner, contractors, and technology providers to jointly develop a practical and sustainable execution model during FEED, rather than imposing it later through a traditional EPC tender process, which often lacks early commercial alignment.

However, funding a high-quality FEED study remains challenging due to the significant capital required and the absence of secured offtake agreements or revenue streams. Targeted public support, in the form of grants or recoverable finance, is therefore essential to bridge this pre-investment gap and enhance project bankability.

② Packaging suitable work scopes across multiple contractors

Multi-contractor delivery models assign responsibility for distinct work packages to contractors based on their technical expertise; for instance, one may oversee the core process plant (electrolysis, RWGS, FT, hydrocracking) and balance of plant, while another handles grid infrastructure and utilities. This structure reduces risk concentration but introduces interface risk between scopes, complicating execution and financing.

To partially mitigate this, developers can appoint an owner's engineer to coordinate delivery and implement incentive mechanisms, such as profit shares or back-ended payments, to align contractor performance with project outcomes. However, these carve-outs reallocate residual risk back to the project SPV, which is challenging from a project finance perspective and may require the SPV to hold additional financial contingencies.



04

Technology Performance Insurance



Specialist insurers and agents are playing an increasingly pivotal role in managing the risks associated with delivering FOAK e-SAF projects.

Traditional project stakeholders – such as contractors, OEMs, developers and sponsors – often lack the technical capability or financing capacity (i.e. balance sheet) to absorb the full spectrum of performance risks that these novel projects entail. As a result, specialist insurance solutions are emerging to take on residual risk beyond what the market can conventionally bear, thereby enhancing project bankability.

A growing suite of tailored products is being developed to bridge financing and risk gaps. These products have proven themselves in a variety of other sectors by enabling billions of dollars' worth of investment in infrastructure projects around the world. These products are outlined on the subsequent page.

Following technical completion of an e-SAF facility, technology performance insurance serves as a critical safeguard against sustained underperformance risks during commissioning and the operational phase. As outlined above, these instruments offer flexible protection levels – ranging from coverage of specific technology components (e.g. electrified Reverse Water Gas Shift reactor), to enhancements to the credit profile of key delivery contracts, interim debt service coverage during ramp-up, and even full debt protection for up to 10-years.

Table 4

Technology performance insurance risk share through the e-SAF project lifecycle

	Construction	Commissioning	Operation
Technology	N/A	High	Medium
Integration	N/A	High	Medium
Delivery partner	N/A	High	Medium

Note: Risk share table: a relative assessment of the amount of risk the technology performance insurance carries across project life cycle stages. High = carrying a significant amount of the risk. The risk through the project lifecycle will vary with each project and is dependent on the limits of the project contracts. The above is indicative only.



Table 5

Overview of Technology Performance Insurance Products

Product	Coverage Scope	Risk Transfer Target	Trigger Mechanism	Investor Benefit
Equipment Warranty Backstop	Underperformance or failure under OEM warranty terms (Technology Risk, Delivery Partner Risk)	Underperformance and OEM default pursuant to warranty obligations, or underperformance beyond usual OEM warranty limits	Equipment not meeting performance spec and OEM default, or equipment not meeting performance spec and OEM usual warranty limits exceeded	Acts as credit enhancement to an OEM warranty, potentially increasing project bankability; safeguards asset integrity
Technology Performance Wrap	Output, efficiency, or availability below level required to meet minimum capital service. (Technology Risk, Integration Risk, Delivery Partner Risk)	Technology risk across the integrated process	Verified shortfall in output during commissioning or operations and shortfalls in cash flow	Secures debt service and fixed cost coverage; underlying debt protection; reduces tech risk to lender and reduces cost of debt
Term Performance Cover	<i>As per 'Technology Performance Wrap'</i>	<i>As per 'Technology Performance Wrap'</i>	<i>As per 'Technology Performance Wrap'</i>	Secures debt service and fixed cost coverage; reduces tech risk to lender and reduces cost of debt



Warranty backstops function to enhance the bankability of warranty and long-term service agreements and can even enable warrantors to offer increased limits of liability. They provide surety to the project that the liabilities found in these warranties and service agreements will be paid for by a highly credit worthy counterparty, even if the OEM or licensor is unable to do so.

Wrap products typically contract with the project itself and are to the benefit of senior capital with the least tolerance for risk. Importantly, this coverage activates only once primary project contingencies – such as cost overrun budgets and debt service reserve accounts (DSRA) – are fully exhausted. Insurance, therefore, functions as the final layer of risk transfer, preserving project cash flows to senior capital. As a result, equity investors are shielded from foreclosure during underperformance and can recover losses if performance improves. Senior capital protection holds project owners accountable and prevents moral hazard, while allowing them to benefit from higher returns through low-cost senior funding.

These instruments facilitate risk transfer across the project lifecycle. Construction contractors typically assume primary performance liability during construction, with risk gradually shifting to sponsors and insurers during commissioning, providing continuity and reassurance for lenders. Nonetheless, contractors often retain limited liability into early operations, maintaining alignment and reinforcing accountability.

If the insurance policy is called, in some cases, once performance stabilises, a portion of the levered free cash flow may be repaid to the insurer, which allows the insurer to offer lower upfront premiums.

Although these insurance products can improve the bankability of an e-SAF project, certain elements require further consideration:

- **Limited global insurance capacity:** Coverage offered through technology performance insurance may fall short of lender requirements, particularly for capital-intensive e-SAF plants. For instance, a €1.5 billion project financed at a 60/40 debt-to-equity split would require €0.9 billion in debt. However, market feedback indicates that the

global insurance market capacity for technology risk may only cover up to €0.45 billion per policy, leaving €0.45 billion of debt exposed. This gap limits the ability of such instruments to fully derisk projects for financiers, especially where long-term debt relies on firm cash flow assurances.

- **Upfront premium costs:** The novelty and limited deployment history of e-SAF technologies mean that insurance providers must price in a heightened level of uncertainty. Indicative pricing suggests premiums in the upper bounds of the 5-10% range which, when applied to large-scale projects, is a significant cost. These costs reflect the lack of operational benchmarks and the complexity of performance risk. Premiums for the life of cover are generally paid at financial close, front ending financing costs. However, these premiums can be incorporated into the total financing package and drawn down alongside other project costs. Importantly, the risk transfer provided by insurance should decrease financing costs over the life of the asset.
- **Added complexity in credit assessment:** Commercial lenders are often constrained by conventional assessment frameworks, meaning unfamiliar insurance products, particularly those new to sustainable infrastructure, can complicate due diligence and act as a barrier to credit approval. The application of these insurance products and their effect on capital requirements may also be subject to further discussions with bank regulators.

Insurance can play a valuable role in covering risks in e-SAF project financing, particularly with regard to performance and delivery uncertainties. However, coverage limits, premiums, and credit assessments make it difficult to rely on insurance alone for FOAK projects. To unlock bankability and mobilise investment, targeted government financial support should complement insurance and help de-risk the initial wave of FOAK e-SAF projects.



05

The Role of Public Financial Institutions

- Outstanding Residual Risks
- Targeted PFI Support
- Design Considerations
- State Aid Rules



Outstanding Residual Risks

The successful execution of an e-SAF project ultimately depends on the availability of both technical expertise and liquidity. While the market can supply expertise via project developers, contractors and Technology Licensors/OEMs, access to long-term, risk-tolerant capital remains a core constraint.

For FOAK projects, long-term capital support typically comes from strategic investors with strong balance sheets alongside operational expertise. For e-SAF projects, these strategic investors are not currently active in Europe, and sponsors are often institutional investors who may be constrained by fund mandates to provide flexible and/or open-ended capital support. Debt capital is essential to the financing of commercial scale e-SAF projects.

Nevertheless, due to the breadth of project delivery risks and insufficient capacity of sponsors to absorb these risks, commercial lenders are not able to extend the necessary level of debt financing for e-SAF projects via traditional project finance structures. While technology performance insurance can offer a measure of senior capital protection, the global insurance market currently possesses only enough capacity to partially cover the capital at risk. There remains a significant financing gap for FOAK e-SAF projects.

