Project SkyPower

Accelerating the take-off for e-SAF in Europe

Project SkyPower insights report

October 2024

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:

SYSTEMIQ

Green Finance Institute

Mission Possible Partnership

Supported by:

Children's Investment Fund Foundation

Breakthrough Energy

ClimateWorks Foundation

Project SkyPower

Accelerating the take-off for e-SAF in Europe

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-scale[1] e-SAF plants in Europe to reach Final Investment Decision by end of 2025

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

Organisations supporting this report

Disclaimers

This report constitutes a collective view of participating organisations in Project SkyPower. Participants support the general thrust of the arguments made in this report, but their support should not be taken as agreeing with, or committing to, every finding or recommendation, or as agreeing with the views of each other participant on reducing carbon emissions associated with the aviation industry. These organisations acknowledge the importance of scaling e-SAF this decade to drive significant emission reductions by 2050 and support the 10-point action plan highlighted in this report to pave the way for the first large-scale e-SAF projects to get to Final Investment Decision. For an organisation's individual approach to reducing carbon emissions associated with the aviation industry, please visit the website of that organisation. For more information on Project SkyPower, please visit www.project-skypower.org.

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Foreword

As Europe embarks on a transformative journey towards climate neutrality, it faces the dual challenge of ensuring long-term competitiveness while achieving the ambitious goals outlined in the European Green Deal.

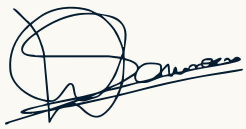
As recently emphasised in the EU's report *The future of European competitiveness – A competitiveness strategy for Europe*, it is time to redefine Europe's industrial identity. Ensuring competitiveness and decarbonisation is particularly challenging for hard-to-abate sectors like aviation. Sustainable Aviation Fuels (SAFs) can reduce emissions of flying by over 90% but are significantly more expensive than fossil jet fuel[1].

E-SAF, SAF produced from clean hydrogen and captured CO2, has emerged as a promising Power-to-X technology to reduce emissions in aviation, since the technology could abate more than 500 million tonnes of CO2 globally by 2050[2]. However, since cost parity with fossil jet fuel is not in sight for SAFs, projects are not yet getting to Final Investment Decision. The European Green Deal and ReFuelEU Aviation provide a regulatory foundation for the market uptake of e-SAF but will not be sufficient to get large-scale e-SAF projects off the ground. This transition will not take off because of its economics, but only if enough political will is mustered and full stakeholder involvement is secured.

Project SkyPower has convened the e-SAF ecosystem in Europe and cleared the runway for e-SAF projects to take off within the next year. It has created alignment among critical actors across the European e-SAF value chain on the current techno-economics of e-SAF and has mapped out the barriers and solutions for e-SAF projects. This report outlines the collaborative efforts necessary to accelerate the development of e-SAF, culminating in a powerful 10-point action plan.

This report aims to inform key decision makers in industry, policy, finance and civil society to work together on those tangible actions to make the e-SAF scale-up in Europe a success story. The lessons and experiences from Project SkyPower could also be translated to other sectors facing similar challenges. By driving the scale-up of e-SAF, Europe can not only accelerate the energy transition, but also regain its leadership in clean-tech innovation.

This report shows that a paradigm shift is necessary to achieve 2030 e-SAF targets: policy makers need to increase support from the millions to the billions, offtakers need be able to enter into 10+ year binding offtake agreements to provide revenue certainty, and financiers need to better understand the risks of first-of-a-kind e-SAF projects to manage them adequately and provide financing. With several projects discontinued this year, it is clear more than ever that we need a fundamentally different approach in which industry, financiers and policy makers put their weight behind the European e-SAF industry. The members of Project SkyPower are dedicated to taking the lead in this effort.



Diederik Samsom
Former Head of Cabinet for Executive Vice President of the European Commission Frans Timmermans responsible for the European Green Deal

1 WEF (2022); German Federal Office for Environment (2022)
2 IATA (2024)

Executive Summary

The opportunity

With two-thirds of the global e-SAF pipeline concentrated in Europe, the region is set to lead the development of this technology, which is central to reducing life-cycle emissions from mid-to-long haul flights. Europe's established aerospace and energy industries, along with its policy leadership – including the introduction of e-SAF blending mandates – provide a solid foundation to lead the development of first-of-a-kind e-SAF production at commercial scale. Europe is currently home to around two-thirds of e-SAF projects announced globally. This creates a major strategic and commercial opportunity, with Europe positioned to become a global leader and exporter in e-SAF technology, reducing life-cycle emissions from aviation and unlocking an estimated EUR 80+ bn e-SAF market in Europe by 2050.[1] Beyond aviation, spillover effects from innovation in the core technologies of e-SAF (e.g. hydrogen and carbon capture) can accelerate the broader energy transition.

1 Number refers to e-SAF offtake in Europe, not production as this may occur outside of Europe as well. High-level estimation assumes total SAF demand of 70 Mt by 2050; 35% of SAF to be e-SAF, price of e-SAF in the long run to be EUR ~3,000–4,500 per tonne.

The challenge

Currently, 2030 ReFuelEU Aviation and UK e-SAF mandates are at risk of not being met. Within Europe, none of the 30 large-scale projects have reached a final investment decision (FID). Only a handful of projects, with a combined production capacity of approximately 300 ktpa, show strong potential to start production by 2030. Should all these projects succeed, this still falls short of the ~600 ktpa required to meet mandated minimum shares of synthetic aviation fuels in the EU in 2030 - and the ~60 ktpa e-SAF required to meet the upcoming UK e-SAF mandate.[2] E-SAF plant construction typically takes 3–4 years; therefore, plants need to reach FID by the end of 2025, or in an optimistic case 2026, to get capacity online by 2030.. With more than three quarters of planned projects still in the early feasibility stage, substantial support is needed to accelerate timelines and get further projects on track to reach FID.

Levelised e-SAF production costs are projected to range from EUR 5,000 to 8,000 per tonne in Europe by 2030. With no path to cost parity with fossil jet fuel in sight – the transition to e-SAF will not be driven by economics; it will be driven by political will and a lack of scalable alternatives to decarbonise long-haul aviation. Project SkyPower's technoeconomic modelling shows that currently, unsubsidised e-SAF production costs in Europe are 5–8 times higher than fossil jet fuel prices (factoring in the CO_2 price within the EU/UK Emissions Trading Scheme). The regional power price is the major determinant of competitiveness – from the five countries assessed,[3] Norway and Sweden have the most favourable conditions for renewable power, and hence the lowest e-SAF production costs. Even if potential cost reductions of 40–50% are achieved over the long-term, without cost parity, a strong policy framework is crucial to drive the transition. ReFuelEU Aviation and the UK SAF Mandate provide an excellent demand signal to the market. While critical, it is not sufficient – financing, technology and offtake risks remain (in particular for first-of-a-kind-plants) which require further policy support.

Building the investment case

To meet the EU's and UK's upcoming e-SAF mandates in 2030, EUR 15–25 bn of capital investment is needed (with 90% for the EU market, 10% for the UK market). To establish a viable business case, four essential building blocks are required: (A) regulatory certainty on the e-SAF mandates, (B) adequate public funding via existing industry-generated tax or carbon pricing revenues (e.g. via the ETS) (C) long-term offtake agreements, and (D) appropriate de-risking measures to reduce first-of-a-kind project risk. First, investors need clarity on the absolute penalty levels within ReFuelEU Aviation and certainty of the e-SAF mandates for 2030 and beyond even in a supply shortage scenario. Second, public subsidies must be restructured to provide long-term revenue certainty. To achieve cost competitiveness with other regions like the US (as an exemplary benchmark[4]), an expansion of existing instruments such as the EU Innovation Fund is required (to provide support in the order of EUR 400–600 mn per 50–70 ktpa e-SAF project) in 2025/2026 until the number of ETS allowances for uptake of SAF[5] can be increased from 2027 (incl. dedicated e-SAF Allowances provided on a 10-year basis). For the UK, adequately funding the revenue certainty mechanism is key. Third, securing bankable 10+ year offtake commitments is crucial for financing, as stable contracts provide revenue certainty in the absence of long-term public funding. Fourth, reducing compliance risk through clear and enduring production criteria (i.e. eligibility of renewable electricity and captured CO_2 feedstock), along with appropriate allocation of technological and financing risks via de-risking mechanisms (e.g. low-interest loans and guarantees in the order of EUR 250-500 mn per e-SAF project), is vital.

2 Based on estimated demand of aviation fuels in the EU of ~48 Mt in 2030 and ~12 Mt in the UK.
3 Five countries were assessed: Denmark, France, Norway, Sweden, and the UK. The country selection criteria can be found in the Annex.
4 Given the support of the Inflation Reduction Act.
5 Hereinafter referred to as SAF Allowances.

Critical actions to achieve 2030 targets

To reach commercial-scale e-SAF production by 2030, a collective step-change is needed from producers, incumbent fuel suppliers, offtakers, financiers, policymakers, and public finance organisations to deliver five critical short-term actions.

	To get first e-SAF projects to FID in the short term...
Create regulatory certainty…	1 **Ensure regulatory certainty** on e-SAF mandates and penalties
Bridge the premium with public funding…	2 Secure **public funding** commitments via existing industry-generated tax revenues
Stimulate demand for e-SAF…	3 Establish bankable 10+ year **offtake contracts** (e.g. take-or-pay) for first e-SAF projects
Unlock investment…	4 **Establish low-interest loans and loan guarantees** from the EIB, NWF, UKEF, national investment banks and ECAs[1]
	5 Develop more effective **risk sharing models** that recognise the unique risk profile of e-SAF projects

Note: 1 EIB: European Investment Bank; NWF: National Wealth Fund; UKEF: UK Export Finance; ECA: Export Credit Agency.

Insights report

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E-SAF in Europe: today and the aspiration for the future

1.1 The role of e-SAF in reducing emissions from aviation

The aviation industry faces its greatest challenge to date: significantly reducing the sector's emissions by 2050. The industry has a proud record of innovation in its 120-year history, providing the fastest means of transportation, spurring trade and tourism, and creating jobs and economic opportunities globally. Yet, reducing the environmental impact of flight is a challenge which places the industry's license to operate at risk. Aviation is currently responsible for ~2.5% of global greenhouse gas (GHG) emissions,[6] a proportion that is likely to increase as demand for travel continues to rise while other sectors accelerate their decarbonisation efforts.

Several emissions abatement solutions are emerging, but Sustainable Aviation Fuels (SAFs) are currently considered the only viable option for mid-to-long haul flights (above 2,500 km) which account for approximately 60 per cent of global emissions from commercial passenger aviation.[i] Important abatement levers are efficiency improvements and demand measures, e.g. modal shifts to high-speed rail, but those are insufficient on their own. Electric and hydrogen aircraft could reduce about 10 to 15 per cent of aviation's emissions by 2050 but face two issues for mid-to-long haul flights: low energy density and thus limited range, as well as time to market.[ii] High-integrity[7] SAFs offer a scalable, drop-in solution now. By 2050, 70% of aviation fuel used in the EU is mandated to be SAFs[iii] – yet today, they make up less than 1% of total jet fuel consumption.

Virtually all SAF used today is biofuel (HEFA)[iv] but their future expansion is constrained by the availability of sustainable feedstocks. Bio-SAFs, i.e. biofuels that are produced from high-integrity, sustainable biogenic material, offers an affordable and commercially available decarbonisation solution for aviation both in the near and long term. However, due to the globally limited availability of sustainable biomass feedstock and competing demands from other sectors, bio-SAF alone will not be able to decarbonise the aviation industry. It will need to be complemented by alternative solutions, including large volumes of e-SAF, recognising that e-SAF itself is an imperfect solution, requiring large amounts of renewable electricity.[8]

E-SAF is a critical part of the solution and offers several long-term benefits. E-SAF has the potential to offer at least 90 per cent life-cycle CO_2 emissions reduction relative to fossil fuels,[9] as it is synthesised using additional renewable electricity to produce clean hydrogen[10] and to capture CO_2. As the markets for these key feedstocks mature, e-SAF production offers significant cost reduction potential. Given production is not dependent on biomass feedstocks, the risk of adverse environmental impacts, such as biodiversity loss and deforestation, is minimised.

To reach the scale required to meet the sector's 2050 emission reduction targets, e-SAF needs to reach commercial maturity this decade. Initial scale-up is essential to trigger the tipping points at which the adoption of a new technology exponentially grows. For e-SAF, commercial-scale first-of-a-kind (FOAK) production plants will provide proof points for further adoption, demonstrating viability and scalability, and paving the way for a wave of similar projects to be developed worldwide.

6 Factoring in non-CO_2 emissions (e.g. NOx, contrails and cirrus clouds), aviation is responsible for even 3.5% of global warming (measured in the net anthropogenic effective radiative forcing). Source: Lee et al. (2021).

7 Key requirements for a 'high-integrity' SAF are that it significantly reduces life-cycle emissions, meets a high standard of environmental integrity (e.g. to avoid indirect land-use change) and is transparently and accurately accounted for to avoid double counting emissions reductions. For further information, please refer to Chapter 7 of ICAO (2022), '2022 Environmental report' or EDF (2022), 'The High-Integrity Sustainable Aviation Fuels Handbook'.

8 Other use cases of renewable electricity can offer a larger GHG emissions avoidance per invested kWh, since aviation requires highly energy-dense fuels and direct electrification (e.g. as for cars or trucks) is not possible for mid to long-haul flights. In an ideal world, additional renewable electricity would be used according to a merit-order curve, starting with the lowest hanging fruits. However, climate change has become so urgent that it is imperative to tackle all sectors at the same time. Considering market dynamics, the FOAK, large-scale e-SAF production plants need to reach FID in the next years to allow for the necessary ramp-up of production capacities in the 2030s and 2040s and to achieve the required scale for 2050. Furthermore, technology innovation has the potential to considerably reduce the electricity intensity of e-SAF production over time. Importantly, this report always refers to e-SAF as synthetic aviation fuels that are compliant with the Delegated Acts of RED II.

9 Life-cycle CO_2 emissions include emissions produced in the production of e-SAF hence the less than 100% reduction in CO_2 emissions in some cases.

10 Refers to hydrogen produced via electrolysis, powered by renewable electricity.

1.2 Europe's e-SAF ambitions

Europe is in a unique position to write the first chapter of the e-SAF story. Supported by comprehensive policy frameworks, a dominant e-SAF project pipeline and a strong SAF offtake market, Europe is fertile ground for innovation and leadership within the e-SAF space. Developing the e-SAF industry will further the energy security ambitions of the region.

Firstly, the European Union (EU) has a robust and one of the most comprehensive policy frameworks for SAF: ReFuelEU Aviation[v] sets a clear ambition level for the EU with legally binding SAF blending mandates starting in 2025. The regulation includes sub-targets for e-SAF which start with an average of 1.2% in the period of 2030–2031, requiring ~600 kilotonnes per annum (ktpa) e-SAF, increasing to 2.0% from 2032, requiring ~1,000 ktpa e-SAF, up to 35% (up to 21,750 ktpa) by 2050. The obligation on fuel suppliers will be enforced with non-compliance penalties to be implemented by Member States,[11] including fines amounting to at least double the premium (i.e. the difference between the yearly average price of e-SAF[12] and conventional jet fuel) as well as a requirement to make-up the shortfall in the subsequent reporting period.

The United Kingdom (UK) is due to enact a similar policy framework on SAF this year,[vi] strengthened further by a robust revenue certainty mechanism due year end 2026. The House of Commons has passed the legislation and the House of Lords are expected to approve it in the coming months. When passed into law, the mandates will require blending of 0.02% e-SAF in 2028 (equivalent to around 2 ktpa), 0.5% by 2030 (~60 ktpa), increasing to 3.5% (~450 ktpa) from 2040. A buyout price, of GBP 6,250 per tonne for e-SAF,[vii] will also be introduced to allow aviation fuel suppliers to opt out of the mandate with no make-up obligation for the following year. The UK is also proposing to introduce a revenue certainty mechanism at the end of 2026, most likely via a Guaranteed Strike Price mechanism, to provide projects with a guarantee of receiving a price per tonne to cover their levelised cost of production – an important measure that will support bankability.

11 Article 12 of the ReFuelEU legislation.
12 This is expected to be informed by a forthcoming EASA report.

Exhibit 1

Europe is in a unique position to write the first chapter of the e-SAF story

Policy
Mandates
for e-SAF blending (ReFuelEU and UK SAF)

Supply
70%
of planned global e-SAF capacity in Europe

Offtake
~50%
of global SAF offtake from European airlines in 2022

→

Market opportunity
EUR 80+ billion
in Europe by 2050[1,2]

Note: **1** This number refers to offtake in Europe not production, as production may occur also outside of Europe. High-level estimation assumes total SAF demand of 70 Mt by 2050; 35% of SAF to be e-SAF, price of e-SAF in the long run to be 3,000-4,500 EUR/tonne. **2** The global market opportunity could be EUR 350+ bn. **Sources:** EASA, European Aviation Environmental Report 2022; BNEF 2023; Systemiq analysis.

Secondly, Europe is home to more than 2 Mt[viii] of announced e-SAF capacity, two thirds of the global pipeline, and European airlines accounted for roughly half of the global SAF offtake in 2022.[ix] While only ~10–20% of this capacity is likely to make it to FID (according to usual success rates of announced cleantech projects getting to FID[13]), Europe's strong foundation in aerospace, ambitious e-SAF technology innovation, as well as decades of experience in the oil and gas industry, have positioned it to be an early adopter and global leader in this critical space – but is at risk of losing its competitive edge without a clear industrial strategy.

