WHEN TRUST MATTERS

The SAF product journey

Barriers and opportunities for establishing a SAF supply chain in Norway

December 2025

Image: Getty/Scharfsinn86

About this report

This report was commissioned by Avinor to explore the strategic and practical considerations for scaling domestic production of Sustainable Aviation Fuel (SAF) in Norway. The backdrop for this initiative is a growing recognition of the critical role SAF plays in decarbonizing aviation, and the need for Norway to transition from reliance on imported, pre-blended fuels to a more resilient and sustainable domestic supply chain.

The analysis presented here is grounded in extensive stakeholder engagement, including discussions with industry experts, fuel suppliers, infrastructure operators, and regulatory bodies. These conversations have helped shape a nuanced understanding of the opportunities and barriers facing SAF development in Norway.

Key themes addressed in the report include:

- **Logistics and infrastructure:** Mapping the physical journey of SAF from production to aircraft fueling, and identifying critical infrastructure needs for refining, blending, and distribution.
- **Security of supply:** Assessing the strategic importance of domestic SAF capabilities in enhancing Norway's energy security and resilience, particularly in light of geopolitical uncertainties.
- **Sustainability and certification:** Exploring the regulatory frameworks and certification schemes that govern SAF sustainability, with a focus on traceability, compliance, and the evolving role of systems like ISCC and the EU Union Database.

By combining technical insights with strategic foresight, this report aims to support informed decision-making for both public and private stakeholders. It provides a foundation for evaluating supply chain models, investment priorities, and policy interventions that can enable Norway to build a robust and future-proof SAF ecosystem.

Image: Getty/Scharfsinn86

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Prepared by	Ingrid Bye Løken, Susanne Andresen, Frida Berglund	Contact name	Ingrid Bye Løken
Verified by	Magnus Killingland	Contact email	ingrid.bye.loken@dnv.com
Approved by	Frida Berglund	Contact phone	

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Acronyms

Acronym	Description
CAF	Conventional Aviation Fuel
CEF	CORSIA Eligible Fuels
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EEA	European Economic Area
ETS	Emission Trading System
GHG	Greenhouse Gas
LCAF	Lower Carbon Aviation Fuel
ICAO	International Civil Aviation Organization
ISCC	International Sustainability and Carbon Certification
RCF	Recycled Carbon Fuel
RED	Renewable Energy Directive
RFNBO	Renewable Fuel of Non-Biological Origin
RSB	Roundtable on Sustainable Biomaterials
SAF	Sustainable Aviation Fuel
UDB	EU Union Database

Executive summary

Developing a SAF supply in Norway

Key findings and strategic recommendations

Sustainable Aviation Fuel (SAF) is a cornerstone of the aviation sector's decarbonisation strategy, offering a viable path to reduce emissions without requiring major changes to aircraft or fuelling infrastructure. As global demand for SAF grows, Norway faces an important strategic decision: whether to remain reliant on imported, pre-blended fuels or to invest in a resilient, domestic SAF value chain that supports long-term energy security and industrial development.

This report explores the practical and strategic considerations for establishing such a value chain in Norway. It examines both the physical logistics of SAF – from production to aircraft fuelling – and the regulatory and certification frameworks that govern sustainability compliance.

Key findings

- **Norway is fully dependent on imported SAF,** all of which is pre-blended abroad. This exposes the country to global supply chain risks and rising international competition for feedstock and fuels.
- **No domestic SAF production is currently operational**, though several projects are in early stages of development. Most plan to export semi-finished products due to limited local refining and blending capacity. Without domestic co-processing and blending capacity, Norway risks missing out on both energy security and industrial value creation.
- **Mongstad is the only refinery in Norway capable of jet fuel production.** While it could be adapted for SAF blending, reliance on a single facility creates a strategic vulnerability.
- **A hub-and-spoke supply chain model could offer a balanced approach** – supporting domestic production, improving resilience, and enabling cost-effective infrastructure development.
- **Sustainability certification is fragmented and administratively burdensome.** While later-stage blending improves traceability, it requires SAF-specific infrastructure, increasing cost and complexity.
- **Traceability has been challenging, but new developments offer solutions:** Updated ISCC mass balance guidance and Norwegian fuel suppliers' access to the EU Union Database (UDB) under RED II will improve end-to-end traceability, likely reducing administrative burdens.