Targeted PFI Support

PFI's are well positioned to fill the financing gap. However, the form of government support must be carefully designed to maintain private sector accountability and ensure that those with operational expertise remain incentivised and responsible for delivery.

In practice, government-backed instruments can complement private solutions by providing:

- **Cornerstone lender backing to e-SAF projects:** PFI's should be among the first movers to provide senior project finance debt to e-SAF projects to supplement the private sector project finance market and build confidence in the bankability of this nascent industry.
- **Enhancements to insurance products,** leveraging best in class risk assessment capabilities, whilst ensuring debt protection is adequate, providing the necessary risk mitigation to ensure debt and equity can invest in e-SAF in line with their internal risk/return requirements.
- **Contingent reserve facilities** that may be accessed after project contingencies are depleted, allowing projects to address essential remediation requirements.
- **FEED funding:** comprehensive FEED studies are crucial to prepare the financing and construction of multi-contractor projects. PFI's could match private investment into FEED studies against a convertible loan at FID, repayable during operation.
- **Backstopping and enhancement to supplier guarantees** where they are insufficient to cover underperformance or when weaker contractual counterparties would be difficult to accept in a project finance structure.



Design Considerations

We initially explored structuring PFI instruments to trigger only under specific, predefined circumstances, to preserve market discipline and minimise moral hazard. However, feedback from stakeholders highlighted that overly narrow triggers can create interface risk, leading to delays and disputes over fault attribution.

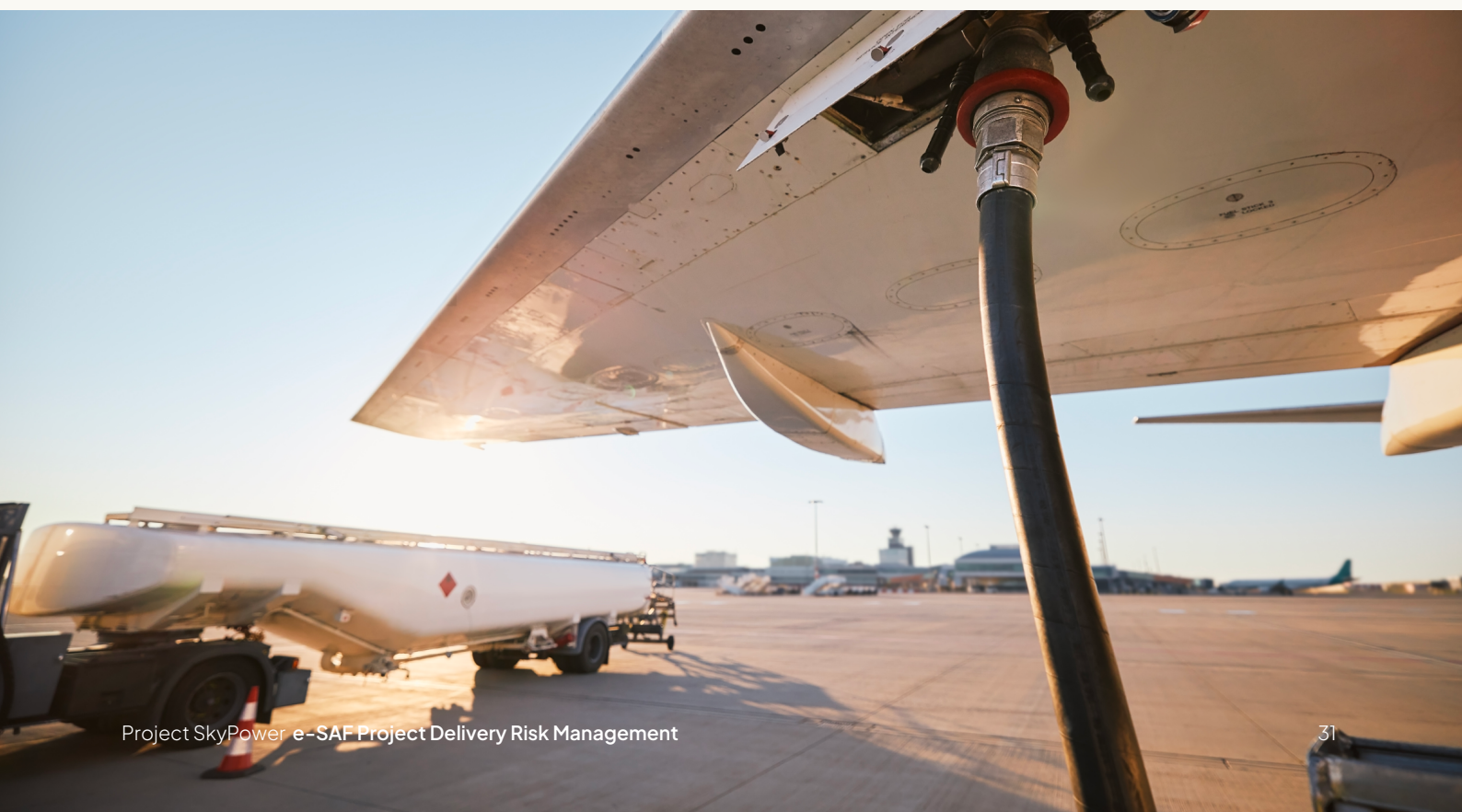
Instead, there is a strong preference for holistic, flexible instruments i.e. those that can be triggered based on overall project performance. This helps ensure that capital can be accessed by the project when needed; reducing the risk of default, preserving project continuity, protecting investor returns, and sustaining investor confidence.

State Aid Rules

While support provided at the European level, such as by the EIB Group using its own resources, is generally not considered state aid, any involvement of Member State funding (e.g. grants, guarantees) will likely trigger state aid rules. This means an additional approval process may be required. Under EU law, state aid refers to any advantage granted by a public authority using state resources that may distort competition and affect trade between Member States.

In the recently adopted Clean Industrial Deal state aid guidelines (CISAF),⁶ sustainable aviation fuel has been recognised among the eligible sectors that contribute to the EU clean industrial objectives. Among other measures, de-risking solutions for these sectors are considered compatible with the internal market rules. Some of the instruments we suggest on the EU level in this report could thus be implemented by individual member states on the condition that they meet all of CISAF and general state aid rules.

⁶ Framework for State Aid measures to support the Clean Industrial Deal (CISAF), July 2025, available at: [EUR-Lex - 52025XC03602 - EN - EUR-Lex](#)





06

Proposed PFI Instruments

- Cornerstone Lender to FOAK e-SAF projects
- Recoverable Grant for Detailed FEED Studies
- Technology Licensor / OEM – Performance Guarantee
- Contingent Reserve Facilities
- PFI Financing Support behind Technology Performance Insurance
- PFI e-SAF Sector Financing Requirements



The following instruments are intended to provide a conceptual framing of a selection of EU or member-state level PFI product options that could address project delivery risk associated with e-SAF project financing.

They target different levels of intervention across the capital stack, to support project delivery and mitigate varying levels of commercial and FOAK risk, improving the financing viability of e-SAF projects. It is not expected that a project would require all of these, but rather would significantly benefit from accessing any single one, with varying levels of impact on the overall cost of financing, as indicated in the instrument impact tables, along with an assessment of the financial exposure to the PFI.

Disclaimer

The calculation of financial exposure through this section is based on stakeholder engagement and market estimates. Actual figures will vary by project and the relative assessment of risk.

Cornerstone Lender to FOAK e-SAF projects

The most impactful role a PFI can play is acting as a cornerstone lender to FOAK e-SAF projects, offering immediate, large-scale, long-term, risk-tolerant capital through existing product lines – even on commercial terms. If a PFI provides 50% of the debt requirements of an e-SAF project, for example, this significantly reduces the volume of commercial debt required and has the potential to reduce requirements from commercial lenders to a level that is within the current private insurance market capacity of €450 million (as described in section: [Technology Performance Insurance](#)).