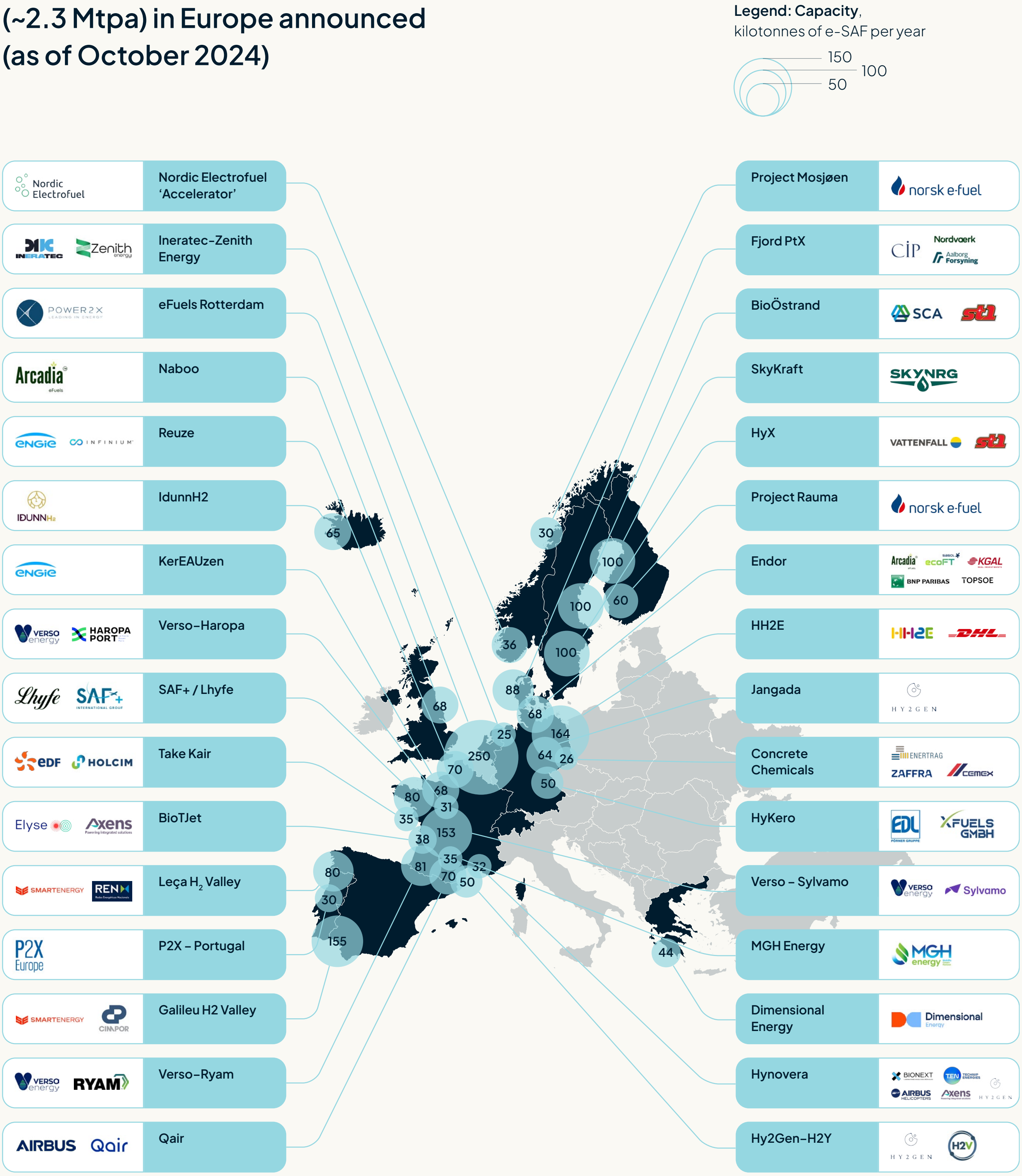
Domestic e-SAF production presents a once-in-a-century opportunity for Europe to reduce its dependence on fossil jet fuel imports and increase energy security. It could also unlock a commercial opportunity for Europe to lead on the global e-SAF scale-up. E-SAF could create a EUR 80+ bn market opportunity in Europe alone by 2050.[14] While other regions will likely offer highly competitive production opportunities in the future due to cheaper renewable electricity costs, Europe is well equipped to overcome technical challenges towards realising first commercial scale plants in the short term. In the long run, Europe, as an early adopter, would be well-positioned to export e-SAF expertise and equipment while retaining some level of domestic production, particularly where there is opportunity to decouple feedstock production (e.g. methanol) from e-SAF synthesis.

13 Based on observations from participants of Project SkyPower – incl. SAF projects, but also other cleantech (e.g. hydrogen).

14 Number refers to e-SAF offtake in Europe, not production as that may occur outside of Europe as well. High-level estimation assumes total SAF demand of 70 Mt by 2050; 35% of SAF to be e-SAF, price of e-SAF in the long run to be EUR ~3,000–4,500 per tonne.

Exhibit 2

Around 30 large-scale e-SAF plants (~2.3 Mtpa) in Europe announced (as of October 2024)



Notes: All projects plan to use biogenic CO_2. Some projects also plan to use point source CO_2 from cement or steel production. Map excludes projects <25 ktpa e-SAF capacity. **Source:** Systemiq, T&E (2024), MPP (2024), based on public announcements and press search.

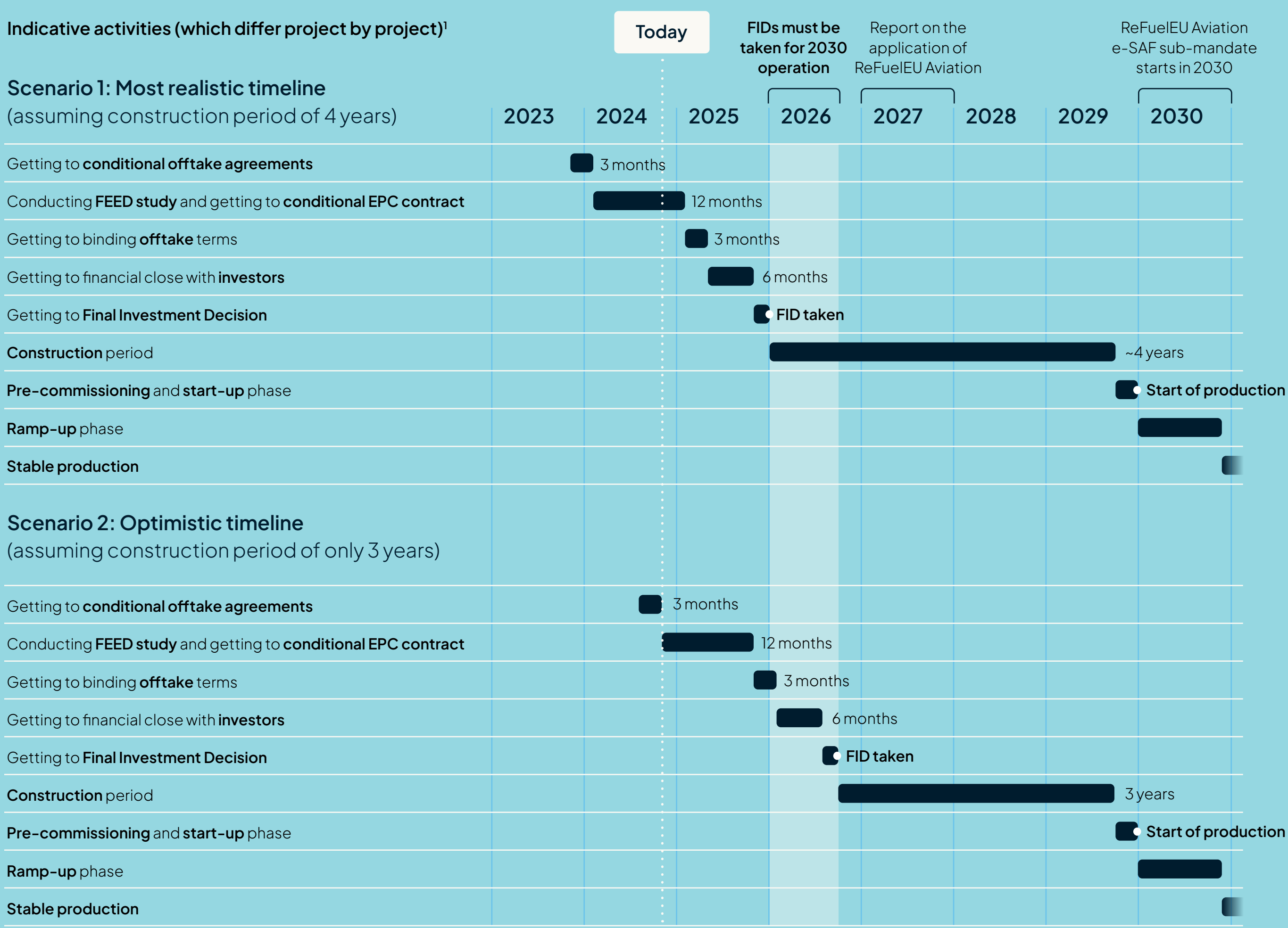
1.3 Progress to date against 2030 e-SAF mandate

Despite ambitions, e-SAF is struggling to take off – out of the approximately 30 large-scale e-SAF projects announced in Europe, none have reached Final Investment Decision (FID) and the majority will not before 2026. Over three quarters of planned e-SAF production capacity is in feasibility or pre-feasibility stages, and yet to start front-end engineering design (FEED) studies. With estimated project development timelines, shown in Exhibit 3, this means these projects are most likely more than 2 years away from FID.

To be operational by 2030, projects need to reach FID by the end of 2025 or at the latest 2026 (given the construction period of 3–4 years for FOAK e-SAF plants). Currently, this is only achievable for a handful of projects. Exhibit 3 shows a simplified indicative timeline for e-SAF project development in both realistic and optimistic scenarios; given the project-

Exhibit 3

Without Final Investment Decisions by 2025/26, e-SAF projects will not be in production by 2030



Note: 1 Durations for individual activities are best-case scenarios and could often take twice as long. In contrast, certain activities prior to FID can potentially be parallelised. Note that this is a simplified view and does not show all activities involved in project development e.g. securing a grid connection, getting permits etc. which can be done in parallel.

on-project risks involved, there is a high degree of uncertainty. These timelines imply that to reach FID by the end of 2025, in line with Project SkyPower's mission, projects must be in or past the FEED phase today. Based on public information, one project has concluded its FEED study, one project is in the process of delivering it, and a handful of projects are about to begin the process. Yet, even for these projects key barriers persist to reaching FID. If these barriers were removed, this could translate into ~300 ktpa of e-SAF production capacity coming online by 2030.

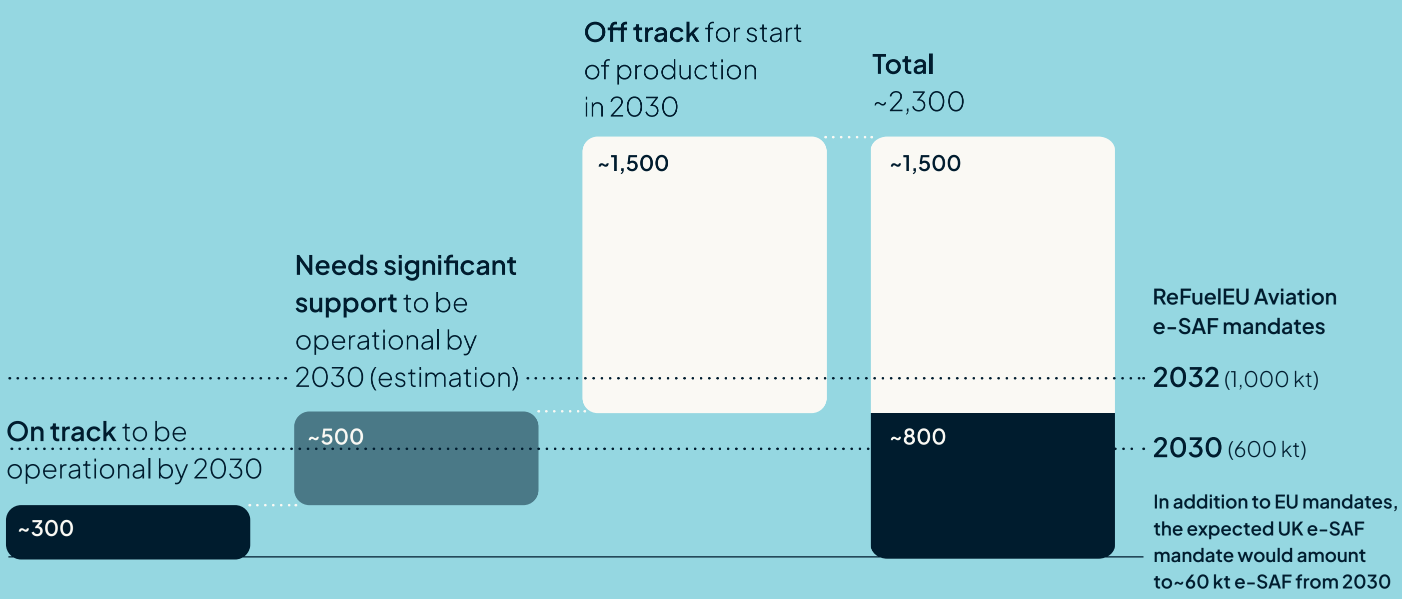
Beyond the e-SAF projects in advanced stages (~300 ktpa), additional equivalent capacity is required to meet 2030 e-SAF mandates in the EU (~600 ktpa) and the UK (~60 ktpa). Only with significant additional support could domestic e-SAF projects fill this gap but their readiness for production by 2030 is increasingly unlikely (Exhibit 4). However, it is also unlikely that any expected shortfall will be fully met by imports, given that only 700–1,000 ktpa of e-SAF capacity has been announced outside of Europe of which only a small share is on track to being operational by 2030.[15] To bridge the gap to 2030 mandates and meet the subsequent EU sub-mandate increase from 1.2% to 2.0% in 2032, greater levels of support are required to accelerate projects towards offtake and financing agreements.

15 This excludes a recent announcement of Sasol to produce 650 kt AF at its Secunda plant, as the publicly available information doesn't specify that captured CO_2 would be used as feedstock - hence, the fuel would not qualify as e-SAF under the RED II Delegated Acts.

Exhibit 4

We are off-track to fulfilling the e- SAF blending mandate through domestic production, unless projects receive significant support

European announced e-SAF capacity, in kt of annual e-SAF output, ranked by estimated likelihood of being operational by 2030



Notes: Planned e-SAF capacity only refers to e-SAF output and does not include byproducts such as e-naphtha or e-diesel/gasoline. If announcement does not state SAF fraction of total product output, a SAF share of 70% is assumed. Some plants are hybrid power and biomass to liquid plants (PBtL), for which the e-SAF share on the total SAF fraction is assumed as 50%, the rest being classified as biofuel. The estimated demand of aviation fuels in the EU is 48 Mt in 2030/31 and 50 Mt for the period 2032-2034. **Source:** Press search. Non-exhaustive data, upsides possible. Data status: October 2024.

02

Baseline techno-economics of e-SAF projects

The transition from fossil jet fuel to e-SAF will be driven by Europe's already demonstrated political will, not by economics. In the EU, ReFuelEU provides a comprehensive policy framework to create a robust offtake market in the long-term. However, today's baseline techno-economics for e-SAF production, assuming a pessimistic case with no subsidisation and current SAF market prices, do not demonstrate a viable business case.[16] Early investments in FOAK projects, supported by subsidies, and adequate willingness to pay from the private sector, are therefore imperative to unlock cost reductions in e-SAF production - which would otherwise not materialise.

Current technoeconomic modelling[17] indicates that the levelised cost of unsubsidised e-SAF ranges between EUR 5,000 to EUR 8,000 per tonne. While this is already 5–8 times the historical average price of fossil jet fuel plus the expected ETS allowance price,[18] this does not yet cover additional costs e.g. taxes, and project development costs. In addition, e-SAF prices would need to carry a larger proportion of the production costs compared to the by-products (e.g. e-naphtha and e-diesel), because of the lower willingness to pay significantly above fossil prices in the by-product offtake markets. This analysis is based on Project SkyPower's comprehensive asset-level cashflow model, developed in collaboration with industry stakeholders and rigorously reviewed by independent experts. As the first of its kind for e-SAF production, this model aims to bring transparency to e-SAF techno-economics, highlighting and quantifying the key levers needed to achieve bankability. By providing a shared, evidence-based foundation, the model is designed to support dialogues across the value chain, with investors and with policymakers. The model is open-source and publicly accessible on the Project SkyPower website from November 2024.

The major cost driver in e-SAF production is the power price, accounting for 35–45% of the levelised cost of production. Power price is the primary determinant of competitiveness. Renewable electricity prices vary regionally depending on renewable energy resources and grid fees. As a result, e-SAF production costs vary significantly across Europe as shown in Exhibit 5, which considers the five countries assessed in this analysis.[19] The lowest costs can be found in countries like Norway and Sweden, with power prices as low as EUR 55 per MWh, where the renewable electricity share in the grid exceeds 90%, therefore avoiding the requirement of additionality, and enabling the use of grid power.[x] The other end of the spectrum is marked by the UK with power prices up to EUR 120 per MWh. The need for additionality and temporally correlated continuous renewable power further increases the power prices faced by e-SAF producers beyond market averages, resulting in high e-SAF production costs in regions with less than a 90% share of renewables in their grid.