Strategic recommendations

To reduce import dependency, strengthen energy security, and unlock industrial value creation, Norway could consider the following strategic actions:

- **Establish regional SAF hubs** to support a hybrid supply chain model that combines cost-efficiency with resilience and flexibility.
- **Invest in domestic refining and blending infrastructure**, such as at Mongstad, to enable local processing of SAF intermediates and reduce reliance on foreign facilities.
- **Leverage public procurement power,** as demonstrated by the Armed Forces, to create stable offtake agreements that de-risk private investments and accelerate market development.
- **Ensure that the implementation of RED II and ReFuelEU Aviation** fosters fair competition between Norwegian and EU-based actors, providing regulatory clarity and predictability.
- **Support certification readiness across the SAF value chain,** including clear guidance on voluntary certification schemes, access to the UDB, and alignment with evolving sustainability standards.

1. The backdrop to our report

Next-generation SAF in Norway

Sustainable Aviation Fuel (SAF) has emerged as the key component in the aviation industry's decarbonization strategy, being an effective way to achieve emission reductions without requiring major changes to existing aircraft and fuel infrastructure. Fuel suppliers in Norway have been obliged to blend in a share of SAF in their fuel since 2020, and in the EU since January 2025.

The majority of global SAF production today relies on biogenic feedstock such as used cooking oils, but new production pathways based on a wider range of technologies and feedstocks, known as next-generation SAF, are needed to cover the increasing SAF demand. Next-generation SAF include Renewable Fuels of Non-Biological Origin (RFNBO) produced from renewable electricity and CO_2, Recycled Carbon Fuels (RCF) from fossil waste and industrial waste gases, and various biofuels from waste and forestry and agricultural residues.

There is no SAF production in Norway today*, and Norwegian suppliers import SAF to meet the blending mandates. However, there are several companies planning next-generation SAF production in Norway. While the focus often has been on the barriers to establish production, the industry also face challenges related to integrating the SAF into the existing fuel supply chain, both in terms of logistics pathways, infrastructure and certification requirements. SAF produced in Norway can reduce Norway's reliance on import and increase security of fuel supply, but only if logistics pathways from SAF production to aircraft fuelling are available.

This report looks at the alternative logistics pathways for SAF in Norway «from production to the wing», and is divided into two parts:

1. **The physical SAF journey**: What does the Norwegian fuel logistics pathway look like, and what barriers and opportunities are next-generation SAF producers likely to face along the supply chain?

2. **The SAF paper-trail**: How do you document and trace the sustainability aspects of the fuel along the supply chain? Here, ISCC certification is used as an example.

We would like to extend our appreciation to the external experts and stakeholders from the aviation industry who generously shared their insights and expertise throughout the development of this report. Their input has been invaluable in strengthening the quality and relevance of the analysis.

** Although bioethanol currently produced at Borregaard could be upgraded to aviation fuel via the alcohol-to-jet pathway*