The private insurance cover effectively acts as a partial guarantee, covering a portion of the debt

up to a predefined value in the case of default due to technology performance issues. In the scenario where a PFI acts as first lender to the project, this insurance can cover the majority (if not all) of the commercial debt, giving commercial lenders greater certainty and supporting a viable financing structure. However, as the insurance only covers defaults related to technology performance, additional de-risking measures (such as secure offtake) would still be required within a bankable SPV structure.

If PFIs are willing to take on additional risk, they can further strengthen project bankability by offering more flexible structures, including covenants, first loss provisions, subordination and other credit enhancements. For example, if a facility is operational but underperforms due to technical issues, PFIs could reduce cash flow strain by extending grace periods, considering longer tenors or sculpting repayments using lower debt service cover ratios in the first few years of operation. These features would help stabilise the SPV's financial position, allowing projects to focus on remediation, restoring performance, and demonstrating commercial viability.

Product table definitions

Impact on financing cost- a relative measure (1-5):
5 = significant impact on reducing financing cost.

Technology & Integration risk- a relative measure (1-5): 5 = the instrument has high impact on reducing residual technology and integration risk not covered by the private sector during that phase (not applicable to Recoverable Grant for Detailed FEED Studies as this occurs in the development stage)



In consideration of more targeted financial products, the following PFI instruments have been set out as credible options that an EU or member-state level PFI could provide to e-SAF projects.

Recoverable Grant for Detailed FEED Studies

Although the report primarily addresses project delivery risk during construction, commissioning, and operation, the significance of high-quality FEED studies remains essential for effective project execution. Therefore, it was deemed appropriate to include this instrument recommendation.

PFI financial exposure per project	€8–22.5M
Impact on financing cost	2

Note: See 'Product table definitions' at beginning of this section for an explanation of table descriptions. **Assumptions:** PFI financial exposure per project refers to the estimated risk exposure for the PFI on each project, based on a total project cost of €1–1.5 billion, a cost of FEED of 1.5–3% of total cost, and the PFI providing 50% of the cost. For the financial exposure analysis to a PFI across proposed solution combinations, FEED is assumed at 2% of total cost.

Context

To advance from planning to Final Investment Decision (FID) and ultimately into construction, projects must complete a robust FEED study that delivers a clear, defensible assessment of technical feasibility and cost estimates. For FOAK e-SAF facilities, this step is especially vital as, without comparable historical data, investors rely heavily on FEED outputs to evaluate risk-adjusted returns. Partnering with an engineering firm capable of transitioning into the construction contractor role post-FID adds continuity and credibility, helping to streamline delivery while enhancing investor confidence.



Issue

Securing private capital to support the crucial FEED stage remains a significant hurdle for e-SAF projects. The FEED study can cost between €15M and €45M. Most available equity is channelled through infrastructure funds whose constitutional mandates preclude investment in projects with TRLs below 8. The limited pool of investors that are willing to come in at that stage often seek returns of 2-3 times their initial investment via development fees or sale of the SPV to the construction investor at an increased valuation.⁷ While undertaking a comprehensive FEED study can help de-risk the opportunity and improve visibility into future returns, accessing the upfront capital to execute it is challenging. Public-sector support, such as the EU Innovation Fund, is intended to fill this gap; however, e-SAF initiatives often fail selection criteria due to the Fund's prioritisation of projects with the lowest cost of emissions abatement, effectively sidelining early-stage, higher-cost e-SAF technologies.

Solution

Funding could be allocated to an existing EU PFI, creating a dedicated call focused on e-SAF projects, that could provide 50/50 public/private funding for detailed FEED studies. Eligibility criteria could include independent validation of credible pre-FEED studies and project alignment with ReFuelEU. This support would sharpen assessments of technical and commercial viability, helping to attract a broader base of equity investors willing to commit at more moderate risk-adjusted return thresholds. Offtake pricing could also be optimised, ultimately lowering costs for fuel suppliers, airlines and passengers. For developers and their project delivery partners, robust FEED outputs would provide a firmer foundation for structuring delivery risk-sharing mechanisms, thereby reducing exposure and enhancing bankability for both commercial and PFI lenders. The funding mechanism should take the form of a recoverable grant, designed to transition into a subordinated repayable obligation once the project reaches FID. (There being no recourse on the grant if the project does not reach FID).

⁷ Return expectations based on market engagement with industry stakeholders.

Exhibit 4

While the most advanced projects may not need FEED support, it is likely support may extend to a larger number of projects than other proposed products.





Technology Licensor / OEM – Performance Guarantee

Context

An e-SAF facility comprises a series of interconnected technology process units, each playing a distinct role within the production chain. Consistent achievement of nameplate output across these individual systems,

such as electrolysis, electrified reverse water gas shift, Fischer–Tropsch synthesis, and refining, is essential for ensuring the integrated performance of the overall plant.

	Construction	Commissioning	Operation
Technology & integration risk impact	2	2	1
PFI financial exposure per contract	€5–15M		
Impact on financing cost	1		

Note: See ‘Product table definitions’ at beginning of this section for an explanation of table descriptions. **Assumptions:** PFI financial exposure per project refers to the estimated risk exposure for the PFI on each transaction. The value per contract has been established through stakeholder engagement. A single project may require multiple guarantees, which would increase the overall financial exposure for a given project.





Issue

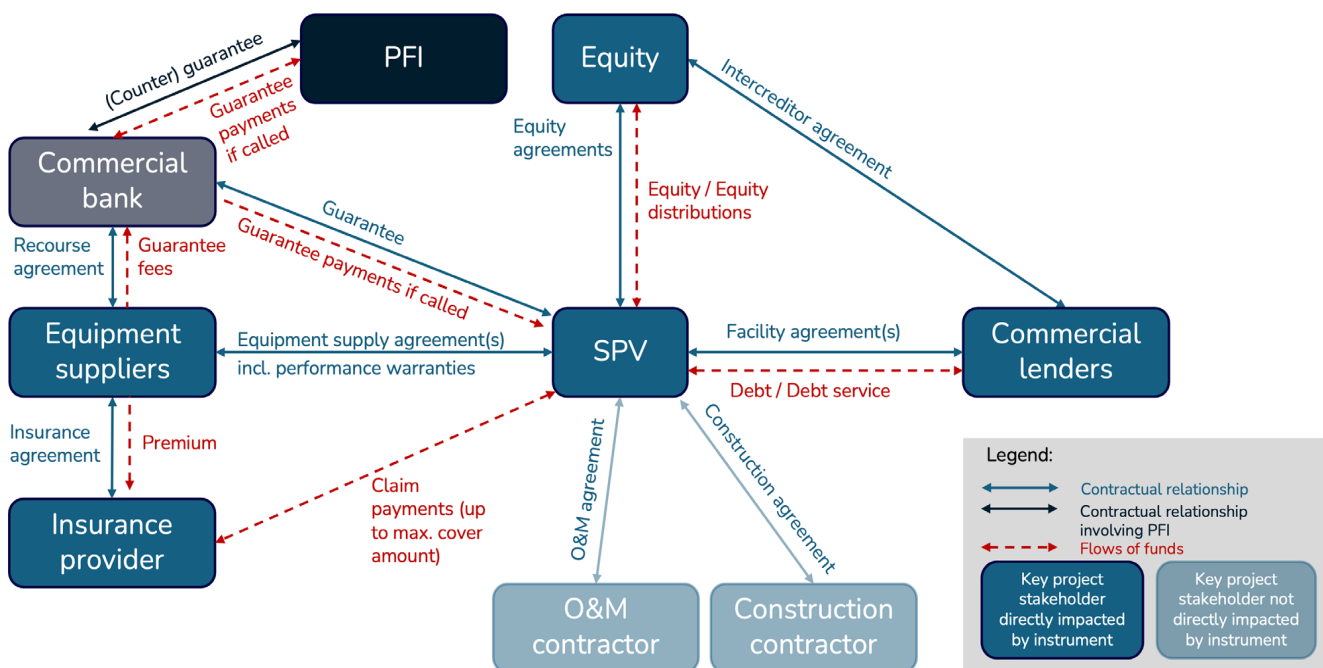
Technology unit manufacturers and licensors usually provide limited performance warranties, often covering only part of the License Fee or equipment replacement. When a unit fails, it can cause costly problems for downstream systems, leading to overruns and revenue losses throughout the plant. Licensors may also lack the financial strength to fulfil warranties in worst-case scenarios, and contractors are unable to replace proprietary equipment due to technical and IP constraints. Private insurance can fill these gaps by extending warranty coverage and transferring residual risk to more creditworthy insurers. However, insurers may have limits on their underwriting capacity.