Approximately half of the levelised production costs result from upfront investments (fuel synthesis and electrolyser). Building a ~50 ktpa e-SAF plant requires close to EUR 1- 2 bn in total financing, to cover the plant infrastructure, project development costs, EPC costs, financing costs, contingency etc. For the CAPEX required for the physical infrastructure, approximately two-thirds of it is attributed to the fuel synthesis unit and balance of plant equipment, and one-third to the electrolyser; this is reflected in the levelised cost of production.

The planned non-compliance penalties are essential to enforce the mandate and avoid 'buying out'. Exhibit 6 shows that in the UK, the cost of non-compliance is expected to be EUR 8,000–9,000 (GBP ~7,000[20]) per tonne. In the EU, much higher penalties could enter into law shortly due to both the fine, linked to the e-SAF

16 This assumption does not factor in penalties and make-up obligations, which are strengthening the investment case. However, to ensure that the first wave of e-SAF projects gets to FID, a portfolio of measures are required in addition to non-compliance fines, as laid out later in the report.

17 Project SkyPower, in close collaboration with its members, has developed an open-source technoeconomic model of e-SAF production in various geographies. The model allows customization of key parameters (e.g. feedstock prices) and can be accessed on www.project-skypower.org. The model is for informational purposes only and should not be used for investment, financial, or any other form of professional advice. It is not meant to be used as the basis for financial and investment decisions by third parties or a part of any financial transaction.

18 Throughout this report, the historical average price of fossil jet fuel is assumed at EUR ~600 per tonne and the average ETS allowance price by 2030 is assumed to be EUR 100 per tonne CO_2. The emissions factor of kerosene-type jet fuel is ~ 3.16 tonne CO_2 per tonne fuel.

19 Five countries were assessed: Norway, Sweden, Denmark, France and the UK. The country selection criteria can be found in the Annex.

20 This is the total of the planned e-SAF buyout price of GBP 6,250 per tonne plus the cost of traditional fossil fuel.

market price, and the make-up obligation the following year. While penalties are expected to be prohibitively expensive, the absolute values are yet to be published. This uncertainty inhibits financiers from adequately assessing project risks – a quick adoption of absolute penalty levels by Member States in Q1/2025 would resolve that uncertainty. Additionally, adequate foresight of exact penalty levels over time (based on evolving underlying e-SAF price benchmarks published by Member States) would reduce price risk. However, even if the e-SAF benchmark price is based off the lower-end production cost assumption of 5,000 EUR per tonne, a fuel supplier would pay considerably more (~3x e-SAF costs) in a non-compliance case, due to the stacking of costs of fossil fuel, the ETS, penalties and the make-up obligation.

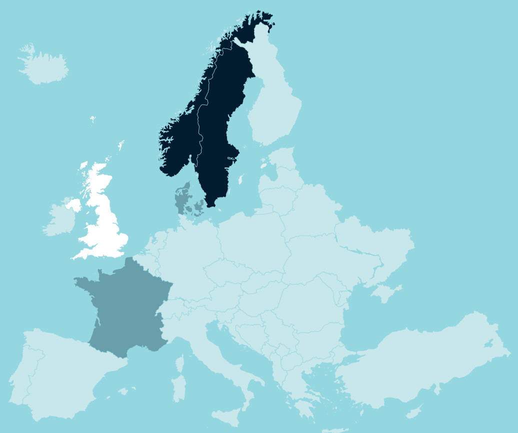
Incentivised by mandates, early investments and long-term scale-up could lead to potential cost reductions in e-SAF production of 40–50%, but future price-parity with fossil fuel is not in sight.[21] If – and only if – investments are made in FOAK plants today and sufficient scale is reached, future production costs could theoretically halve given the following long term cost reduction potentials, based on Project SkyPower modelling. Learning curves could lead to lower electricity prices of approximately EUR 40 per MWh, and to a lower hydrogen electrolyser CAPEX (EUR 1,000 per kW, down from EUR 2,300 per kW). Those two cost reductions could lower production costs by around EUR 1,000 to 2,500 per tonne of e-fuels. Economies of scale in future e-SAF production plants and a reduced weighted average

21 This is based on a “what-happens-if” sensitivity analysis. The underlying assumptions of what you need to believe for this to be true are shown in Exhibit 7.

Exhibit 5

Power price is the strongest determinant of e-SAF production costs, causing substantial variations across Europe

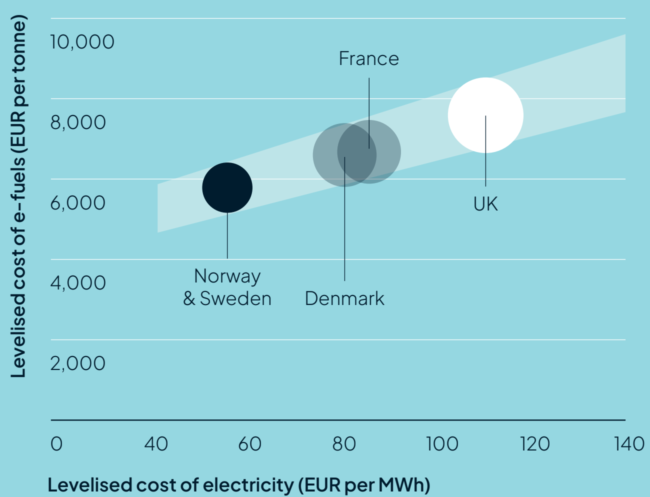
Renewable electricity price across Europe



Total power price in EUR per MWh

<60 · 60–80 · 80–100 · >100

Levelised cost of e-fuels at given cost of electricity

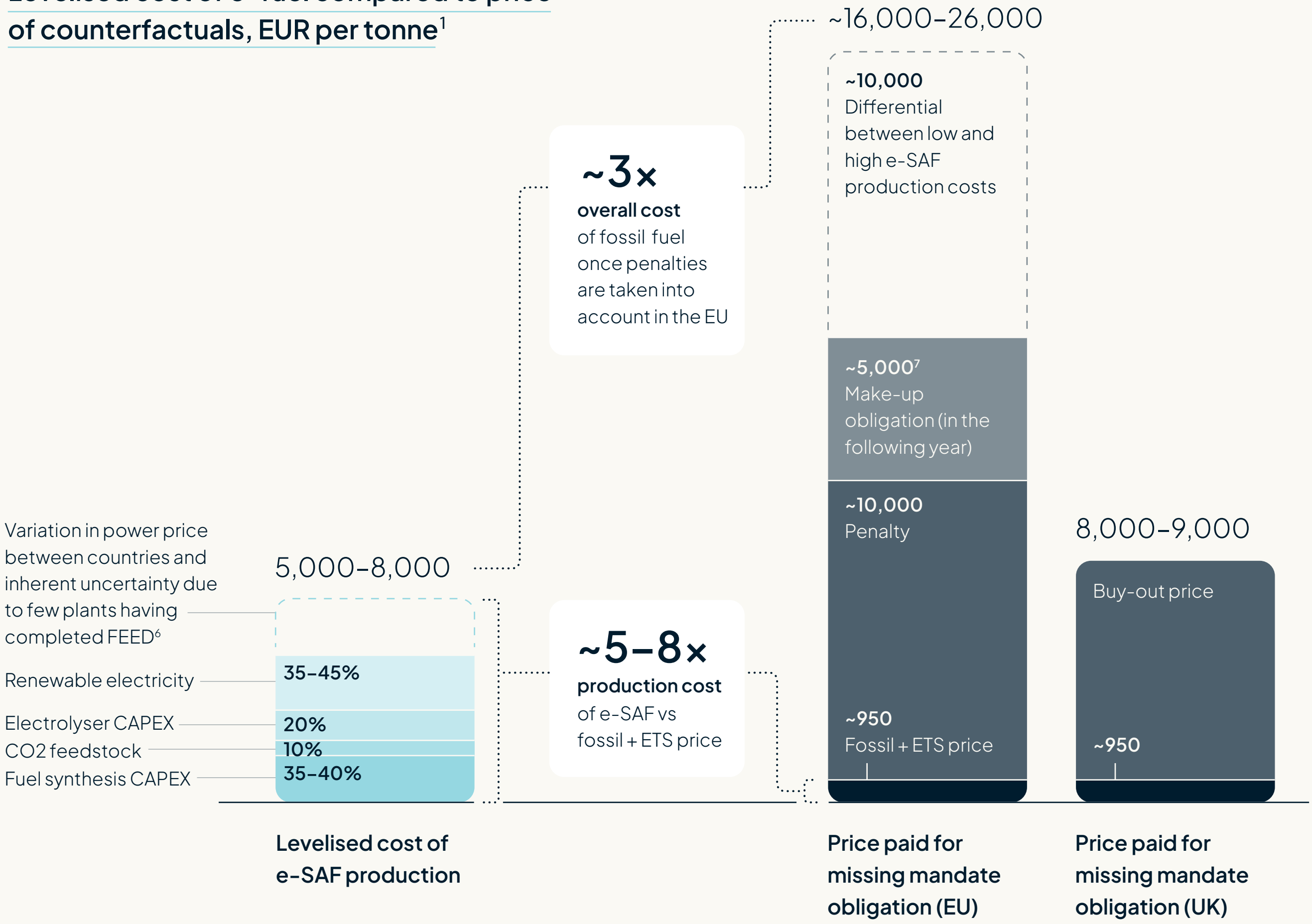


Note: All other cost components are assumed fixed. Based on current technology and WACC assumption of 11%; future cost reduction potentials not accounted for. **Source:** Bruegel (2024), Lessons from the European Union's inaugural Hydrogen Bank auction.

Exhibit 6

By 2030, the levelised cost alone of unsubsidised e-SAF production in Europe could be 5–8x the price of fossil jet incl. ETS

Levelised cost of e-fuel compared to price of counterfactuals, EUR per tonne[1]



Assumptions (for FID in 2025)				
	Size 50 kt e-Kerosene	**Electricity price (PPA):** €55 – 120 / MWh	**LCOH:**[4] €5.0 – 9.3 / kg	**CO_2 price:**[5] €165 / t CO2
	Electrolyser capacity: 160 – 200 MW	**Electrolyser installed costs:**[3] €2,000 – €2,500/kW	**WACC:** 11%	

Notes: 1 Reverse-Water Gas Shift Fischer Tropsch e-SAF production route – 85% of product slate is e-SAF; **2** levelised cost is shown here only to give an indication of the magnitude of e-SAF production costs for FOAK plants. It only includes CAPEX and OPEX of the project itself and does not include e.g. pre-development costs and tax etc.; hence the actual price of e-SAF required is expected to be higher than this. The LCOX is also very sensitive to assumptions around how CAPEX is spread over the construction period. **3** Global expected learning rate of 18% assumed for stack replacement (IRENA 2021); **4** Levelised cost of hydrogen; Capacity factor of 92%; **5** Offtake of biogenic CO_2 via offtake contract and all-in cost including capture, transport and handling. **6** 20% uncertainty. **7** The make up obligation in the following year will also mean an equivalent volume of fossil jet fuel that is displaced, and therefore a cost saving that is not shown here. **Sources:** Bube (2024); Eyberg (2024); IRENA (2023); IRENA (2021); Jasper (2015); Kelley (2018); Lazard (2024); Maersk Mc-Kinney Moller Centre (2024); NREL (2023); Soler et al. (2022); US Department of Energy (2024); US Department of Energy (2020); Zang et al. (2021); Expert input.

cost of capital (WACC) as a result of lower project risks of nth-of-a-kind plants could bring about a further reduction of EUR 1,100 per tonne of e-fuels. Yet, production costs for e-SAF are unlikely to fall below EUR 3,000–4,000 per tonne, which is equivalent to triple the historic prices of fossil fuels plus ETS prices. This is unlike other sectors, such as electric vehicles,[xi,xii] where cost parity has either already been reached (in terms of total cost of ownership) or is in sight and hence superior economics will accelerate the transition.

Despite increased fuel costs, the estimated impact on passenger ticket prices resulting from the EU and UK e-SAF mandates is minimal (<2%) in 2030 and could be less than 15% by 2050. As the mandated blending percentage for e-SAF in 2030 (1.2% for EU, 0.5% for UK) is still very low, an increase in fuel costs (which are estimated to account for between a quarter to a third of ticket prices today[xiii]) would lead to an average ticket price increase of <2%, i.e. well within the range of typical ticket price fluctuations within a year. For example, an intra-European flight with a hypothetical ticket price of EUR 300 would increase by less than EUR 5 under these assumptions, to cover the extra costs of 1.2% e-SAF. Despite the expected impact of e-SAF on ticket prices in early years being low, there is a risk that even this level of increase could lead to changing travel patterns, leading to carbon leakage. The rising blending percentages under the mandates (up to 35% e-SAF use in the EU by 2050 and 3.5% in the UK by 2040) will result in further fuel cost increases in the absence of subsidies. However, if potential production cost reductions are realised in parallel with continued improvements in aircraft efficiencies,[xiv,xv,xvi] estimated increases in ticket prices due to e-SAF blending in the EU could stay under 15% in 2050 compared to today.[22] It should be noted that the blending mandates of other forms of SAF will also drive higher ticket prices.

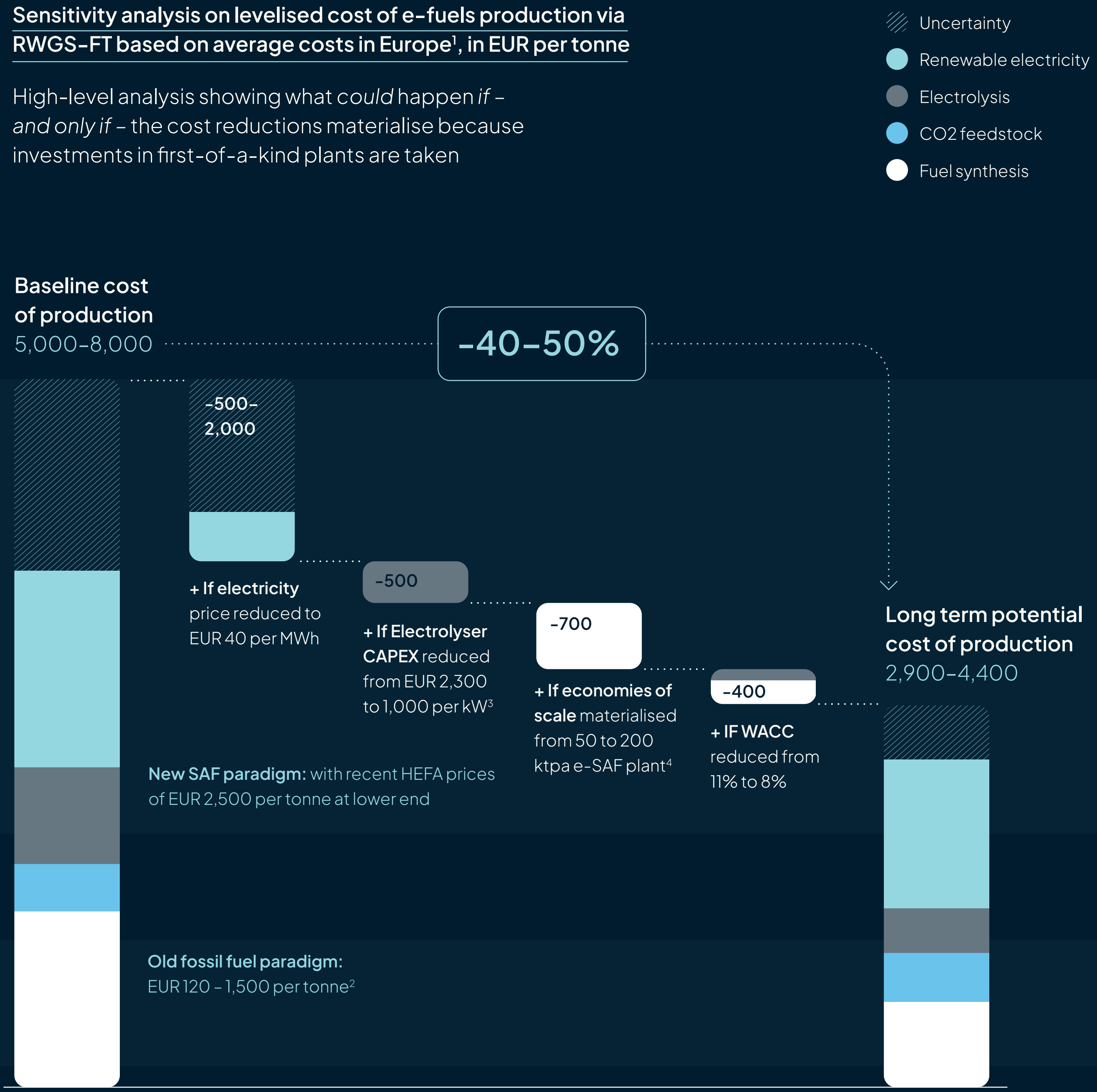
22 Assuming a fossil kerosene price of EUR 600 per tonne, annual fuel efficiency improvements of 1.5% until 2050, and a hypothetical, long-term potential e-SAF price of EUR 3,000–4,500 per tonne.