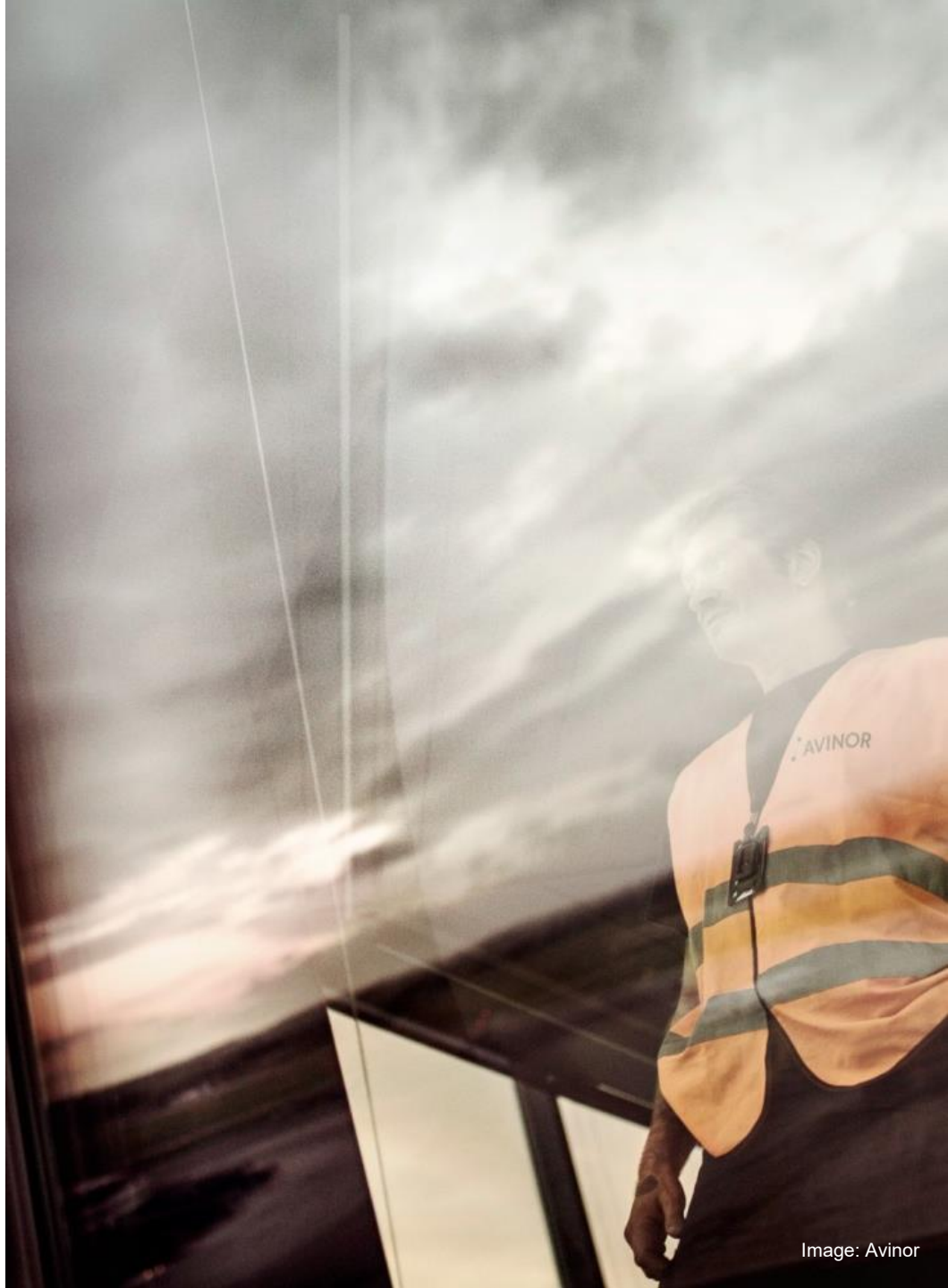


Image: Avinor

Regulations and blending mandates

An important backdrop to our report

Norway is closely aligned with EU climate and environmental policy through the European Economic Area (EEA) Agreement and participation in the EU's 2030 climate framework under the Paris Agreement. While the EEA does not automatically cover all EU legislation, a substantial share of EU rules on climate, environment and energy are incorporated into Norwegian law through the EEA. For sectors like aviation, this means that EU regulatory developments – including those related to SAF –shape the framework conditions for Norwegian actors.

For companies investing in SAF, it is therefore essential to understand not only EU regulation itself, but also how and when these rules are implemented in Norway – as this directly affects long-term competitiveness and investment risk.