Solution

An EU or member-state level PFI could back performance guarantees issued by technology licensing companies, increasing the creditworthiness of the supplier and therefore the whole project contracting structure, reducing the risk for sponsors and lenders. This is a proven instrument, most recently applied to wind turbine and grid equipment manufacturers in the EU. The instrument should complement, not compete with, private insurance, providing coverage above policy caps. This could allow due diligence responsibilities to shift partly to the insurer, reducing the burden on the PFI.

Exhibit 5

SPV contractual agreements and fund flows for Technology Licensors Guarantee





Contingent Reserve Facilities

Context

A construction contractor is typically responsible for constructing projects and achieving mechanical completion. However, given the relative immaturity of certain technological process flows, the scope and clarity of their completion obligations can vary significantly, as highlighted in 'Stakeholder Challenges – Construction Contractors.' Project finance structures generally embed contingency allowances in the base case for unforeseen costs, but debt providers, on

advice from their technical advisors, may require sponsors to provision for additional contingencies if they consider that there is a high risk the modelled (base case) contingency will be exhausted. These additional buffers would serve to absorb overruns beyond the coverage of the construction contract beyond base case contingencies, preserving financial stability and ensuring the project's ability to reach commissioning without jeopardising lender confidence. These facilities, where appropriate, may be hybrid or convertible in nature depending on the needs of developers and lenders.

	Construction	Commissioning	Operation
Technology & integration risk impact	1	3	2
PFI financial exposure per contract	€60-90M		
Impact on financing cost	3		

Note: See 'Product table definitions' at beginning of this section for an explanation of table descriptions. **Assumptions:** PFI financial exposure per project refers to the estimated risk exposure for the PFI on each transaction, based on a total project cost of €1-1.5 billion with 60/40 debt/equity ratio, and a technical advisor requiring an additional sponsor contingency of 10% of TIC, with the PFI providing the debt portion.





Issue

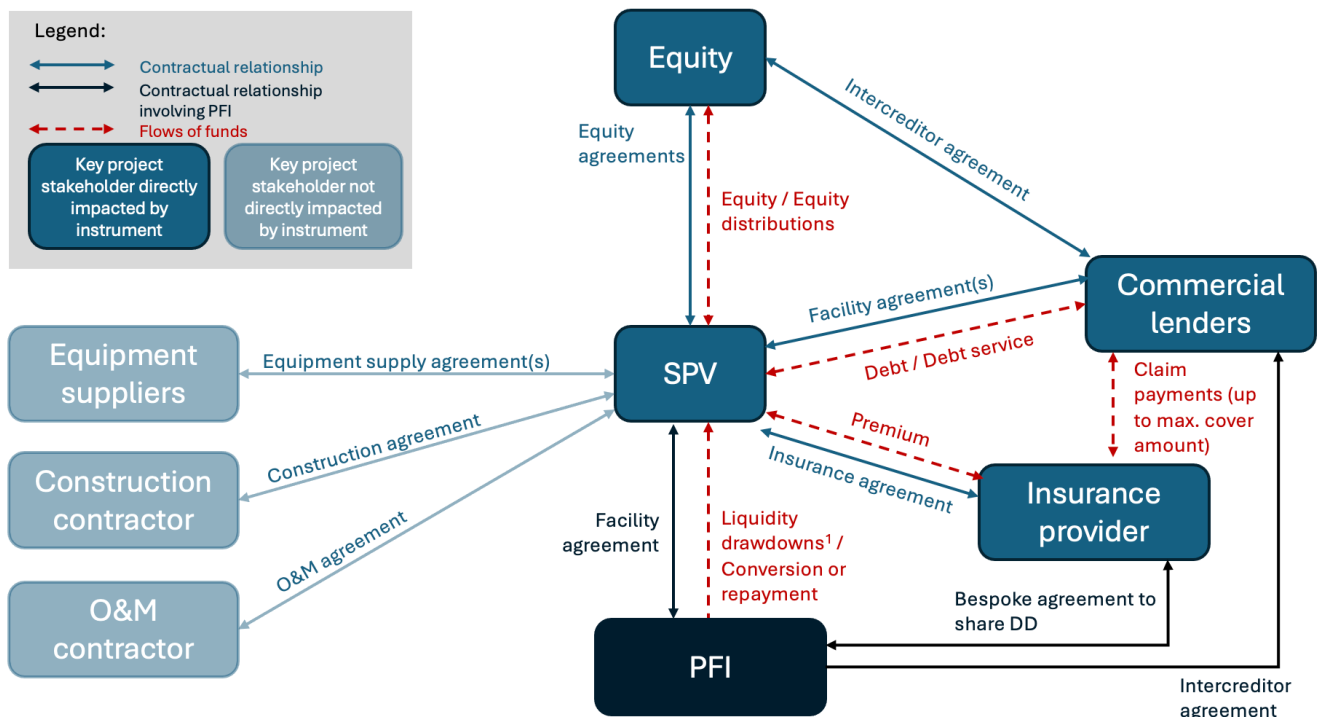
Although project sponsors may have considerable access to capital, the additional contingent equity requirements introduced by the FOAK nature of e-SAF projects can be challenging for sponsors to justify within the financing structure while still maintaining an appropriate risk/return profile for the investment.

Solution

An EU or member-state level PFI could offer a contingency 'top-up' facility to cover the debt share of the required additional contingency. The facility would only be called once all base case contingencies are exhausted and could be structured with repayment via a cash sweep facility or potentially via conversion into equity. By reducing the equity overhang required from sponsors, the facility would accelerate capital formation for FOAK e-SAF projects and improve project bankability.

Exhibit 6

SPV contractual agreements and fund flows for the Contingent reserve facility





PFI Financing Support behind Technology Performance Insurance

The next two options propose PFI debt facilities that stand behind a technology performance insurance policy. This could present an efficient and responsible use of government credit in that they are standing behind only what commercial insurers will insure, benefitting from best available underwriting and standing at a meaningful distance from the risk.

This would put government behind the terms of the policy itself. The PFI remains shielded up to the sum insured, while commercial lenders benefit from reduced risk exposure, enabling them to price debt at materially lower spreads and thereby improving overall project economics.

Option 1 – Debt Service Protection

Context

In project financing structures, lenders typically require projects to maintain Debt Service Reserve Accounts (DSRAs) to safeguard debt repayment post-completion. These reserves serve as a liquidity buffer against any temporary cash flow fluctuations. Insurers are increasingly providing various forms of technology performance insurance (see section: [Technology Performance Insurance](#)) to cover for underlying technology performance issues, providing further debt protection.

Issue

DSRAs offer valuable protection for servicing debt obligations, however, given FOAK uncertainty for e-SAF projects the buffer required to service debt in the case of commissioning delays could be significant and go beyond the temporary cash fluctuations covered by DSRAs. Technology performance insurance term cover can provide debt service protection for more permanent cash flow issues, but with limits on the total sum insured, 50% of the debt service may remain unprotected by the policy.

	Construction	Commissioning	Operation
Technology & integration risk impact	1	4	2
PFI financial exposure per contract	€90–230M		
Impact on financing cost	4		

Note: See 'Product table definitions' at beginning of this section for an explanation of table descriptions. **Assumptions:** PFI financial exposure per project refers to the estimated risk exposure for the PFI on each transaction, based on a total project cost of €1–1.5 billion with 60/40 debt/equity ratio. PFI provide 36 months of debt protection on top of underlying technology performance insurance cover of €200 million, with annual debt service based on 12-year debt term and 6% interest rate with combined PFI and insurer protection on 80% of debt service.