Exhibit 7

A "what-if" analysis indicates that e-SAF production costs could fall by 40–50% over the long-run, if investments are made now

Sensitivity analysis on levelised cost of e-fuels production via RWGS-FT based on average costs in Europe[1], in EUR per tonne

High-level analysis showing what *could* happen *if – and only if* – the cost reductions materialise because investments in first-of-a-kind plants are taken



Notes: 1 based on an avf. European production location; not specific to a particular country. **2** Historical fluctuations of fossil jet prices over last decades, from MPP (2022): Making net-zero aviation possible. **3** Assuming ambitious stack learning rates of ~20-30%. **4** Scaling factors based on proxy industries; will be reviewed prior to publication given the small scale of plants being considered.

03

Building the e-SAF investment case in Europe

3.1 The scale of the challenge

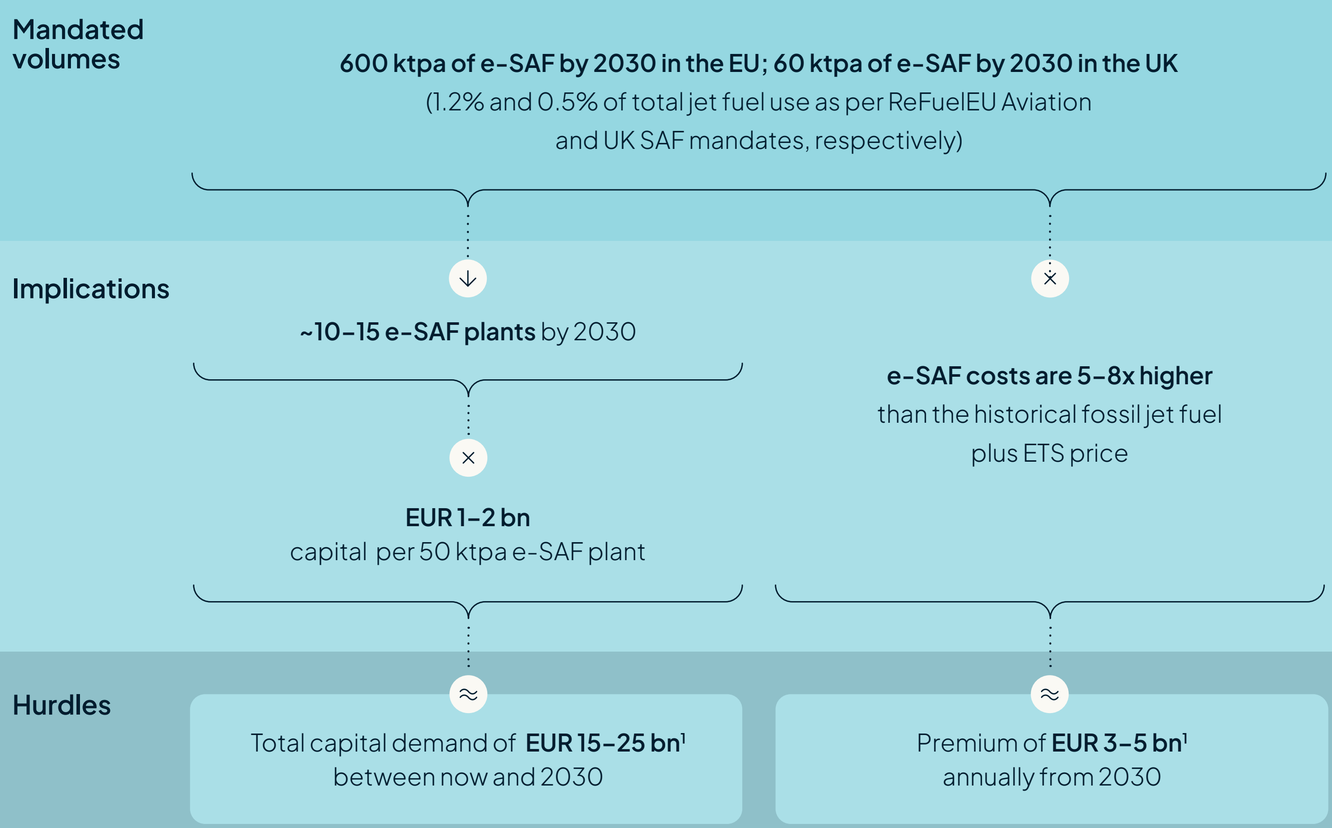
Europe needs to build approximately 10–15 large-scale e-SAF production plants (depending on the production capacity per plant) between now and 2030 to meet its e-SAF mandates, requiring EUR 15–25 bn of capital investment in this period. 90% of the production capacity and the capital investments would be needed for the EU's e-SAF mandate, 10% for the UK's expected mandate.

To reach the mandated volumes of around 600 ktpa of e-SAF in the EU and 60 ktpa in the UK by 2030, approximately 10–15 large-scale e-SAF plants (of ~50–70 ktpa average capacity) are required. This is more than the number of dedicated HEFA plants built on a single continent to date,[xvii] requiring an unprecedented mobilisation of the industry.

E-SAF production is highly capital-intensive, hence securing upfront capital of this scale is the first major hurdle. The second is the higher costs of e-SAF relative to fossil jet fuel plus the EU ETS allowance price. From 2030 onwards, **EUR 3–5 bn will be required annually to cover the premium** of e-SAF, to meet the European e-SAF mandates (with 90% of the premium from EU demand and 10% from the UK).

Exhibit 8

The size of the challenge is significant – European mandates required EUR 15-25 bn in capital investment between now and 2030, and EUR 3-5 bn in premiums to be bridged annually thereafter



Notes: 1 Thereof, 90% are related to mandated e-SAF volumes in the EU.

3.2 Key levers to unlock FID

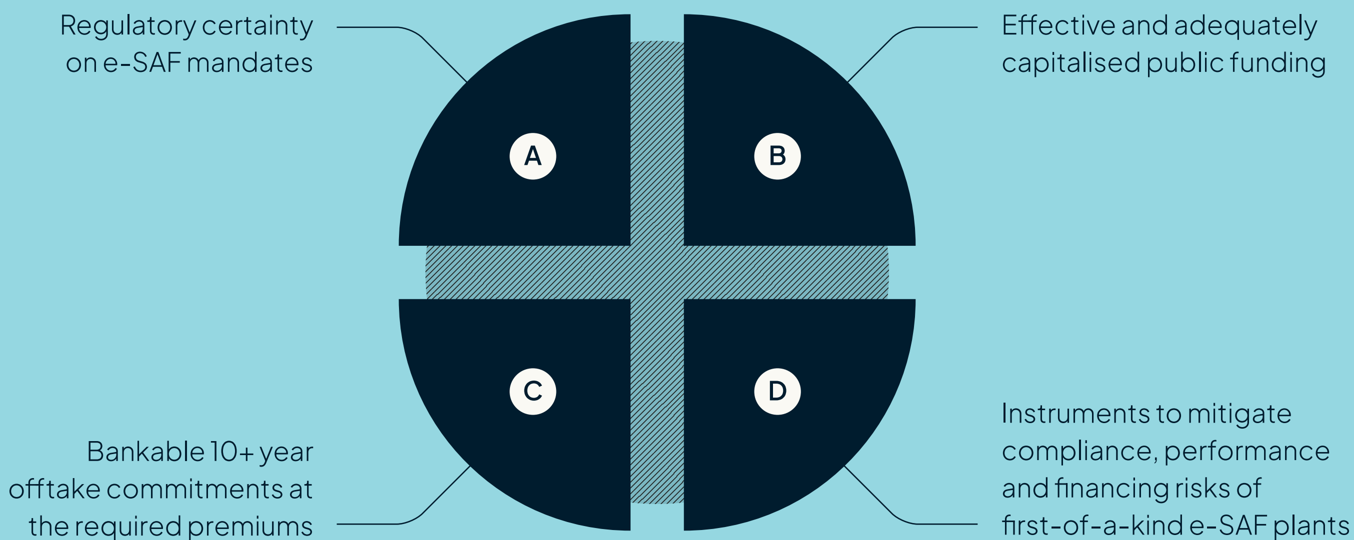
Through extensive engagement with stakeholders from across the European e-SAF ecosystem, Project SkyPower has identified four levers required to unlock FID for FOAK e-SAF plants.

(A) **Regulatory certainty on e-SAF mandates** – Regulatory certainty on mandated e-SAF blending percentages is a key prerequisite to e-SAF investments. The ReFuelEU Aviation regulation provides a very solid foundation for investments into e-SAF production and for offtake commitments to be made, thanks to the e-SAF sub-mandates from 2030 until 2050. Also, Member States are legally obliged to provide clarity on penalty systems by the end of 2024. For the UK, regulatory certainty is on the horizon as the mandates are expected to be passed into law in the coming months.

(B) **Effective and adequately capitalised public subsidy schemes** – Current support mechanisms are not enabling bankability for the first projects, as they are inadequately capitalised and do not provide the long-term revenue certainty required by financiers. However, existing policy instruments (e.g. the EU Innovation Fund and ETS allowances for uptake of SAF) could be tailored in the near term to increase their accessibility for e-SAF projects, and upcoming instruments (e.g. the Revenue Certainty Mechanism in the UK) can be appropriately designed, to be more effective in enabling net present value (NPV) positive FOAK e-SAF projects in Europe and cost competitiveness with other regions.

Exhibit 9

Four key levers can unlock FID for European e-SAF projects



C **Bankable 10+ year offtake commitments at the required premiums** – In the absence of revenue certainty provided by public funding (e.g. via a Contract for Difference type mechanism, as planned in the UK), bankable 10+ year offtake contracts for the vast majority of future production volumes of e-SAF plants are essential to secure financing.

D **Instruments to mitigate compliance, performance and financing risks of FOAK e-SAF plants** – Without adequate mitigation of project risks associated with FOAK e-SAF plants, projects are unable to secure financing. On compliance risks, clear long-term e-SAF production criteria (e.g. eligible renewable electricity and captured CO_2 feedstocks) across Europe are crucial. Performance and financing risks need to be distributed appropriately between producers, technology licensors, engineering, procurement and construction providers (EPCs), and public finance organisations (e.g. European and national investment banks or export credit agencies). Designing inherently robust FOAK projects by taking supplemental risk-mitigation measures is critical to seeding the industry and creating proof points for the follow-on wave of projects.

The sections below describe the options that could be explored to enable these four levers.

A

Regulatory certainty on e-SAF mandates

While the EU's e-SAF mandates are clear and legally binding since 2024, perceived regulatory uncertainty[23] forms a barrier to FIDs – in addition to the others listed in this section. While a review of the ReFuelEU Aviation regulation is planned in 2027, this does not oblige the European Commission to open it up for revision. The review process will evaluate the evolution of the aviation fuels market[24], as shown in Exhibit 10. In line with their legal obligation, Member States should provide clarity on penalty systems (foremost absolute penalty levels) by the end of 2024.

23 Some parties fear that a supply shortage will lead to a revision of ReFuelEU Aviation by 2027. The perception of regulatory uncertainty is driven by the precedent of potentially changing regulations in other sectors, e.g. CO2 emission standards for cars.

24 The reporting and review obligation of the Commission within Article 17 of ReFuelEU Aviation, however, follows standard EU review processes as provided in the Better Regulation. Article 17 of ReFuelEU Aviation foresees a regular review of ReFuelEU Aviation, starting with a report by 1 Jan 2027 and every four years thereafter.

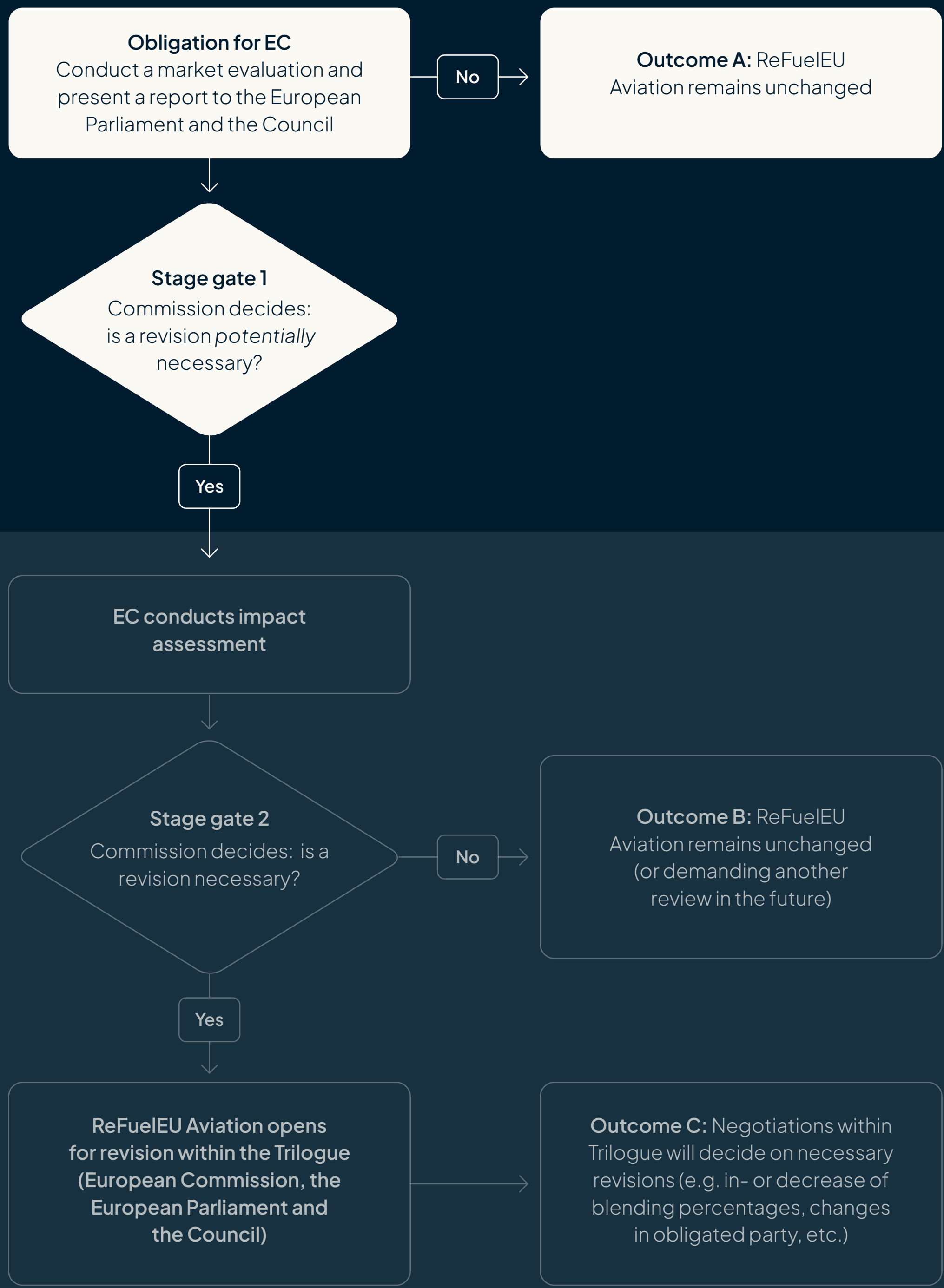
Exhibit 10

The European Commission is obliged to *review*, not necessarily *revise* the ReFuelEU Aviation regulation in 2027

Review process of ReFuelEU Aviation by the European Commission in 2027, with potential outcomes

2027: European Commission has only the obligation to **review** ReFuelEU Aviation

Process, if – and only if – the European Commission decides to open up ReFuelEU Aviation for **revision**



Notes: For the official text on evaluations, please refer to Article 17 of ReFuelEU Aviation and the European Commission's guidelines on Better Regulation.

B

Effective and adequately capitalised public subsidisation schemes

A production cost difference between European and US e-SAF developers of EUR 1,000–4,000 per tonne is expected. Driven by lower power prices, particularly due to low grid fees, higher renewables capacity, and most notably, high subsidies resulting from the Inflation Reduction Act (IRA). e-SAF production in the US is expected to cost EUR ~4,000 per tonne in 2030.[25] Assuming production is compliant with European e-SAF production criteria, this compares to EUR 5,000-EUR 8,000 per tonne in Europe (Exhibit 11). The contribution of transport costs for imports from the US to Europe is marginal.

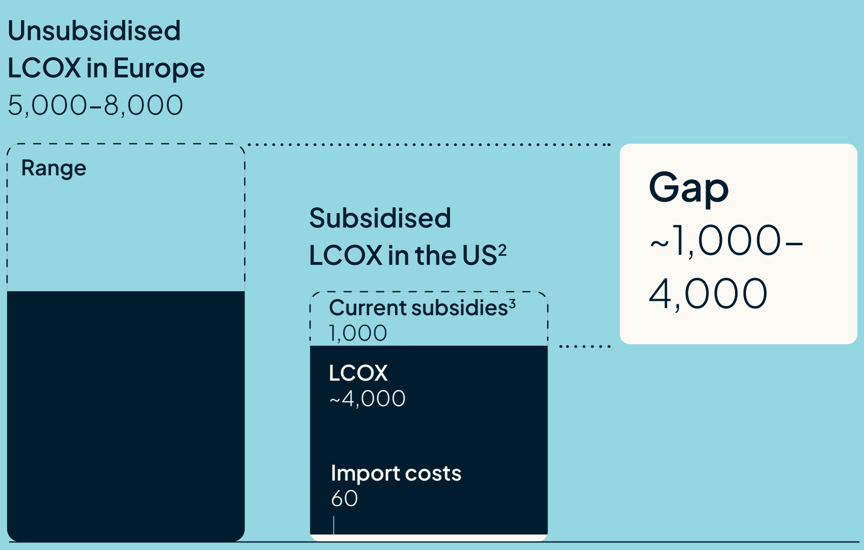
In their current form, existing EU and national-level support instruments are insufficient to bridge the gap to US production costs. Several funding instruments exist both at the EU and national levels to support the ReFuelEU Aviation mandate. Yet,

25 With ~EUR 850 per tonne e-fuels subsidy from 45V credits (based on a tax credit of USD 3 per kg hydrogen provided to an e-SAF project for the first 10 years of operation, and a hydrogen demand of ~0.5 kg hydrogen per kg e-fuels) and ~EUR 150 per tonne e-fuels subsidy from 45Q credits (based on a tax credit of USD 60 per tonne of captured CO_2, provided for 12 years of operation), assuming the parties receiving the 45V and Q credits are two separate entities, as required.

Exhibit 11

To compete with US-based production, public support must bridge a levelised cost gap of ~EUR 1,000–4,000 per tonne e-SAF

Levelised cost of e-SAF produced in Europe vs. the US[1], EUR per tonne (note all figures are rounded)



Assumptions

- **Assumes identical CAPEX** requirements in the US as in Europe, and the same prices for biogenic CO_2, of EUR 165 per tonne.
- **Renewable electricity prices** of EUR 50 per MWh are assumed for the US compared to EUR 55–120 per MWh in Europe
- **In the US, e-SAF is eligible for 45V credits** and, in this case, is assumed to purchase CO_2 from a separate entity receiving **45Q credits**

Notes: 1 Assuming RWGS-FT process. **2** Indicative high-level analysis assuming similar capital requirements to Europe. Renewable electricity PPA prices incl. levies are assumed at USD 55-70 per MWh with ~EUR 850 per tonne e-fuels subsidy from 45V credits (based on a tax credit of USD **3** per kg hydrogen provided to an e-SAF project for the first 10 years of operation, and a hydrogen demand of ~0.5 kg hydrogen per kg e-fuels) and ~EUR 150 per tonne e-fuels subsidy from 45Q credits (based on a tax credit of USD 60 per tonne of captured CO_2, provided for 12 years of operation), assuming the parties receiving the 45V and Q credits are two separate entities, as required. **Sources:** Sustainable Aviation Fuel Credit; Panteia (2021), Cost Figures for Freight Transport – final report; Energy Tax Directive 2003/96/EC.

Exhibit 12

Public support mechanisms are inadequately capitalised and not sufficiently accessible to e-SAF projects

Attractiveness for bankability of FOAK e-SAF plants:

High · Medium · Low

	Awardee	Share of green premium covered	Accessibility for e-SAF (vs other sectors)	Payout schedule	Current capitalisation	
EU Innovation Fund	Fuel producer	**Medium** – up to 60% of NPV differential to fossil	**Medium** – five selection criteria[1]	Max. 10 years	**High** – ~EUR 40 bn	**Existing EU-level funding**
EU Hydrogen Bank	Hydrogen producer	**Low** – first auctions yielded a subsidy of < € 0.5 /kg H_2	**Low** – strong focus on price	Max. 10 years	**Medium** – EUR 3 bn. Can be topped up by Member States but subject to State Aid rules	
SAF Allowances	Airline	**High** – 95% or 100% of green premium	**High** – but competing w. bio-SAF & first-come-first-serve	1 year	**Low** – ~EUR 1.6 bn – with a high potential increase by 2027. Not subject to State Aid rules	
H2 Global-type auctions	Fuel producer and airline	**High** – up to 100% of green premium	**High**	10 years	**Medium** – ~EUR 4 bn (currently). Funded by Member States but subject to State Aid rules	**Instruments to enable state aid**
IPCEI	H2 Value Chain	**High** – up to 100% of green premium	**Low** – dependent on project initiation by Member States	Project specific schedules	**Medium** – ~EUR 18.9 bn from State Aid for existing H2 IPCEI	
Advanced Fuels Fund (closed)	Fuel producer	**Low** – max. awarded grant £12 mn (mainly for FEED funding)	**Medium** – six PtL projects awarded funding amounting to 20% of total funds	One-off grant	**Low (funding closed)** – GBP 165 mn across windows 1 and 2 and all funds are already allocated. No indication of future funding rounds.	**UK level funding**
Revenue certainty mechanism (upcoming in 2026/2027)	Fuel producer	**High** – up to 100% of green premium	**High** – likely only accessible to advanced bio SAF and e-SAF	Yearly (expected for 12–15 years)	TBD	

Notes: 1 Effectiveness of greenhouse gas emissions avoidance, degree of innovation, project maturity, replicability, cost efficiency. **Sources:** European Hydrogen Bank auction provides €720 mn for renewable hydrogen production in Europe (2024); Official Journal of the European Union (2023); Official Journal of the European Union (2024); H2Global Stiftung; European Commission (2024) none of them are sufficiently accessible to e-SAF or adequately capitalised to bridge the premium of FOAK e-SAF projects, e.g. to match US production cost levels. Exhibit 12 provides an overview of existing support instruments available to projects in Europe, highlighting the elements that would need to be restructured to effectively support e-SAF projects.

Different layers of public funding are needed to get the first wave of e-SAF projects off the ground – spanning the full development cycle. Development Expenditure support is required to de-risk e-SAF project development (e.g. at least EUR 10–15 mn per project to de-risk FEED studies which require EUR 40–60 mn). CAPEX support is required to de-risk investment, reduce financing costs and ensure the plants are built. OPEX support could further create revenue certainty and enable offtake agreements (if confirmation of funding can be secured prior to FID). To bring European e-SAF projects in line with US production costs, CAPEX/ OPEX support in the order of EUR 400–600 mn per project would be required, but a higher willingness-to-pay from offtakers could reduce this.[26]

In the EU, ETS allowances for uptake of SAF (hereinafter referred to as SAF Allowances) can be the most impactful funding instrument from 2027. However, there is a funding gap in the near term (2025/2026) that could be bridged. To fill that gap, the EU Innovation Fund could be leveraged to effectively bridge part of the current cost premium of e-SAF (vs fossil jet fuel), covering 60% of the NPV differential to bankability. From 2027, restructured, 10-year dedicated 'e-SAF Allowances' could become the primary mechanism for long-term revenue certainty. Within the next year, an adjustment of award criteria or, if possible, a dedicated e-SAF call from the EU Innovation Fund would increase the accessibility of funds for e-SAF projects, which are intended to cover up to 60% of the NPV differential with fossil-based alternatives.[27] The EU Innovation Fund has awarded e-SAF projects in previous calls including Nordic Electrofuel's e-fuel pilot project,[xix] as well as the Shell and Vattenfall-led HySkies project, which has since been paused, and BioOstrand in Sweden – indicating that e-SAF projects can be eligible for this type of funding. The European Hydrogen Bank could also provide OPEX subsidies, but e-SAF specific tenders would be required due to strong competition with other eligible technologies. Beyond these two mechanisms, SAF Allowances could support bankability of e-SAF projects from 2027 onwards. SAF Allowances are a welcome support mechanism for airlines to bridge part of their (e-)SAF costs incurred on their inter-EU flights. In 2026, the European Commission will evaluate the effectiveness of the EU ETS,[xx] providing an opportunity for restructuring SAF Allowances from 2027 onwards. SAF allowances could unlock the first wave of e-SAF projects if two adjustments were made: an increase in the number of SAF Allowances beyond 2030 dedicated to e-SAF (e.g. by creating 'e-SAF Allowances'), and provide 10-year instead of annual allocations.[28] Exhibit 13 illustrates the extent to which the instruments in their current design can bridge the cost gap with production in the US, compared to the potential that could be realised by implementing the recommended restructuring.

The most powerful tool for national governments to provide complementary support to domestic production would be the funding of a H2Global-type mechanism – i.e. a capitalised market intermediary with double-sided auctions and a contracts-for-difference mechanism – or topping up SAF Allowances. Several national governments in Europe have introduced subsidies that are, in theory, accessible to e-SAF producers (see Annex B

26 The comparison to US-based production serves for the purpose of providing a benchmark for a geography where we have seen investments and offtake agreements, based on considerable de-risking of FOAK projects through the US Inflation Reduction Act. However, the range of EUR 400-600mn to close the gap to the US is not necessarily describing what public funding is required in the EU, given a different regulatory environment (with ReFuelEU Aviation and SAF Allowances in the EU, and the SAF mandate and the revenue certainty mechanism in the UK).

27 As the EU Innovation Fund is not set up to provide support for individual end use sectors, a dedicated e-SAF call may be challenging. In contrast, certain changes to the five award criteria (effectiveness of greenhouse gas emissions avoidance, degree of innovation, project maturity, replicability, cost efficiency), in particular to the cost efficiency criterium, could enhance the accessibility of EU Innovation Fund funding for e-SAF projects. In order to avoid the administrative burden of applying for EU Innovation Fund support, a two-step approach could be considered in which only pre-selected projects are encouraged to develop a full application.

28 Project SkyPower's engagement with the aviation and energy industry in Europe showed that the duration of SAF Allowances (i.e. being provided for 10+ years) emerged as more important than the level of funding (i.e. that less than the current 95-100% of the premium could be covered if SAF Allowances would be given out for 10+ years).

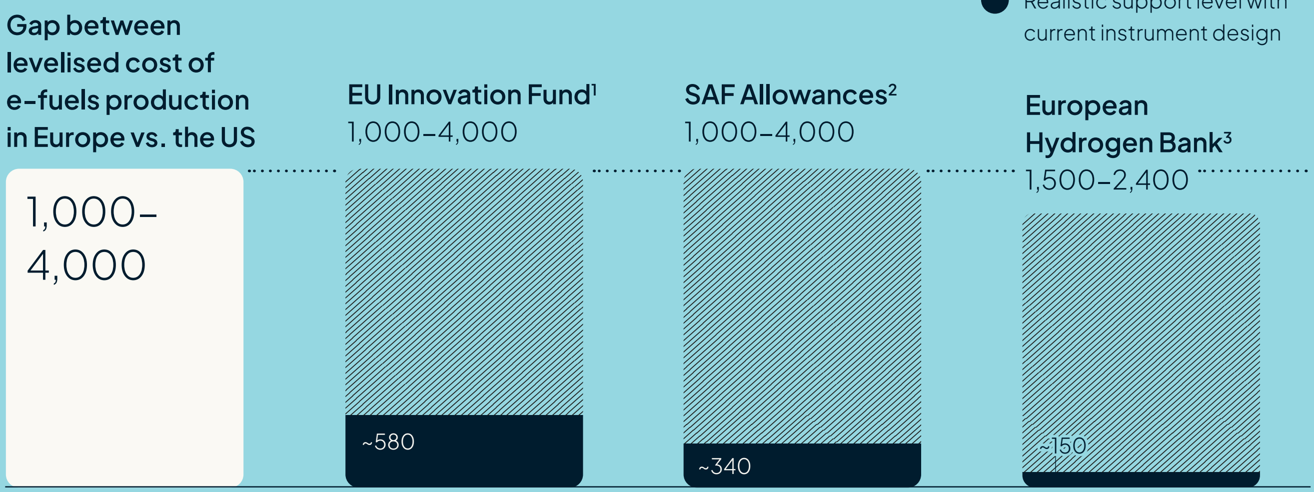
for details). However, existing subsidies are typically inadequately capitalised and difficult to obtain given incompatible selection criteria. Upcoming schemes that could be effective are the Danish passenger tax (averaging around EUR 14 per passenger, provided the raised funds will be earmarked for aviation decarbonisation efforts) and the French contract-for-difference (CfD) scheme under the National H2 strategy (although not confirmed to date). Member States that see e-SAF as a strategic opportunity and national priority could provide such funding to regional e-SAF projects e.g. via the H2Global mechanism or by topping up EU-level funding, e.g. SAF Allowances, through national ETS revenues from the aviation sector.

While the mechanisms discussed above would support CAPEX or OPEX of e-SAF projects, there is an additional need for DEVEX support. To advance more e-SAF projects towards FID, grants in the order of EUR 10–15 mn each could offer catalytic capital in early project development stages to co-fund FEED studies. Conducting feasibility and FEED studies are significant investments of EUR 40–60 mn, made pre-FID. Another example of DEVEX investments is

Exhibit 13

While existing public support in the EU is insufficient, current policy instruments can be restructured to bridge the gap vs. the US

Range of European public support mechanisms which could be leveraged to bridge the cost gap to the US, EUR per tonne



Recommended restructuring of support mechanism to unlock their full potential for e-SAF:	**Adapt selection criteria for e-SAF projects** and ensure 60% coverage of NPV differential, requiring ticket sizes of at least EUR 400 mn	**Increase capitalisation** (potentially with Member State top-ups) **and change to multi-year allocations**	**Organise e-SAF specific tenders** to increase offtake clearing price to **~EUR 5–8/kg** for 10 years

Notes: 1 assumes a EUR 200 mn grant as realistic, and a EUR 0.4-1 bn grant for max. support level required. **2** Assumes SAF Allowances cover ~EUR 5,000 per tonne i.e. 95% of the cost differential with fossil jet fuel over 10 years – for max. support level; instead of one year, in the realistic support case **3** Assumes EUR 1.1 per kg H_2 in the realistic case and EUR 6-8 per kg H_2 in max support case. **Sources:** European Hydrogen Bank auction provides €720 mn for renewable hydrogen production in Europe (2024); Official Journal of the European Union (2023); Official Journal of the European Union (2024); H2Global Stiftung; European Commission (2024); Danish Energy Agency (DEA) (2023); DEA Power-to-X Tender (2023); DEA CCUS Fund (2024).

securing grid connections. Given a considerable risk of projects falling through, equity is difficult to secure at this stage. Grants can play a vital role in enabling initial project development. Existing programs include the UK Advanced Fuels Fund (up to GBP 12 mn per project, now closed), the French FEED Call for SAF (up to 80% of FEED study costs) and the Swedish Industrial Leap (up to EUR 13 mn per project, to date).

In the UK, the upcoming revenue certainty mechanism (RCM) will be the major instrument used to provide support to domestic e-SAF projects via industry-generated revenues. This mechanism aims to cover the premium for an expected period of 12–15 years. Additional support prior to the RCM e.g. in the form of catalytic grants for project development, as was provided by the Advanced Fuels Fund, would support the announcement of more projects, as there is currently only one large-scale e-SAF project planned in the UK today.

C

Bankable 10+year offtake commitments at the required premiums

Offtake models must manage risks on the side of the offtaker (i.e. future market price risk and supply volume risk) as well as the producer (i.e. revenue and credit risks). Offtakers prefer short-term contracts to reduce future price risk and supply volume risk. Meanwhile, producers and financiers require long-term offtake contracts with creditworthy offtakers to ensure revenue certainty and bankability for the project. Creditworthiness is relevant in the case of offtake from airlines, but to a lesser extent in the case of fuel suppliers, traders and aircraft lessors, with larger balance sheets and higher credit ratings. Fuel suppliers, as the obligated party, should therefore play a significant role in establishing these offtake agreements. Contradictory interests (i.e. short vs long tenures) currently hinder conventional, direct offtake agreements.

Alternative offtake models such as offtake via a capitalised market intermediary or collective/ diversified offtake, could reduce the level of risk carried by any single offtaker, transferring the risk to another party or distributing it between multiple offtakers. Yet, in each of these models the physical flow of fuel should be a key design consideration.

A market intermediary can allow for asymmetrical contracts, with shorter tenures on the offtake side e.g. a H2Global-type mechanism. If the intermediary is capitalised with public funding e.g. from the revenues collected via penalties or from other existing industry-generated tax revenues, the gap between the maximum offtake and minimum selling price yielded through a double-sided (supply and offtake) auction can be bridged via a CfD-like mechanism.[29] In this case, the government-funded intermediary acts as the counterparty for both the offtaker and the supplier of e-SAF, which covers all credit risk for the producer and future price risk for the offtaker. The H2Global e-SAF pilot auction launched at the end of 2022. Two key insights emerged from the bidding process:[xxi] First, larger lots (i.e. contract value and duration) will be needed to ensure the success of future auctions, such that the e-SAF project can benefit from sufficient economies of scale. Second, GHG savings allocation rules could be reconsidered, since proportional rather than flexible allocation of GHG savings across end products (as currently required by the EU's Delegated Acts of RED II) can hinder the economic viability of e-SAF production in an upgraded existing Fischer-Tropsch plant.

Even without an intermediary, other models can allow for multiple parties on one or both sides (supply and offtake). On the demand side, a collective offtake model could syndicate demand from multiple offtakers (incl. tier 2/3 airlines) to reduce the premium and risks carried by any single offtaker. Collective offtake commitments should be designed and vetted in line with pro-competitive objectives and stimulate both competition and innovation in the market, which will lead to adoption certainty and industry wide benefits. With multiple offtakers, joint and several commitments from the group of offtakers would be required and the credit risk would be the sum of individual risks—each needing to be evaluated separately—rather than an average, posing a challenge to investors. On the supply side, a diversified offtake model could pool supply from multiple plants to reduce volume and technology performance risk. This could be facilitated through a common fund with access to e-SAF volumes from a variety of producers and plants. This would address a key concern voiced by offtakers, i.e. their limited in-house expertise (e.g. of tier 2/3 airlines) and the high risk involved with assessing and selecting individual e-SAF projects to enter agreements with.