Solution

An EU-level PFI could establish a debt service facility that stands behind a technology performance insurance policy. The PFI facility could stand in the excess layer, providing debt service coverage above the limits put up by commercial insurers. The facility could be time-bound, offering coverage for 36 months,⁸ covering up to 80%⁹ of debt service (inclusive

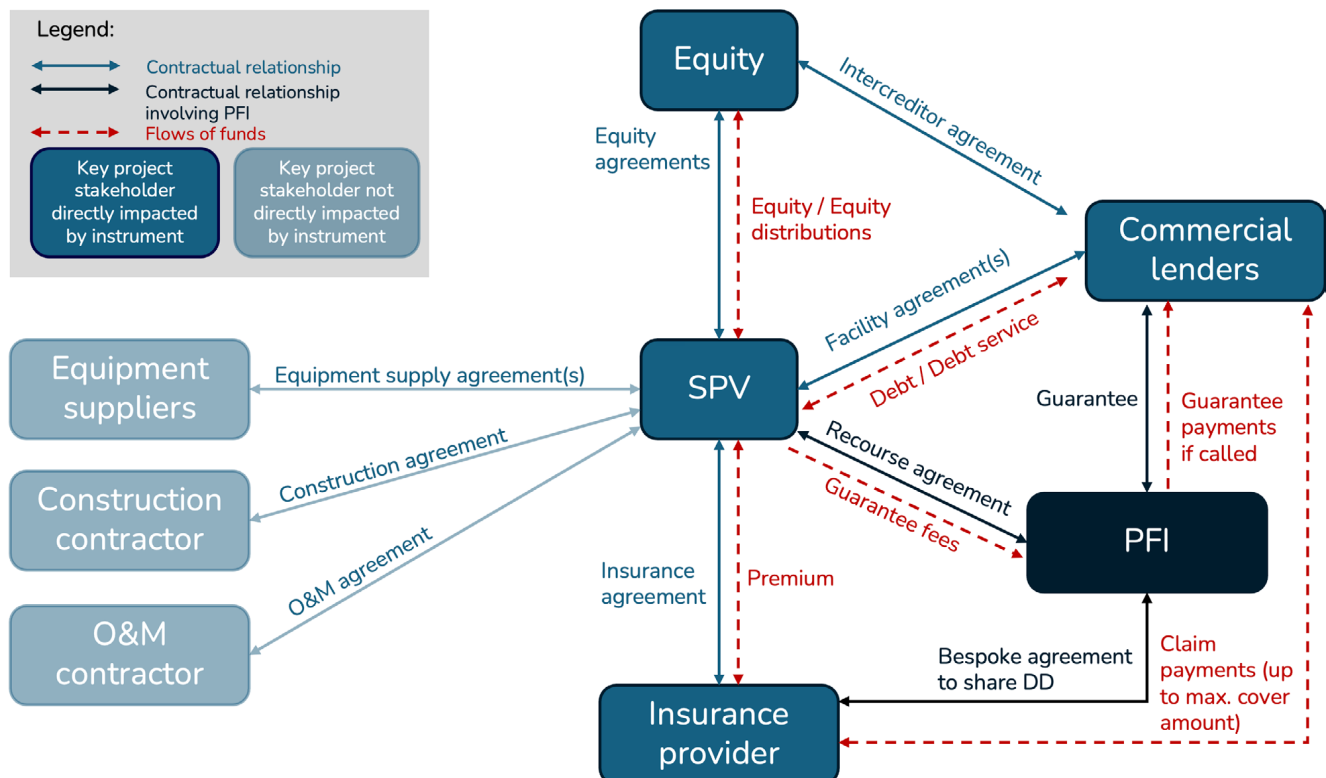
of insurance policy). Access to these facilities could require an upfront transaction fee, calibrated similarly to guarantee-type fees and based on the estimated financial exposure. If and when the plant regains performance stability, levered cash flows could be used to repay the facility through a cash sweep on terms proportionate to the underlying risk, or in the case of a hybrid instrument, convert into equity’.

8 Aligns to the optional coverage provided under a Term Cover technology performance insurance policy.

9 80% debt coverage aligns to guarantee type instruments provided by PFIs in other settings (e.g. ECAs).

Exhibit 7

SPV contractual agreements and fund flows for Debt Service Protection with Technology Performance Insurance





Option 2 – Debt Guarantee

Context

Successful project financing hinges on the ability to demonstrate reliable, forecastable cash flows within the SPV, anchored in primary cash flows backed by bankable contractual agreements. These contracts, primarily long-term offtake, feedstock supply and project delivery and operations service agreements, provide the certainty that lenders and investors require to evaluate risk-adjusted returns and deploy capital with confidence.

Issue

Due to the FOAK nature and integration complexities of e-SAF facilities, no single private sector actor is positioned to assume full end-to-end construction and commissioning risk. This leaves residual risk within the project structure that constrains the ability of debt and equity providers to commit capital. Technology performance insurance offers a compelling solution for transferring this residual exposure away from the SPV, enhancing its financial resilience. However, maximum coverage limits often fall short of fully covering debt (see section: [Technology Performance Insurance](#)), and there may be gaps in policy cover that leave some project delivery risks unprotected. With capital readily deployable into more conventional opportunities, this additional complexity may prove to be a barrier in advancing e-SAF projects through credit approvals.

	Construction	Commissioning	Operation
Technology & integration risk impact	2	5	4
PFI financial exposure per contract	€150–450M		
Impact on financing cost	5		

Note: See 'Product table definitions' at beginning of this section for an explanation of table descriptions. **Assumptions:** PFI financial exposure per project refers to the estimated risk exposure for the PFI on each transaction, based on a total project cost of €1–1.5 billion with 60/40 debt/equity ratio. Underlying technology performance insurance policy cover of €450 million, with PFI providing added protection on debt up to 80% of total debt coverage, plus 1-year of debt service coverage in scenario where some debt service is required prior to guarantee being called.



Solution

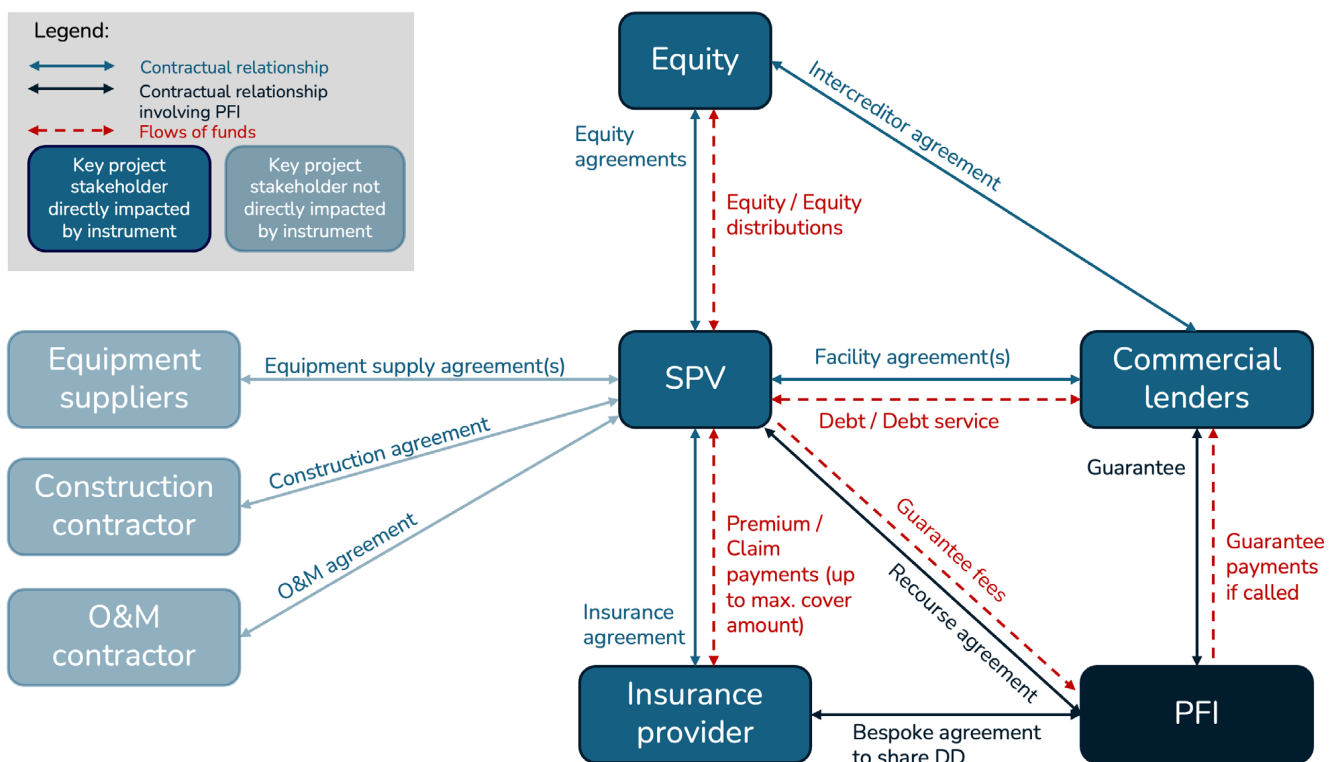
An EU-level PFI or national guarantors, such as export credit agencies, could offer a debt guarantee that stands behind a technology performance insurance wrap. Whereas the above 'Debt Service Protection' would only cover debt service for a time bound period, this would provide both debt service cover and a debt guarantee over the term of the debt, matching the terms of the underlying Technology Performance Wrap policy (see section: [Technology Performance Insurance](#)). Effectively, increasing the total sum insured to a project SPV up to 80%¹⁰ of the debt capital, with