Alternatively, project developers can offer incentives to reduce the future price risk faced by the offtakers e.g. by providing drawing rights to e-SAF supply from future plants. This is beneficial in a scenario with declining production costs, and a forecast short market.

Early adopters of e-SAF could be found in certain offtake segments of end customers and of aircraft operators. Premium customers and the public sector could be interested in purchasing e-SAF as shown in Exhibit 15, to support initial investments, and the

29 A CfD-like mechanism would not be intended to cover the full price differential between e-SAF and fossil jet fuel, as the mandates intend to level the playing field via penalties and via carbon pricing on ETSs.

scale-up of e-SAF, covering a higher proportion of the premium. In addition, self-supplying aircraft operators and freight forwarders operating their own fleets are in a strong value chain position to avoid reliance on a third-party supplier. Freight forwarders and cargo owners could potentially (partially) compensate premium costs in aviation with other, easier-to-abate transportation modes such as road freight. Furthermore, aircraft lessors could tie e-SAF offtake agreements to their aircraft leases and support e-SAF investment cases with their usually high credit rating.

E-SAF producers and airlines could consider engaging premium customer segments with a high willingness to support the purchase of e-SAF. Demand from this segment in Europe totals ~2.5 Mtpa from fuel for business and charter aviation and another ~11 Mtpa fuel[30] from premium customers of commercial aviation (e.g. first and business class). These segments are understood to be less sensitive to increases in fuel costs compared to standard economy passengers given that fuel account for a lower proportion of the end ticket price. Corporate customers often also have an interest in reducing their Scope 3 emissions from flying, e.g. to achieve SBTi targets. Private jet users, in turn, often have a significant incentive to invest in e-SAF to mitigate their climate impact and avoid public scrutiny. These customers could reduce the climate impact of their frequent flying by purchasing e-SAF volumes to cover their flights, contributing to

30 Estimate based on premium seating being responsible for 19% of commercial aviation (i.e. passenger and freight) emissions in 2019, according to the ICCT (2020).

Exhibit 14

To minimise price risk, collective offtake models or a capitalised market intermediary could be explored

Options for offtake models, non-exhaustive

Model	Annual e-SAF supply to airline, ktpa	Avg. annual premium for airline 1 assuming no subsidy, mn EUR	Contract duration	Price risk per party
Direct offtake (1:1 contract, or trilateral contract incl. supplier)	50	250	10 years	High
Administrative market intermediary	50	250	2 years	
Diversified offtake (pooled supply)	Producer 1, Producer 2, Producer 3: 50	Producer 1, Producer 2, Producer 3: 250	10 years	
Collective offtake (demand syndication)[1]	Airline 1, Airline 2, Airline 3: 50	Airline 1, Airline 2, Airline 3: 250	10 years	
Capitalised market intermediary (assuming 80% of green premium covered)	50	50	2 years	Low

Note: 1 Structured in compliance with joint purchasing and offtake rules that ensure alignment with anti-trust parameters.

scaling the technology and unlocking cost efficiencies in e-SAF production.

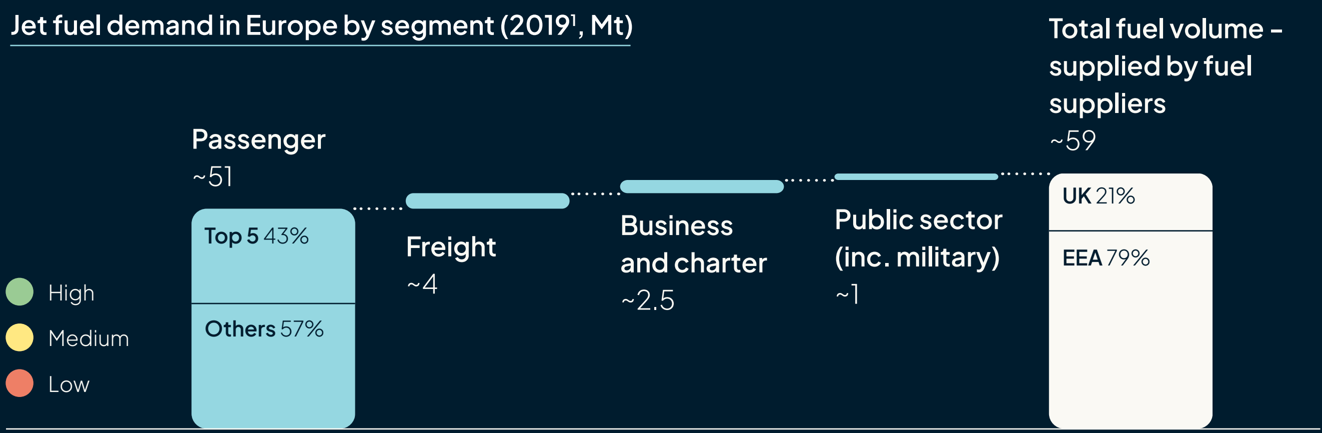
Innovative models to leverage demand from premium customers through crowdfunding, as well as cost pass-through models could be explored. Voluntary financial contributions from passengers could be in the form of large-ticket investments in a diversified e-SAF plant fund as a part of the customer journey. Alternatively, we are seeing large airlines including the Lufthansa and Air France-KLM Groups,[xxii] introducing mandatory ticket price increases in the absence of sufficient voluntary contributions.

The public sector could set an example by buying e-SAF for flights by government officials as well as the military. Given many European governments have high credit ratings, long-term public procurement of e-SAF could help de-risk FOAK plants. In addition, it would signal to potential offtakers that national policy is aligned with EU policy.

Exhibit 15

Premium segments and public sector are well-positioned to be early adopters, but airlines/ freight are needed for larger volumes

Jet fuel demand in Europe by segment (2019[1], Mt)



	Passenger	Freight	Business and charter	Public sector (inc. military)	Total fuel volume – supplied by fuel suppliers
Level of consolidation	**Fragmented** but top 5 have ~40% of total volume	**Fragmented**	**Fragmented**	**Consolidated** at national level	**Highly consolidated,** 3 major suppliers
Motivation to pay	**Depends on segment and route**	**Low proportion of end product cost** depending on product type	**High margin**	**National interest,** energy security	**High**, as fuel suppliers are the obligated party
Impact on bankability	**Volatile industry and low margin**	High margin and **diversified**	**Low risk**; strong creditworthiness	**Low risk**; strong creditworthiness	**Low risk**; strong creditworthiness

Notes: 1 Fuel demands from top 5 airlines are based on 2023 data. **Sources:** IAG Analysis (2024); EASA (2023), European Aviation Environmental Report 2022; UK DfT (2023), Sustainable Aviation Fuels Mandate; Systemiq analysis; estimations.

D

Mitigation of first-of-a-kind project risks

De-risking e-SAF projects is critical to secure investments. This entails (i) ensuring that the project is compliant with e-SAF production criteria (e.g. eligible electricity and CO_2 feedstock) throughout its lifetime, (ii) establishing a risk-sharing model with governments to manage project-on-project risk and carry part of the performance risk for FOAK plants, and (iii) ensuring access to key financial de-risking instruments.

Firstly, adequate public support and guidance must be provided for e-SAF projects to comply with production criteria; and compliance must be guaranteed over the project's lifetime. The stringent regulation around additionality, temporal correlation, and geographic correlation of renewable electricity feedstocks (via the Delegated Act of RED II[xxiii]) has created different power system archetypes[xxiv] (Exhibit 16). As a result, regulation favours e-SAF projects in countries like Norway and Sweden, where the grid is over 90% renewable by 2030. However, in other countries power regulation makes a project's economic viability challenging.[31] Policymakers in these countries can help ease regulatory barriers, scale additional renewables, and bring down the cost of power, e.g. with tax/fee exemptions and dedicated auctions. Scaling additional renewables for hydrogen (derivative) production will likely need to go hand-in-hand with grid expansions and investments in renewable energy storage. The second Delegated Act for the production of renewable fuels of non-biological origin specifies the eligibility of different captured CO_2 sources. Where individual countries are supporting the scale-up of CCS infrastructure, it should be ensured that CCU[32] projects (e.g. using captured CO_2 within e-SAF projects) have equal access to CO_2 capture, transport and logistics infrastructure as CCS projects. To ensure long-term economic viability for FOAK e-SAF plants, any future modifications to production standards (on the eligibility of renewable power and captured CO_2) should be accompanied by grandfathering provisions. Grandfathering principles can protect investors and offtakers from the risk of future changes to production criteria.

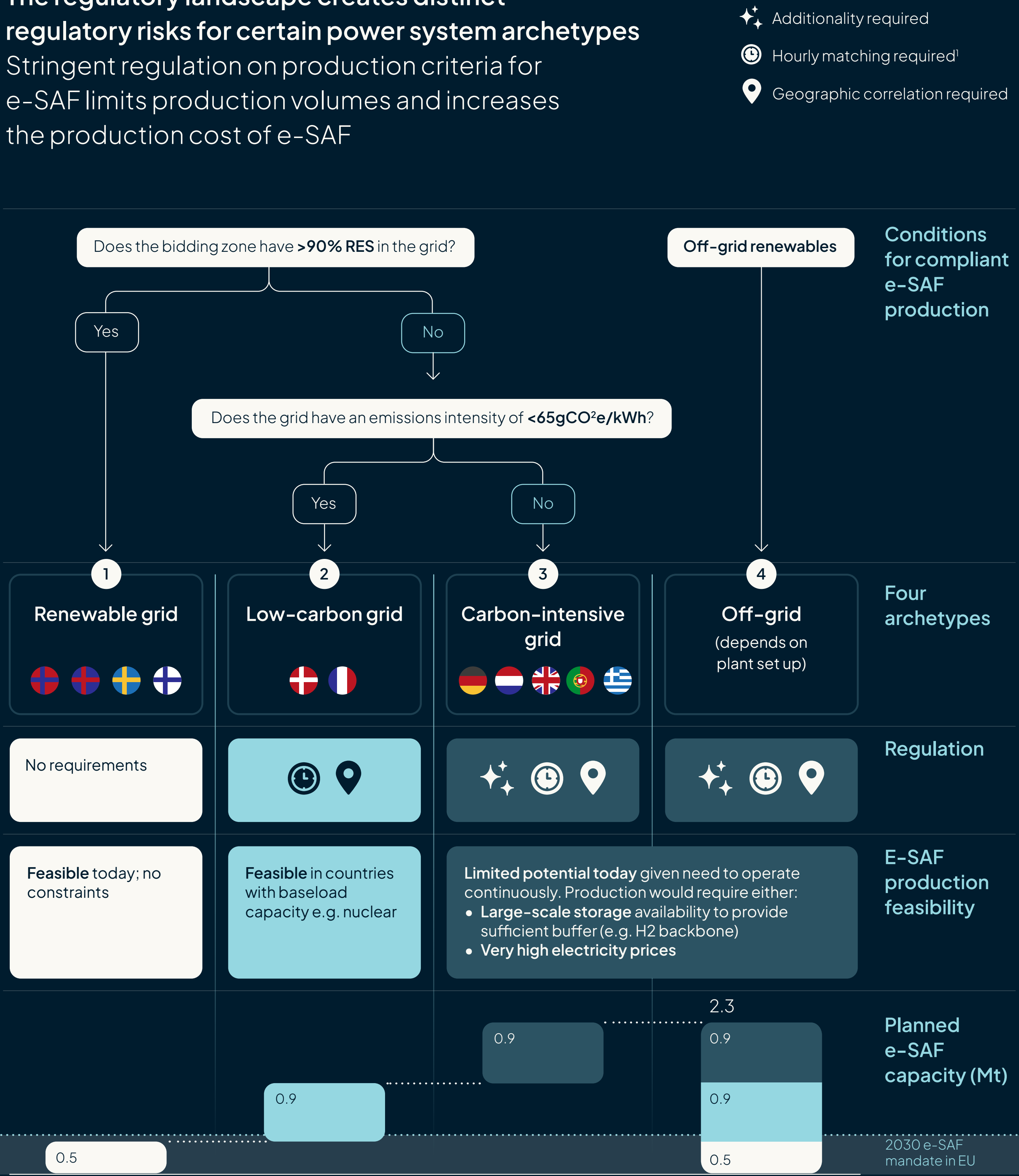
31 As a result, a recent letter by Germany's Minister for Economic Affairs and Climate Action, Robert Habeck, in September 2024, called for the extension of the phase-in period for additionality set out in the Delegated Act until 2035, and the phase-in period for the temporal correlation until 2030.

32 carbon capture and utilisation (CCU) vs carbon capture and storage (CCS)

Exhibit 16

The regulatory landscape creates distinct regulatory risks for certain power system archetypes

Stringent regulation on production criteria for e-SAF limits production volumes and increases the production cost of e-SAF



Note: 1 for the UK, temporal correlation is required in a 30-minute period vs. hourly matching required in the EU after 2030.

Secondly, to manage the considerable performance risks associated with FOAK e-SAF plants, risk sharing with government entities through financial guarantees will be critical. EPC providers are not positioned to manage FOAK performance risk via full EPC wraps given the nascency of end-to-end e-SAF technology, and technology performance guarantees from technology providers only cover a small proportion of the total CAPEX. To address this, public finance organisations can provide guarantees that provide debt protection through the commissioning phase of a project, mitigating performance risk. Such instruments could be complemented by private sector insurance, though the premium costs are significant.

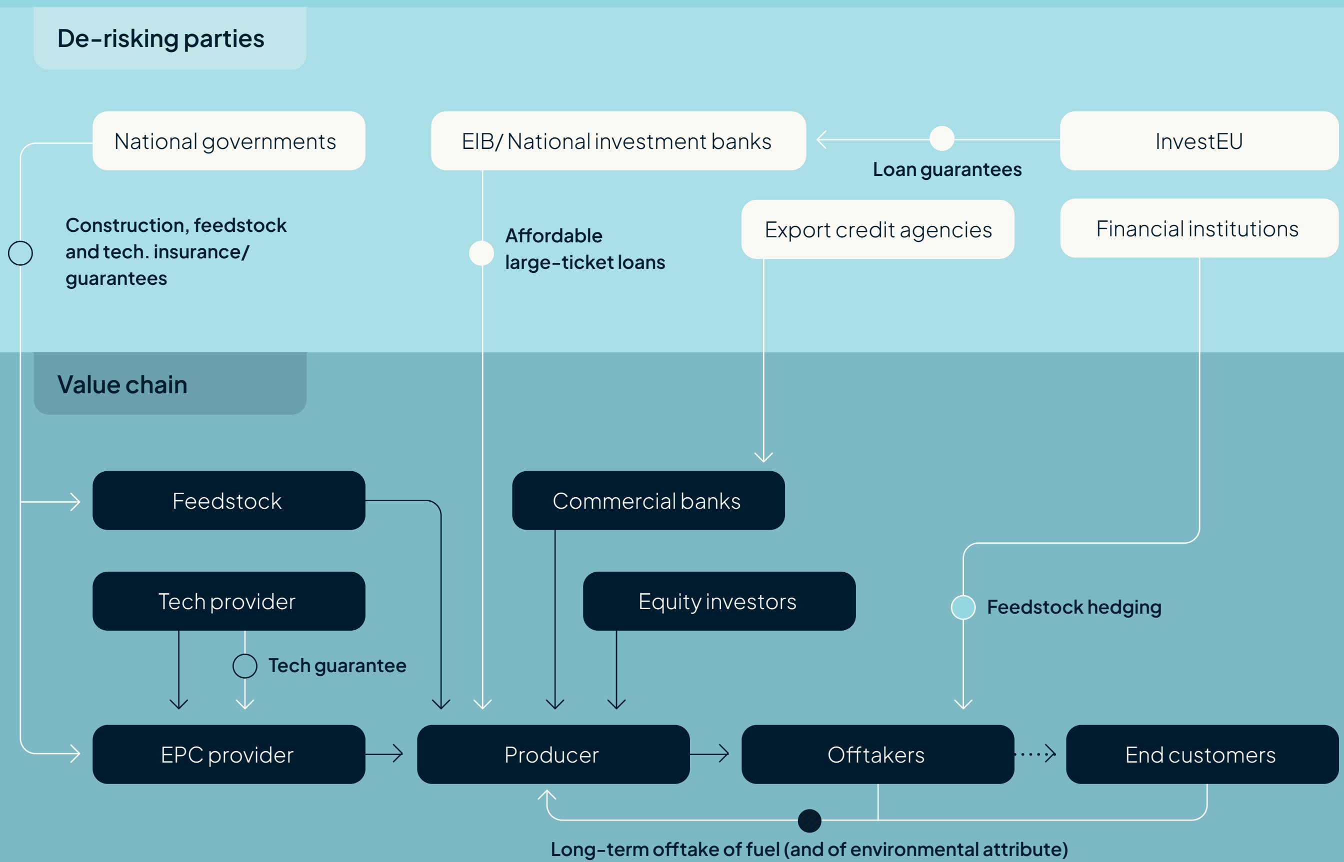
Exhibit 17

FOAK e-SAF plants require involvement of the EIB, export credit agencies and national govs. to sufficiently mitigate all key risks

→ Provision of product/service
→ Provision of de-risking product
■ Value chain player/ investor
□ De-risking party

Type of risk addressed:
○ Tech. and construction risk
○ Feedstock risk
● Revenue and market risk
○ Financing risks

An example of an ideal set-up for the risk mitigation of a FOAK e-SAF plant

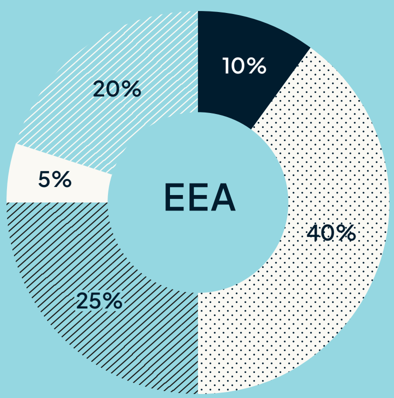


Thirdly, mitigation of high financing risks, resulting from the majority of developers being small and medium-sized enterprises with relatively modest balance sheets, requires involvement of public finance organisations. Accessible and affordable loans from the European Investment Bank (EIB) or UK Infrastructure Bank (rebranded November 2024 as the National Wealth Fund (NWF)) and/or other national investment banks are instrumental in raising funds for EUR 1–2 bn projects. These loans lower the amount of debt that needs to be provided by commercial banks. Additionally, involvement of the EIB or NWF provides a 'stamp of approval', indicating a high level of due diligence, further de-risking investment for commercial lenders. Loan guarantees from institutions such as InvestEU help unlock larger ticket sizes from banks. In addition, guarantees from export credit agencies (ECAs), such as UK Export Finance (UKEF), covering up to 80% of a loan could reduce credit risk to sufficient levels for commercial debt providers to follow.