20% remaining at risk to private lenders to ensure effective due diligence. Access to these facilities could require an upfront transaction fee, calibrated similarly to guarantee-type fees and based on the estimated financial exposure. Once the plant regains performance stability, levered cash flows could be used to repay the facility through a cash sweep on terms proportionate to the underlying risk. This would significantly de-risk project debt finance and dramatically increase project financing viability.

¹⁰ 80% debt coverage aligns to guarantee type instruments provided by PFIs in other settings (e.g. ECAs).

Exhibit 8

SPV contractual agreements and fund flows for Debt Guarantee with Technology Performance Insurance





PFI e-SAF Sector Financing Requirements

To support the scaling of the sector, different combinations of the proposed solutions can help de-risk project financing. Different combinations will have varying impacts on overall financing costs and project feasibility. Importantly, PFI support with higher risk tolerance is expected to be needed only for the first wave of e-SAF projects, until the various technology pathways are commercially proven.

The tables below outline preliminary analysis on a range of intervention levels and associated funding envelope requirements, providing a high-level indication of what level of commitment may be needed from EU or member state-level PFIs over the next 3 to 4 years under 3 example scenarios. The aggregate funding amounts represent the total financial exposure associated with the broader funding envelope needed to advance the first wave of e-SAF projects through Final Investment Decision (FID); a critical inflection point for achieving industry-scale.

Key assumptions on level of support required:

- **Number of FEED projects:** Supporting at least 10 projects across diverse technology pathways in the e-SAF industry will be essential to validate technical and financial feasibility. Funding these early stages will help lay a strong foundation for the sector's long-term development.
- **Number of e-SAF SPVs:** Early e-SAF projects are likely to face financing challenges. Providing targeted support to the first 5 e-SAF SPVs can enable these projects to reach FID, creating the crucial proof points needed to build investor confidence and unlock broader private capital participation.
- **Distribution of balance sheet as projects mature:** These calculations do not take into account the ability of PFIs to sell down debt and/or package debt and equity positions into funds to crowd in capital markets as project risk declines.'

All other assumptions are based on the financial exposure assumptions outlined for each product.

Scenario 1: Highest impact – Direct Lending + FEED

Direct PFI lending from its existing product suite at FID, making a significant contribution to the capital stack for the first five e-SAF projects in Europe. Paired with FEED support for 10 projects, structured as a recoverable grant.

PFI Instrument	Aggregate Funding
FEED funding for 10 projects	€0.10bn to €0.15bn
PFI as direct lender to 5 project SPVs	€1.50bn to €2.25bn
Total	€1.60bn to €2.40bn

Scenario 2: Low intervention scenario – Contingent Reserve + FEED

Contingent credit for first five e-SAF projects paired with FEED support for 10 projects. Lower financial exposure to PFI and capital is earmarked as a contingency rather than direct capital outlay.

PFI Instrument	Aggregate Funding
FEED funding for 10 projects	€0.10bn to €0.15bn
Contingent Credit to 5 project SPVs	€0.30bn to €0.45bn
Total	€0.40bn to €0.60bn



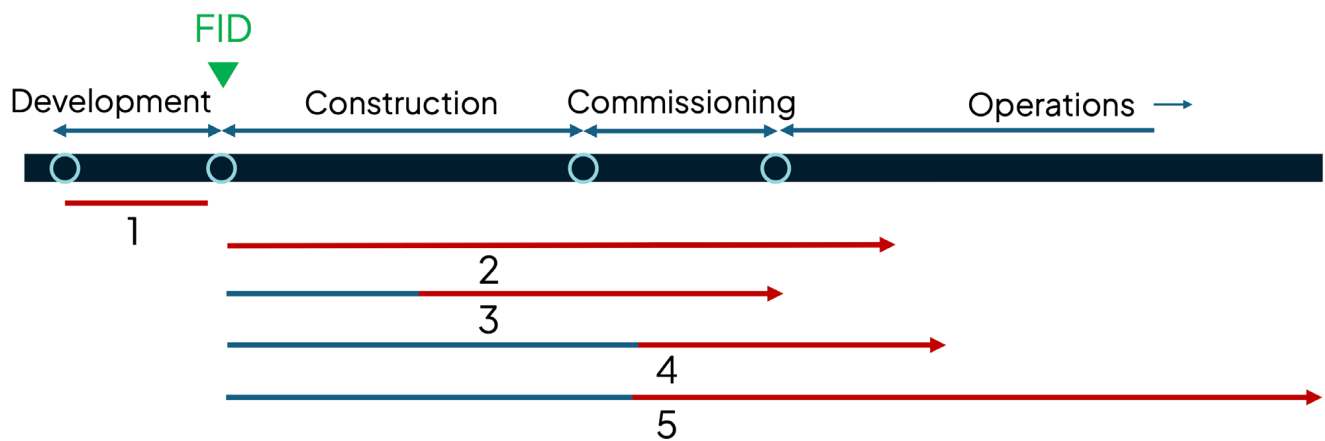
Scenario 3: High intervention scenario (without direct lending) – Debt Guarantee + FEED

Debt guarantee providing a top-up to technology performance insurance which covers debt service and buyout in the event of technology non-performance. Applicable to the first five e-SAF plants, alongside FEED support for 10 projects.

PFI Instrument	Aggregate Funding
FEED funding for 10 projects	€0.10bn to €0.15bn
Debt guarantee to 5 project SPVs	€0.75bn to €2.25bn
Total	€0.85bn to €2.40bn

Exhibit 9

Visual representation of when proposed PFI instruments would be activated and called upon during the lifecycle of an e-SAF project (excl. PFI as direct lender)



1. Recoverable grant for FEED studies is paid upfront pre-FID.
2. Technology licensor guarantees are committed at the point of signing contracts and if called upon, are likely to be throughout construction/commissioning phase as the plant is built and tested.
3. Contingency line of credit, committed at FID but unlikely to be drawn upon until later in construction phase/commissioning phase after other contingencies are exhausted
4. Debt service (backing tech performance insurance), committed at FID but does not become available until debt obligations begin. Remains active for a pre-defined time period i.e. 36 months
5. Debt guarantee (backing tech performance insurance), committed at FID but only drawn once debt obligations begin, either for debt servicing or buyout in the case of default. Its tenor matches that of the debt or the covering insurance product.



Conclusion



With ReFuelEU e-SAF mandates set to take effect in 2030, the first round of projects must reach FID within the next 18 months to align with the expected 4 to 5 year construction, commissioning and ramp up timelines.