Exhibit 18

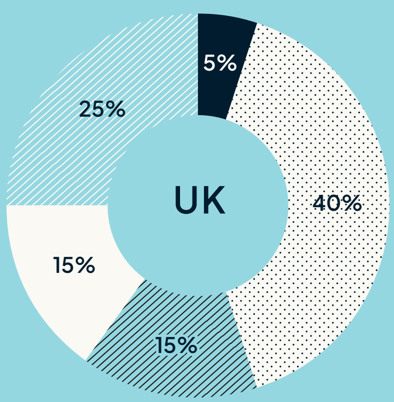
Financing FOAK e-SAF plants requires a combination of high-risk equity, grants, and debt backed by guarantees

Illustrative financing of a 50–70 ktpa FOAK e-SAF plant in Europe



Total EUR 1–2 bn

- **Gov. grant** of ~EUR 100–200 mn
- **High-risk equity** for ~EUR 400–800 mn
- **EIB loan** for 50% of debt ~EUR 250–500 mn
- **National investment bank loan** for ~EUR 50–100 mn
- **Commercial debt** for ~EUR 200–400 mn – 80% backed by ECAs



Total GBP 1–2 bn

- **Gov. grant** of GBP ~50–100 mn
- **High-risk equity** for GBP ~400–800 mn
- **NWF loan** for ~30% of debt GBP ~150–300 mn
- **UKEF loan** for GBP ~150–300 mn
- **Commercial debt** for GBP ~250–500 mn

Key requirements

1. Grant funding for ~5-10% of capital required to act as catalytic capital.
2. High-risk equity for ~40% of the total capital required to reduce debt requirements.
3. Accessible and affordable loans from EIB, national banks, UK National Wealth Fund and UKEF to reduce the cost of capital.
4. Involvement of government entities e.g. EIB, NWF and UKEF to build investor confidence, providing stamp of approval and unlocking capital from commercial banks.
5. Loan guarantees from InvestEU[1], and ECAs including UKEF to unlock larger ticket sizes from the EIB and EIFO through 50/50 risk sharing, and covering 80% of the loan reducing the credit risk to sufficient levels for debt providers to come in.

Notes: 1 InvestEU is a guarantee of EUR 26.2 bn included in the EU multi-annual budget to support investments of the EIB (main partner) and other financial partners via (full or partial) guarantees, selecting investments contributing to key EU policy priorities, e.g. sustainable transport.

3.3 Required solution sets in selected countries

While the high-level approach to creating bankable FOAK e-SAF projects can be applied to any country across Europe, the specific combination of solutions employed will come down to the local e-SAF plant techno-economics (incl. factors such as power price) and the national public support environment.

The figures below show how the levers described in the previous section can bridge the differential between a baseline (NPV-negative) case, with no subsidy support and a willingness to pay from the private sector that is equivalent to current HEFA market price, and a viable NPV-positive case.

The shown solution sets are illustrative ways on how to get to bankability, chosen by the feasibility of being implemented in the near-term. Other levers (e.g. other funding instruments than the proposed ones) could also lead to bankability.

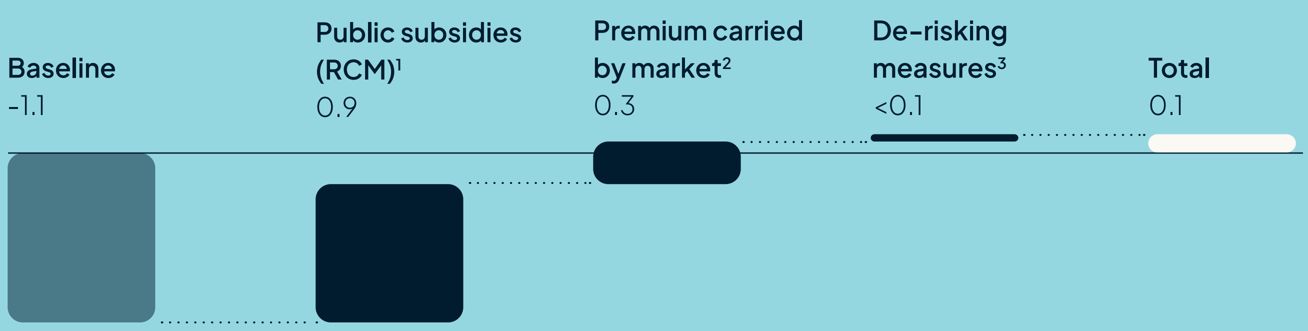
Required solutions in the UK

In the UK, to get to FID, FOAK e-SAF plants need (i) regulatory certainty via the mandates, (ii) revenue certainty, through the introduction of a Revenue Certainty Mechanism (RCM) by the UK Government, and (iii) mitigation of high compliance, performance and financing risks.

Exhibit 19.1

In the UK, the RCM will be the key lever to bridge the NPV differential, in addition to a potentially higher market price for e-SAF

The estimated impact of different levers on the NPV of 50 ktpa e-SAF plant in the UK, GBP bn



Proportion of NPV bridged:	~75%	~20%	<5%	**Bankable project with IRR of ~15%**
Assumptions:	Revenue certainty mechanism, with support for ~15 years	Assuming a market price of GBP ~3,500 per tonne e-SAF (equivalent to estimated US-based production costs)	Cost of debt reduced from 9% to 8%	

Notes: 1 Assuming revenue support for 15 years with GSP of GBP ~7,000-8,000 per tonne; higher than LCOX because assumed that it is not provided for full lifetime of plant and because e-SAF only makes up ~85% of the products hence higher e-SAF support required to reduce the over per tonne of e-fuel cost. **2** Assuming a willingness to pay of GBP ~3,500 per tonne. **3** Assuming a reduction of the cost of debt by 1%..

Firstly, regulatory certainty via legislated mandates is critical to enable investor confidence. The UK SAF Mandate recently passed the House of Commons and is expected to pass through the House of Lords before the end of 2024. The mandate will begin on 1 January 2025.

Secondly, revenue certainty will be essential to achieving FID, through a Revenue Certainty Mechanism (RCM) which the UK Government has committed to introduce by the end of 2026. This public support will enable UK-based production to compete with subsidised e-SAF imports from the US. To bridge the levelised cost gap – currently around GBP 3,000–3,500 per tonne – the RCM strike price will need to reflect the high levelised cost, potentially exceeding the current mandate buy-out price of GBP 6,250 per tonne. If the RCM is to effectively support e-SAF projects, its design must address this cost discrepancy. Given the RCM will not be introduced until year end 2026, for SAF plants to reach FID prior to this date, interim revenue certainty will be required. This could be achieved through offtake agreements (e.g. take-or-pay) with credible counterparties, potentially in the form of a collective offtake model to mitigate counterparty credit risk, or through dedicated support for the main cost driver of e-SAF: regulation-compliant renewable power.

Thirdly, risk sharing across the capital stack with UK public finance organisations will be vital to mitigate FOAK project risk. Loan guarantees and/or mezzanine loans provided by NWF and/or UKEF, with performance risks shared appropriately between public and private finance, would partially mitigate the risk exposure for project sponsors, EPC firms, and providers of debt capital. This would in turn create a vehicle for crowding in private finance and facilitate a clearer path to FID for the FOAK UK e-SAF projects. Technology performance insurance can also play a role in this risk sharing model.

Required solutions in the EEA

In the European Economic Area (EEA), FOAK e-SAF projects could get to bankability through a combination of three levers: (i) public subsidisation via the EU Innovation Fund and, in the longer term, via restructured SAF Allowances, (ii) long-term offtake agreements and increased willingness to pay from the private sector, and (iii) financing provided by the European Investment Bank (EIB) and national investment banks (NIB), backed by InvestEU as well as commercial loan guarantees from export credit agencies (ECAs).

Firstly, public funding in the order of EUR 400–600 mn per FOAK 50–70 ktpa e-SAF plant (e.g. from the EU Innovation Fund[33]) could ensure cost competitiveness compared with US-based production[34] in the short-term (2025/2026) until the availability of SAF Allowances could be increased.

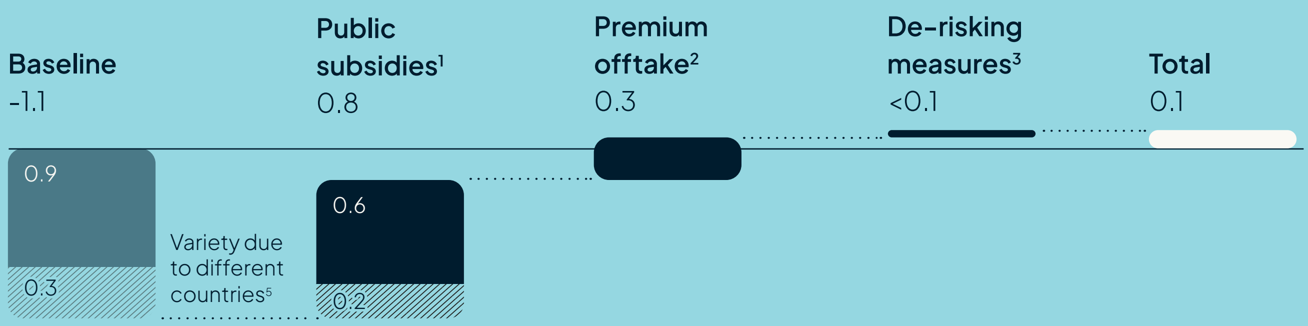
33 The EU Innovation Fund could be made more accessible for e-SAF projects if the award criteria were adapted to the needs of large-scale e-fuel projects. Furthermore, a two-step approach in which only pre-selected e-SAF projects would have to develop a full application could reduce the administrative burden for applicants.

34 The comparison to US-based production serves for the purpose of providing a benchmark for a geography where we have seen investments and offtake agreements, based on considerable de-risking of FOAK projects through the US Inflation Reduction Act. However, the range of EUR 400-600mn to close the gap to the US is not necessarily describing what public funding is required in the EU, given a different regulatory environment (with ReFuelEU Aviation and SAF Allowances in the EU, and the SAF mandate and the revenue certainty mechanism in the UK).

Exhibit 19.2

Public support and premium offtake are required to bridge the premium; the combination depends on market price

The estimated impact of different levers on the NPV of a 50 ktpa e-SAF plant in the EEA[4], EUR bn



Proportion of NPV bridged:	**~60-80%**	**~25-35%**	**<5%**	**Bankable project with IRR of ~15%**
Assumptions:	e.g. ~EUR 450 mn CAPEX subsidy and SAF Allowances for 25-50% of production volume for 10 years	Assuming an acceptable market price of ~EUR 4,000 per tonne e-SAF (equivalent to estimated US-based production costs)	Cost of debt reduced from 9% to 8% through de-risking instruments	

Notes: 1 Assuming a EUR 450 mn grant e.g. from the EU Innovation Fund, and SAF Allowances to cover ~50% of production volume for 10 years with 95% cost differential to fossil jet covered. **2** Assuming a willingness to pay of ~EUR 4,000 per tonne. **3** Assuming a reduction of the cost of debt by 1%. **4** The analysis is carried out for France, Denmark, Norway and Sweden. **5** Higher end of the range includes France and Denmark, lower end of range includes Norway and Sweden.

From 2027, in turn, SAF Allowances could provide revenue certainty, if restructured into 10-year subsidies. While these are considered the most effective EU-level mechanisms to bridge the NPV gap, national-level instruments should also be leveraged to boost domestic production, particularly in the case of Denmark's passenger tax, and France's France 2030 programme, which could provide these countries with a competitive edge. National funding could be used for CAPEX and OPEX support, but also to provide DEVEX support for FEED studies.

Secondly, producers and financiers need binding 10+ year offtake agreements from credit-worthy offtakers (e.g. take-or-pay). This long-term certainty from offtakers to carry a proportion of the premium could bridge 25–35% of the NPV differential.

Thirdly, to enable financing of these projects, FOAK risks must be adequately mitigated. Guarantees are a critical lever to de-risk both equity and debt financing; public guarantees from InvestEU enable higher ticket size from the EIB and NIBs. This, together with commercial loan guarantees from ECAs in e-SAF producing countries or from technology or service-exporting countries, could unlock the commercial debt required to finance projects. Utilising these facilities to carry some of the performance risk during the construction and commissioning phase of project development would reduce the risk exposure of project sponsors, EPC firms, and providers of debt capital, and set e-SAF projects on the path to FID. Technology performance insurance can also play a role in this risk sharing model.

04

Critical actions to achieve 2030 e-SAF targets

A paradigm shift is necessary to achieve 2030 e-SAF targets: policy makers need to scale support from the millions to the billions, offtakers need to sign 10+ year binding offtake agreements to provide revenue certainty, and financiers need to better understand the risks of FOAK e-SAF projects in order to manage them adequately and provide financing.

With a number of e-SAF project setbacks and cancellations this year,[35] it is clear more than ever that we need a fundamentally different approach in which the full value chain and policymakers put their weight behind the European e-SAF industry. The members of Project SkyPower are dedicated to taking the lead in this effort.

4.1 The 10-point action plan

Project SkyPower has aligned on a 10-point action plan that, if implemented, could (i) in the short term, provide a pathway to FID for the first large-scale e-SAF plants in Europe by the end of 2025, and (ii) in the long-run, support the next wave of e-SAF projects and broader scale-up of e-SAF beyond 2030.[36]

Five short-term actions for FOAK projects are required to get to FID in the next year: listed below in order of priority to align with project development timelines.

1. **Ensure regulatory certainty.** In the EU, the current level of ambition in the legally binding e-SAF mandates should be upheld and, in line with their legal obligation, Member States should provide clarity on penalty systems (foremost absolute penalty levels) by the end of 2024. In the UK, mandates should be passed into law and enforced to provide investor certainty. In both regions, FOAK plants should be protected from compliance risks, e.g. through grandfathering principles, to allow potential investors to conduct more complete risk assessments.

2. **Secure public funding commitments via existing industry-generated tax revenues** (e.g. from the ETS). DEVEX support is required to de-risk early-stage e-SAF project development (e.g. EUR 10–15 mn per project to de-risk FEED studies which require a total of EUR 40–60 mn). CAPEX support in the form of grants is required to de-risk equity investments, by providing alternative first-loss capital, and reduce financing costs. OPEX support could further create revenue certainty and enable offtake agreements (if the confirmation of funding can be secured prior to FID). To bring European e-SAF projects in line with US production costs[37] which have the support of the Inflation Reduction Act, CAPEX/ OPEX support in the order of EUR 400–600 mn per 50-70 ktpa e-SAF project would be required, but a higher willingness-to-pay from offtakers could decrease that amount. In the short-term (2025/2026), the most feasible mechanism to provide sufficient

35 A few examples of discontinued projects include Shell's HySkies project in Sweden, Orsted's Green Fuels for Denmark project, and Uniper's SkyFuelH2.

36 The appendix of this report also provides a checklist of additional project-specific requirements (such as permits) to get to FID.

37 The comparison to US-based production serves for the purpose of providing a benchmark for a geography where we have seen investments and offtake agreements, based on considerable de-risking of FOAK projects through the US Inflation Reduction Act. However, the range of EUR 400-600mn to close the gap to the US is not necessarily describing what public funding is required in the EU, given a different regulatory environment (with ReFuelEU Aviation and SAF Allowances in the EU, and the SAF mandate and the revenue certainty mechanism in the UK).

public funding for the first wave of e-SAF projects is the EU Innovation Fund as it provides a degree of flexibility to project developers on how the funds are spent, i.e. before or after start of production. An adjustment in the award criteria[38] or, if possible, a dedicated e-SAF call within the EU Innovation Fund would increase accessibility of this instrument to e-SAF projects. Funding provided by national governments through dedicated funding pots e.g. in Denmark via the upcoming passenger tax, and in France via the announced CfD mechanism for hydrogen, could complement EU-level funding – in particular for DEVEX support. In the UK, grants for development capital e.g. through an expanded Advanced Fuels Fund, could support the industry prior to the revenue certainty mechanism taking effect in 2026/2027. Lastly, any national and EU-level industrial strategy for Power-to-X technologies (incl. e-SAF) should ensure the scale-up of renewable electricity (incl. grid expansion and energy storage) as well as provide harmonised support to scale CCUS (i.e. both CCU and CCS) infrastructure instead of favouring one over the other.

3. **Secure bankable 10+ year offtake contracts (e.g. take-or-pay) for the first wave of e-SAF projects** from a group of pioneers (e.g. fuel suppliers, airlines, freight forwarders, private jet companies[39]). This should be based on a fact-based assessment of the advantages and risks in light of penalties and make-up obligations under ReFuelEU Aviation and a potential short market by 2030. The only two precedents (to date, in Europe) are Norsk e-Fuel's offtake agreements with Norwegian Airlines and Cargolux,[xxv] and Nordic Electrofuel's offtake agreement with P2X-Europe for its pilot plant.[xxvi] Without bankable, long-term (e.g. 10+ year, take-or-pay) offtake contracts, e-SAF projects will not get to FID. Premium demand could also be leveraged e.g. from corporate customers as 'brand partners', to provide strengthened revenue certainty over the investment period, although the existing GHG Protocol limits the capacity for corporate customers to claim Scope 3 emission reductions through book and claim.

4. **Establish low-interest loans from the EIB and national investment banks, as well as loan guarantees from export credit agencies (ECAs)**, with a total ticket size in the order of EUR 250-500 mn, to reduce financing costs and unlock commercial debt. These are existing instruments but need to be made accessible to first-of-a-kind e-SAF projects through a mandate from national governments, and by adapting the project selection criteria to cover the risk profile of e-SAF projects.

5. **Develop more effective risk sharing models** that recognise the unique risk profile of e-SAF projects, and how the role of different stakeholders must evolve to adequately transfer and share risk differently from more mature industrial projects. This should include leveraging government-backed finance to carry some of the performance risk associated with the construction and commissioning of e-SAF projects, such that the risk exposure of project sponsors, EPC firms and providers of debt capital is partially mitigated during this critical phase of project development. Technology performance guarantees and insurance can also partially mitigate some of this risk.

38 The EU Innovation Fund has five main award criteria (effectiveness of greenhouse gas emissions avoidance, degree of innovation, project maturity, replicability, cost efficiency).

39 Note that the obligated party under ReFuelEU Aviation are fuel suppliers.

Five long-term actions are needed to ensure the scale-up of e-SAF beyond 2030:

6. **Create alignment on long-term e-SAF production criteria by ensuring the eligibility criteria** of electricity and CO_2 feedstocks are achievable in the short term, that adequate support from governments (e.g. on electricity grid or CO_2 pipeline expansions) is provided, and by creating certainty around the criteria, to reduce future regulation risk and enable investment decisions to be taken in the short term.

7. **Establish revenue certainty** from the European Commission e.g. via restructuring SAF Allowances into 10-year subsidies and increasing the number of SAF Allowances beyond 2030 dedicated to e-SAF offtake ('e-SAF Allowances'), and from the UK DfT via the planned Revenue Certainty Mechanism, employing a Guaranteed Strike Price.

8. **Establish demand pooling instruments to meet higher e-SAF volume targets**, crowding in additional funding from corporate customers and aggregating demand from smaller (tier 2/3) airlines, freights forwarders and others in order to secure sufficient aggregated demand for the next wave of e-SAF projects. This can also help to ensure a competitive, level playing field within the airline industry.

9. **Explore the feasibility of a SkyPower e-SAF plant fund**, leveraging the use of grant funding s a tranche of first loss capital, to crowd in equity investors into a dedicated e-SAF fund, with the mandate to invest in e-SAF projects in the EU and UK, across a range of different producers, geographies and technologies.

10. **Develop a long-term e-SAF scale-up strategy for Europe**, positioning it as a global leader of this critical technology. Assess Europe's potential for long-term cost reductions compared to other competitive regions, and outline how European e-SAF leaders can support global scale-up efforts in lower-cost production regions.

The e-SAF value chain has aligned behind this action plan, as the required set of actions that will unlock this technology at commercial scale by 2030 and ensure scale up beyond that. The scale-up of e-SAF in Europe, and globally, will therefore rely on the successful delivery of this action plan by the e-SAF ecosystem in Europe.

Exhibit 20

Project SkyPower's 10-point action plan

	In the short term…	In the long term…
Create regulatory certainty…	1 **Ensure regulatory certainty** on e-SAF mandates and penalties	6 Create alignment on **e-SAF production criteria** over the long term
Bridge the premium with public funding…	2 Secure **public funding** commitments via existing industry-generated tax revenues	7 Establish **revenue certainty** through public funding via existing industry-generated tax revenues
Stimulate demand for e-SAF…	3 Establish bankable 10+ year **offtake contracts** (e.g. take-or-pay) for first e-SAF projects	8 Establish **demand pooling instruments** to meet higher e-SAF volume targets
Unlock investment…	4 **Establish low-interest loans and loan guarantees** from the EIB, NWF, UKEF, national investment banks and ECAs[1]	9 Explore the feasibility of a **SkyPower e-SAF plant fund**
	5 Develop more effective **risk sharing models** that recognise the unique risk profile of e-SAF projects	10 Develop long-term **e-SAF scale-up strategy for Europe**
	… to get first projects to FID by end of 2025	… to scale e-SAF production beyond 2030

Note: 1 EIB: European Investment Bank; NWF: National Wealth Fund; UKEF: UK Export Finance; ECA: Export Credit Agency.

05

Flight path ahead

E-SAF offers an opportunity for Europe to lead the global transition towards electricity-based fuels.

As highlighted in the European Commission/ Mario Draghi's recent report on "The future of European competitiveness",[xxvii] Europe lags behind competitors like China and the US on many factors (such as renewable electricity prices, speed of permitting processes or ease of access to public funding) that are critical to scale cleantech innovation, threatening a reliance on imports and missed economic opportunities. However, Europe's strong e-SAF innovation landscape and deep expertise in the chemicals and refining sectors, backed by ambitious adopters, and a comprehensive regulatory framework, could position the region as a frontrunner in this pivotal technology.

Scaling e-SAF can also drive benefits far beyond the bounds of aviation with innovation in its core technologies (e.g. renewable energy, Power-to-X, and carbon capture technologies) having spillover effects, in other, more commoditised sectors, like shipping and fertiliser production. **By driving the scale-up of e-SAF, Europe can not only accelerate the broader energy transition but also reaffirm its global leadership in clean-tech innovation – securing a future of sustainable growth, economic resilience, and climate leadership for the continent.**

Annex

Country selection process

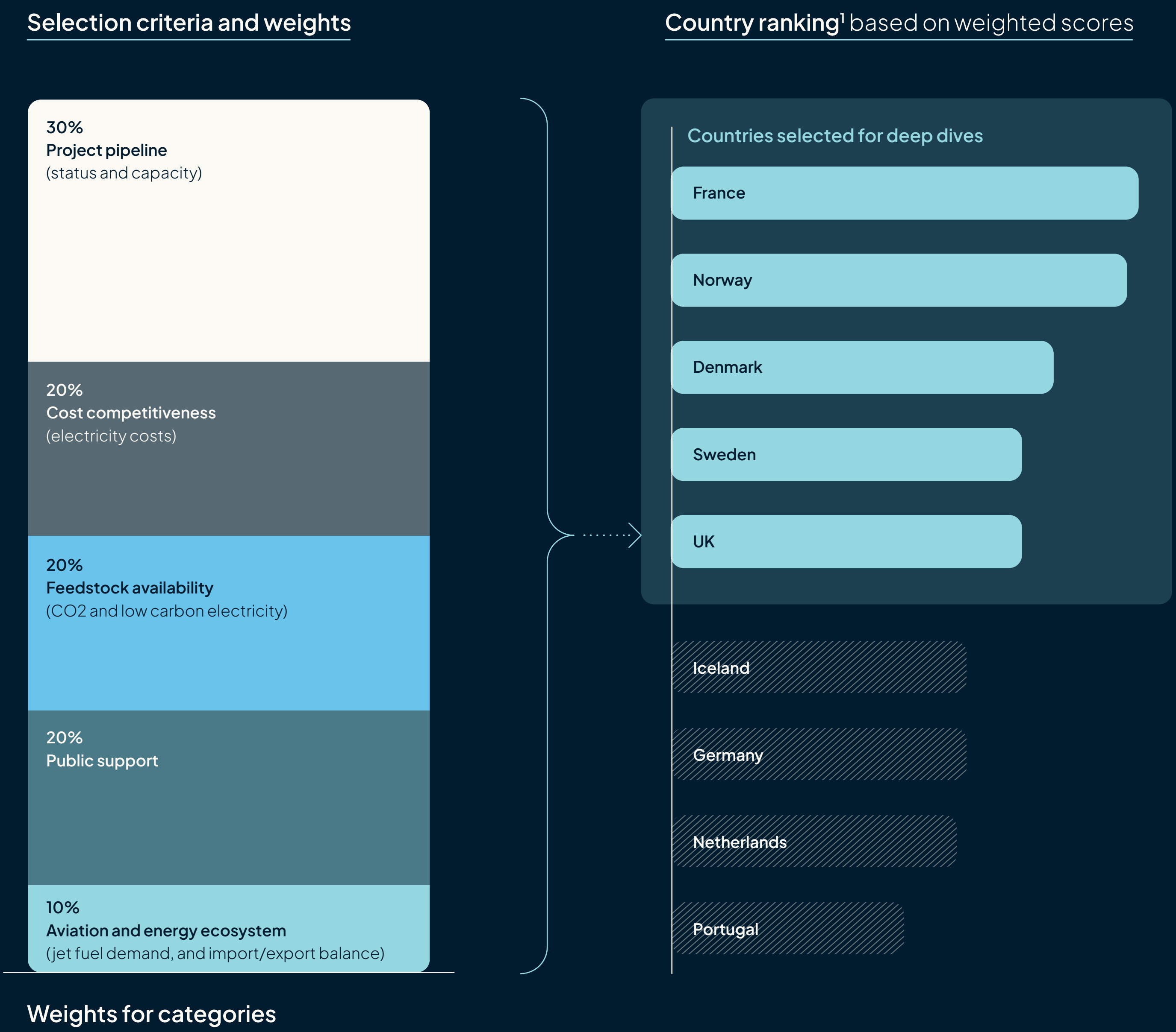
Deep dives on national public support instruments

Key prerequisites for Final Investment Decision

Country selection process

Annex Exhibit 1

The deep-dive countries were identified based on an assessment using 5 weighted selection criteria



Notes: 1 Only countries which had at least one large-scale e-SAF plant announced in July 2024 were assessed.

Deep dives on national public support instruments

Annex Exhibit 2.1

Overview of existing national subsidisation schemes in France

	Awardee	Share of green premium covered	Accessibility for e-SAF (vs other sectors)	Payout schedule	Current capitalisation
France 2030 / National H2 strategy Scheme is not confirmed	H2 producers	Unclear, high if CfD scheme confirmed – could cover 100% of cost differential	**Low** – scheme is for all low-carbon H_2 producers, not specifically e-SAF	10 years via the CfD	**High** – EUR 9 bn (with EUR 4 bn for the CfD) However, budget is set yearly and not confirmed for 2025.
TIRUERT Tax Credits	Suppliers / airlines	**Medium** – ~EUR 1,500–2,000 per tonne	**Low** – only provided to bio-SAF currently	1-year (unclear period of availability)	Unclear
FEED Call for SAF	SAF producer	**Low** – up to EUR 5 mn per project	**High** – specific to SAF	One-time payment	**Low** – ~EUR 0.2 bn
Carbon compensation scheme	SAF producer	**Medium** – EUR 15–25 per MWh until 2030	**High** – given large electricity demand	Until 2030	Unclear

Attractiveness for bankability of FOAK e-SAF plants: High (green) · Medium (yellow) · Low (red)

Annex Exhibit 2.2

Overview of existing national subsidisation schemes in Denmark

	Awardee	Share of green premium covered	Accessibility for e-SAF (vs other sectors)	Payout schedule	Current capitalisation
Power-to-X Tender	H2 producers	**Low** – winning bids < EUR 1.1 per kg H_2	**Low** – auctions are strongly driven by price	10 years	**Medium** – EUR 170 mn has been allocated, capacity targets of 4–6 GW indicate further funding rounds1 currently no open auctions
CCUS Fund	CCUS Companies	**High** – avg. ~EUR 125 per tCO_2 covering a large proportion of costs	**Low** – so far funding has been awarded to CCS projects only, not for utilisation	20 years	**Medium** – ~EUR 100mn annually[2]
Passenger Tax (upcoming)	Passengers	**High** – avg. ~EUR 13 per passenger	**Low** – competition based dual auction mechanism	10 years for the first auction, followed by yearly sales contracts	**Medium** – taxes are projected to raise over ~EUR 74 mn, aims to cover 100% SAF for domestic flights by 2030. Scheme is not yet in place.

Attractiveness for bankability of FOAK e-SAF plants: High, Medium, Low

Notes: 1 EUR 2,7bn is estimated assuming same level of subsidy is distributed to meet the target electrolysis capacity of 4-6GW. **2** Total funding budget planned to be distributed until 2048 consisting of second round of CCUS Fund, NECCUS Fund focusing on biogenic CO_2 and GSR Fund focusing on cost effective CO_2 reductions. **Sources:** Danish Energy Agency DEA) (2023); DEA Power-to-X Tender (2023); DEA CCUS Fund (2024); Reuters (2023);

Annex Exhibit 2.3

Overview of existing national subsidisation schemes in Norway and Sweden (non-exhaustive)

	Awardee	Share of green premium covered	Accessibility for e-SAF (vs other sectors)	Payout schedule	Current capitalisation
CO2 Compensation Scheme (Norway)	Fuel producers	**Low** – est. average EUR 10 per MWh[1]	**High** – requires a min. threshold of 10 GWh power consumption	Yearly until 2030	**Medium** – ~EUR 600 mn annually
The Industrial Leap (Sweden)	SAF Producers / Suppliers	Unclear; max ticket size so far has been ~EUR 13 mn	**Low** – open to all decarb projects; no e-SAF projects funded yet	One time – until 2027	**Medium** – ~EUR 130 mn in 2024 covering research, feasibility studies, pilot projects, and full-scale investments.
The Climate Leap (Sweden)	SAF Producers / Suppliers	Unclear ; max ticket size so far has been ~EUR 19 mn	**Medium** – renewable hydrogen projects for transport can access	One time (unclear until when)	Unclear (budget in 2025 and 2026 is limited compared to 2024)
SAF Incentive Program Private sector scheme (Sweden)	Airlines (via. Swedavia Airports)	**Medium** – 50% of SAF premium	**Medium** – competing with all SAF	Yearly until 2030	**Low** – ~EUR 3.9 mn

Attractiveness for bankability of FOAK e-SAF plants: High Medium Low

Notes: 1 expected to vary with ETS price. **Sources:** The Industrial Leap (2024); Swedish Energy Agency granted ~EUR 5 mn funding to support research on SAF production (2024); Naturvardsverket (2024); Swedavia Airport SAF Incentive Program (2024)

Key prerequisites for Final Investment Decision

Annex Exhibit 3.1

E-SAF projects have a distinct risk profile, which hampers investor confidence

Risk type			
Supply risks	**Offtake risks**	**Regulatory risks**	**Financing risks**
Key examples (non-exhaustive)			
• **Technology:** Greenfield construction with risks in cost overruns, delays and performance issues; lack of system performance guarantees (for EPC and commissioning); project-on-project risks • **Feedstock:** Lack of long-term feedstock supply, e.g. CO2 source, power grid connection • **Infrastructure:** Lack of access to grid infrastructure or refining, blending and supply infrastructure	• **Revenue:** Uncertainties in plant revenues (and feedstock and e-SAF production costs) • **Market:** Uncertainty in e-SAF demand in comparison to other SAF types • **Volume:** Uncertainty in supply volumes of e-SAF (stemming from potential supply chain disruptions, delivery delays or delivery failures)	• **Regulation and subsidies:** Lack of long-term planning horizon, e.g. yearly SAF allowances (vs. long-term offtake agreements needed for e-SAF plants), potential revision of ReFuelEU in 2027, or absolute levels of penalties • **Permitting:** Long planning and permitting durations, e.g. for renewables	• **Financing structures:** Lack of fit-for-purpose financing models • **Credit risk:** Credit-worthiness of offtakers of SAF or of environmental attributes (airlines or corporate customers) • **Liquidity risk:** High capital intensity of e-SAF projects

Annex Exhibit 3.2

Key pre-requisites for FID address risks in first-of-a-kind, large-scale e-SAF projects

Pre-requisites to take final investment decision	Supply risks	Offtake risks	Regulatory risks	Financing risks
Long-term feedstock supply contracts (e.g. constant renewable power supply compliant with Delegated Acts)	✓			
Permits and licensing	✓			
Other agreements (e.g. land lease, technology, utilities)	✓			
Technology performance insurance	✓			
EPC agreement(s)	✓			
Secured access to fuel supply infrastructure	✓			
10+ year offtake contract for at least 80% of production volume at affordable prices with credit-worthy offtakers		✓		
Stable and long-term regulatory environment regarding e-SAF			✓	
Adequate risk allocation to enable firm commitments by equity investors and loan providers				✓

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