For these initial projects, immediate support is essential. The most impactful role a PFI can play is to lend directly to e-SAF facilities from its existing product suite, committing a significant portion of the debt capital. Even at commercial terms, this provides a crucial source of large-scale risk tolerant capital. By reducing reliance on commercial lenders, this enables the effective use of available insurance products, such as technology performance wraps, to de-risk the remaining debt capital. Early capital commitments from PFIs also sends a clear signal that the EU is committed to building a domestic e-SAF industry in line with ReFuelEU targets.

At the same time, we recognise the need for a diversified set of financial instruments that reflect varying levels of risk tolerance among PFIs. The instruments proposed are structured across a range of financial exposure levels, assessed both on an individual project basis and in aggregate to support the first wave of FOAK e-SAF projects to FID – a critical inflection point for industry scale. While more intensive support will be necessary for the earliest projects, we expect PFI involvement to decline as market momentum grows, and early proof points increase private sector risk appetite.

Ultimately, to manage FOAK project delivery risk, there is a requirement for long-term, risk-tolerant capital to complement the technical expertise already present in the market. In this context, we see a clear need for holistic, flexible instruments that are triggered based on overall project performance to ensure capital is available when needed and avoid interface risk.

Finally, while this report focuses on e-SAF, its insights are relevant to FOAK climate technologies more broadly. There is an urgent need to scale climate technologies faster than traditional development timelines. Achieving this will require well-designed public-private risk-sharing mechanisms to de-risk the technology stack. The learnings outlined here can help inform how such support could be structured to accelerate progress towards critical climate targets.



Appendix

- 1.1 ERM Definition of Technology Readiness Level (TRL)
- 1.2 ERM Analysis: Technology & Integration Risks
- 1.3 ERM Analysis: Technology and integration deployment examples



1.1 ERM Definition of Technology Readiness Level (TRL)

TRL	Type of plant	Scale	Definition
1			Basic principles observed
2			Technology concept formulated
3	Lab		Experimental proof of concept
4	Lab		Technology validated in lab
5	Pilot	<0.1 kt/yr	Technology validated in relevant environment (industrially relevant environment in the case of enabling technologies)
6	Demonstration (small)	0.1–2 kt/yr	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
7	Demonstration (large)	2–20 kt/yr	System prototype demonstration in operational environment
8	FOAK Commercial	>20 kt/yr	System completed and qualified
9	Commercial		Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies)



TRL of individual technology components

Component TRL = Highest TRL successfully demonstrated – points for differences in e- and bio-fuels context

If the individual process component would operate at different process conditions (e.g. temperature, pressure, catalyst) or at a considerably different scale in the context of e- and bio-fuels processes, the TRL may be reduced by 1-2 points based on ERM's judgement to account for the technological risks associated with not having been proven at these conditions/scale.

TRL of technology interfaces

Interface TRL = minimum TRL of individual components – 1 point based on integration risks

If two process components are standing at different TRLs, the minimum TRL value is selected for the interface. If two process components are at the same (minimum) TRL value, the interface TRL could be reduced by 1 point (depending on technology integration risks identified by ERM).

TRL of integrated pathways

If there is a successfully operating example of the integrated pathway:

Integrated pathway TRL = Highest TRL successfully demonstrated for the integrated pathway

If there is no successfully operating example of the integrated pathway:

Integrated pathway TRL = Min TRL of individual components – 1 point based on integration risks

- The TRL of an integrated pathway cannot exceed the minimum TRL of its individual components.
- If several individual process components are at the same (minimum) TRL value, the integrated pathway TRL may be reduced by 1 point (depending on technology integration risks identified by ERM).



1.2 ERM Analysis: Technology & Integration Risks

RWGS + FT: Technology Component Risks

Electrolysis: Key risks

- Despite being a mature technology, electrolyser projects often perform below OEM specs, e.g. operating at a reduced load. However, performance guarantees are offered by some OEMs.
- Electrolyser membrane degradation is poorly understood due to the current lack of long-term operation data. This degradation can potentially cause higher electricity requirements and unplanned downtime, raising OPEX.
- Higher CAPEX requirements and project delays are possible, due to the lack of standardization across balance of plant systems currently.

Deployment example: Sinopec Kuqu¹ –
China (2023) 20 kta H₂

Carbon Capture: Key risks

- Point-source CO₂ capture systems are highly sensitive to flue gas variability shifts in temperature, pressure, or contaminants (e.g. SO_x, NO_x) which can reduce solvent or sorbent efficiency, risking lower CO₂ recovery.
- DAC captures and separates CO₂ at low concentrations, which makes it particularly energy intensive and currently high cost. Performance is also affected by humidity, temperature and extreme weather conditions, which can reduce capture rates.

Deployment example: Climeworks Mammoth,
Iceland (2024) DAC capacity ~36 kta CO₂



Reverse Water Gas Shift: Key risks

- RWGS requires high temperatures to achieve high CO₂ conversions, which is associated with specialised material requirements, high operating costs, and catalyst stability. Long term performance is unproven.
- Coking typically occurs on RWGS catalysts due to the high operating temperatures, which can reduce jet fuel production. Efficient decoking is required to minimise down-time.
- Methane is a potential by-product, which could lead to lower jet fuel yields. Selective catalysts and careful selection of operating conditions is required.

Deployment example: Ineratec ERA ONE,
Germany (2025) SAF capacity ~2.5 ktpa

FT Synthesis: Key risks

- Depending on reactor design (varying across developers), reaction temperature control can be challenging, which can affect produced jet volumes.
- FT synthesis typically has a relatively low single pass conversion, so unreacted CO needs to be recycled into the reactor, to minimise carbon losses and increase jet fuel yields. Sub-optimal recovery of unreacted CO will reduce jet fuel production (or increase feedstock consumption).
- The TRL presented above is based on fossil applications. TRL for FT in e-fuels will vary depending on the developer and scale of application (lower TRL for small scale).

Deployment example: Ineratec ERA ONE,
Germany (2025) SAF capacity ~2.5 ktpa

Hydrocracking/ isomerisation: Key risks

- The high temperature required for hydrocracking and isomerisation can lead to catalyst coking and deactivation affecting plant uptime. Efficient catalyst decoking procedures are required to minimise down-time.
- Careful process control is required to achieve the desired amount of cracking to maximise jet yields and minimise lights production.
- Potentially expensive, specialised materials are required for the hydrocracking unit, due to the high temperatures involved.

Deployment example: Shell Pearl GTL,
Qatar (2011) Hydrocracking capacity ~5,300kt/y

Source: ERM proprietary analysis



RWGS + FT: Integration Risks

RWGS + FT

- FT typically produces a fraction of less valuable light hydrocarbons. Process conditions and catalyst selectivity are essential to target jet-range hydrocarbons. Light hydrocarbon components (e.g. methane) need to be recycled to the RWGS for conversion to syngas to minimise feedstock usage. The ability of RWGS to reform these lights is unknown over extended periods of operation. Alternatively, these lights could be fed to a partial oxidation unit, but it is not clear if this has been tested in an e-fuels context.
- Higher than expected concentrations of CO₂ in the feed stream to the FT section (for cobalt based FT catalysts) negatively affect their performance in terms of by-product (methane) formation.

FT + Hydrocracking/isomerisation

- This is a mature interface in fossil applications, but the scales of e-fuels plants are orders of magnitude lower, introducing technology integration uncertainties.

Electrolysis + CO₂ capture + RWGS + FT + Hydrocracking/isomerisation

- The integrated pathway is not proven at commercial capacity, although this is expected within the next few years.
- Its performance over the long term is not proven for the largest operating plants as they have not been operating for extended periods of time. It remains to be seen whether key economic parameters like hydrogen and CO₂ consumption, SAF production, energy consumption change over time.
- The compatibility of the RWGS process with a wide range of CO₂ sources is not proven. Inadequate clean-up of CO₂, particularly from point sources which could contain minor trace components that are poisonous to the catalyst, may negatively impact RWGS performance.
- Some technology developers are pursuing direct production of fuels from the FT step, without the need for hydrocracking/isomerisation. This configuration could have challenges to achieving high jet production rate at large scale, due to the typically limited selectivity of multifunctional catalysts.

Deployment examples

- **Ineratec ERA ONE**, Germany (2025) SAF capacity ~2.5 ktpa
- **Infinium Project Pathfinder**, USA (2025) ~6.3ktpa (mixed hydrocarbons, mostly diesel)

Source: ERM proprietary analysis



e-MTJ: Technology Component Risks

Electrolysis: Key risks

- Despite being a mature technology, electrolyser projects often perform below OEM specs, e.g. operating at a reduced load. However, performance guarantees are offered by some OEMs.
- Electrolyser membrane degradation is poorly understood due to the current lack of long-term operation data. This degradation can potentially cause higher electricity requirements and unplanned downtime, raising OPEX.
- Higher CAPEX requirements and project delays are possible, due to the lack of standardization across balance of plant systems currently.

Deployment example: Sinopec Kuqu –
China (2023) 20 kta H₂

Carbon Capture: Key risks

- Point-source CO₂ capture systems are highly sensitive to flue gas variability shifts in temperature, pressure, or contaminants (e.g. SO_x, NO_x) which can reduce solvent or sorbent efficiency, risking lower CO₂ recovery.
- DAC captures and separates CO₂ at low concentrations, which makes it particularly energy intensive and currently high cost. Performance is also affected by humidity, temperature and extreme weather conditions, which can reduce capture rates.

Deployment example: Climeworks Mammoth,
Iceland (2024) DAC capacity ~36 kta CO₂

Methanol Synthesis: Key risks

- Direct CO₂ hydrogenation is challenging due to CO₂'s low reactivity, which limits per-pass conversion and requires a large recycle loop, driving up energy use and CAPEX.
- Additionally, the water formed as a byproduct limits methanol conversion and gradually degrades the catalyst, reducing its performance over time. Both effects reduce overall process efficiency and increase costs due to more frequent catalyst replacement and higher recycle rates.

Deployment example: European Energy Kasso,
Denmark – (2025) e-methanol capacity 42 kta

MTO: Key risks

- Coking is a major challenge in MTO synthesis, as it is the primary cause of catalyst deactivation, leading to reduced olefin yield, increased feedstock and energy demand to compensate for losses.
- To remove this coke, the catalyst must be regenerated through high-temperature treatments (500°C–600°C) that degrade it over time, leading to higher replacement costs, unplanned downtime, and reduced process reliability. Energy use also increases, further impacting overall production efficiency.
- **Deployment example: Shenhua, Baofeng,**
China (2018) olefin capacity 833 kta



Oligomerisation: Key risks

- The most mature oligomerisation route is from ethylene feed, However even for ethylene the performance of the process and quality of the product is not known at full scale.
- In MTJ the oligomerisation is not using ethylene alone, but in most cases a mixed olefin stream this introduces a number of risks as outlined below.
- Sub-optimal or unproven reaction conditions can lead to excessive undesired products (e.g. naphtha, diesel) which are either lost or need energy-intensive separation. This reduces overall SAF yield.

Deployment example: No plants currently oligomerize methanol-derived olefins to jet fuel.

Source: ERM proprietary analysis





e-MTJ: Integration Risks

Electrolysis + carbon capture + methanol synthesis

- CO₂ captured from flue gases or DAC systems often contains impurities (e.g. O₂, NO_x, SO_x) that can poison methanol synthesis catalysts reducing output and increasing downtime.
- While one commercial-scale plant has very recently begun operation, it has yet to reach full capacity, highlighting the ongoing challenges in scaling the process.

MTO + Oligomerisation

- In the MTJ process, in most cases the MTO step produces a mix of olefins primarily C₂–C₆. When this mixed stream enters the oligomerisation step, co-oligomerisation is required which is a more complex and technically immature process. This is due to the need to balance the differing catalytic needs of C₂ (which requires metal catalysts) and C₃–C₆ (which require acidic catalysts).
- This mismatch at the MTO–oligomerisation interface is a key integration challenge and currently the lowest-TRL bottleneck in the MTJ chain. While this contributes to some uncertainty around jet fuel yields and product quality, efforts are underway to optimise the process. The MTJ route is progressing through the ASTM qualification process, currently under OEM review stage (review by engine and aircraft OEMs).

Electrolysis + Carbon capture + Methanol synthesis + MTO + Oligomerisation + Hydrogenation

- The fully integrated MTJ pathway has yet to be demonstrated at commercial scale, with only a few small pilot plants currently in operation. Therefore, its long-term reliability and process efficiency remain unverified
- New MTJ process intensification methods are being explored such as hydro-oligomerisation (Hydro-OLI) by Topsoe which combines oligomerisation and hydrogenation in one step to save energy and equipment. However, this approach carries the risk of over-hydrogenating olefins, reducing jet yield and limiting recycle opportunities.
- Recycling C₂–C₇ olefins (outside the jet fuel range) back to either the MTO or oligomerization reactor can theoretically improve selectivity to as high as 95%. However, it is unclear how widely this high-recycle approach has been implemented in practice.

Deployment examples

- **European Energy , Kasso Plant**, Denmark (2025) e-methanol capacity ~42 kta
- **Exxon Mobil , Pilot**, Belgium (2023) <0.1 kta (e-SAF)

Source: ERM proprietary analysis



1.3 ERM Analysis: Technology and integration deployment examples

Reverse Water Gas Shift + Fischer Tropsch

Technology	Developer	Location	CO ₂ source	Capacity (ktpa)	Plant startup	Status
Individual components						
Electrolysis	Sinopec	Kuqa (China)	N/A	20 (H ₂)	2023	Operational
DAC	Climeworks	Iceland	DAC	36 (CO ₂)	2024	Operational
Point source CO ₂ capture	Archer Daniels Midland, Schlumberger	USA	Biogenic CO ₂ from corn ethanol plant	1,000ktpa biogenic CO ₂	2017	Operational
RWGS	Infinium	USA	Undisclosed, likely point source fossil	6.3ktpa (mixed hydrocarbons, mostly diesel)	2025	Operational
FT synthesis (fossil)	Sasol	South Africa	Syngas from coal gasification	5,700 (mixed hydrocarbons)	1980	Operational
FT synthesis (non-fossil)	Ineratec	Germany	Biogenic (from waste recycling plant)	2.5 ktpa (SAF)	2025	Operational
Hydrocracking/ isomerisation	Reliance Industries	India	N/A	4,194 (mixed hydrocarbons)	1999	Operational
Integrated technologies						
Point source CO ₂ + Electrolysis + RWGS + FT + Hydrocracking /isomerisation	Ineratec	Germany	Biogenic (from waste recycling plant)	2.5 ktpa (SAF)	2025	Operational
Point source CO ₂ + Electrolysis + RWGS + FT + Hydrocracking /isomerisation	Infinium	USA	Undisclosed, likely point source fossil	6.3ktpa (mixed hydrocarbons, mostly diesel)	2025	Operational

Source: ERM proprietary analysis



e-Methanol to Jet

Technology	Developer	Location	CO ₂ source	Capacity (ktpa)	Plant startup	Status
Individual components						
Electrolysis	Sinopec	Kuqa (China)	N/A	20 (H ₂)	2023	Operational
Point source CO ₂ capture	Archer Daniels Midland, Schlumberger	USA	Biogenic CO ₂ from corn ethanol plant	1,000ktpa biogenic CO ₂	2017	Operational
DAC	Climeworks	Iceland	DAC	36 (CO ₂)	2024	Operational (not at full capacity)
Methanol to olefins	Jiangsu Sailboat Petrochemical Company/ Honeywell UOP	China	Fossil	833	2018	Operational
Integrated technologies						
Electrolysis + Methanol synthesis	European Energy	Kasso (Denmark)	Biogenic CO ₂ from biogas	42 (e-methanol)	2025	Operational (not at full capacity)
	HIF/MAN Energy Solutions	Chile	DAC	0.6 (e-methanol)	2022	Operational
Electrolysis + Methanol synthesis + MTO + Oligomerisation + isomerisation	ExxonMobil	Belgium	N/A	<0.1 (e-SAF)	2023	Operational (pilot)

Source: ERM proprietary analysis



Project
SkyPower