The foundation: Renewable Energy Directive (RED)

The Renewable Energy Directive (RED) is EU's overarching framework for increasing the share of renewables across all sectors, including transport.

- The second update from 2018 (**RED II**) introduced, amongst others, sustainability criteria for biofuels and sub-targets for "advanced" fuels made from residues and waste. It also introduced the concept of RFNBOs, which were later specified through two supporting Delegated Acts, formally adopted in 2023. These define criteria for what qualifies as renewable electricity used to produce RFNBOs, and how greenhouse gas savings from RFNBOs are calculated.[1,2]

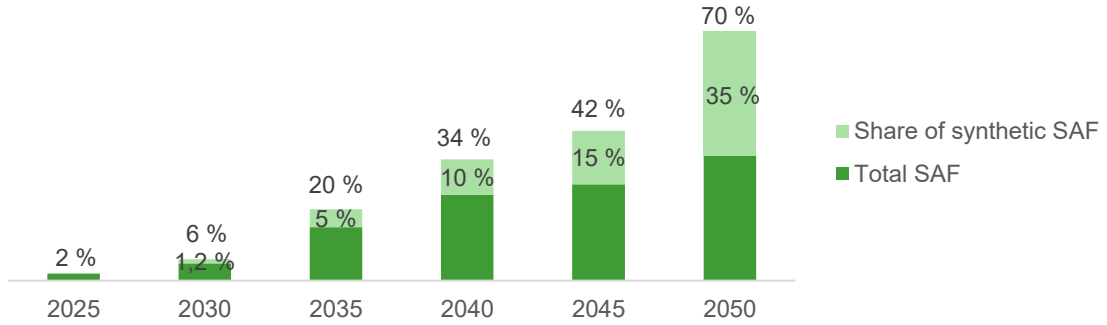
- The third update from 2023 (**RED III**) strengthened ambitions in line with the Green Deal and Fit-for-55, setting higher renewable targets and introducing specific goals for the use of RFNBOs in industry and transport. To compensate for the higher costs compared to biofuels, RFNBOs can be double-counted towards the transport sector targets. On top of that, the use of RFNBOs in aviation and maritime is incentivised via an additional multiplier of 1.5, acknowledging the harder-to-abate nature of these sectors.[3]

The sector-specific regulation: ReFuelEU Aviation

Adopted in October 2023, ReFuelEU Aviation is a standalone regulation tailored to the aviation sector. It complements RED II and III by turning the general goals into specific, enforceable mandates for fuel suppliers, airports, and airlines.

Fuel suppliers: Must deliver a minimum SAF blend at Union airports*, starting at 2% in 2025 and rising gradually to 70% by 2050. Sub-targets for synthetic fuels (RFNBOs) are introduced from 2030. See Figure 1.

Figure 1: ReFuelEU Aviation: Minimum share of SAF in total fuel mix



**Union airports are all EU airports with more than 800 000 passengers per year or freight traffic of more than 100 000 tonnes per year and are expected to cover around 95% of all EU aviation traffic.[4]*

Source: 1) Commission Delegated Regulation (EU) 2023/1184; 2) Commission Delegated Regulation (EU) 2023/1185; 3 Transport and Environment, 2023 Renewable Energy Directive Fact Sheet 4) SkyNRG, Disentangling ReFuelEU: How will it shape the SAF market?

Regulations and blending mandates

An important backdrop to our report

The sector-specific regulation: ReFuelEU Aviation (continued)

A flexibility period until 2035 allows fuel suppliers to meet the mandates by averaging supplies of SAF blends across Union airports, after which the blending target must be met at all Union airports.[1] With over 50% of the aviation fuel in Europe consumed at just ten airports, meeting the mandate for smaller airports could be challenging without mechanisms like book-and-claim (under consideration by the Commission).[2]

- **Union Airport Managing Bodies:** Obliged to ensure SAF access at Union airports from 2035.
- **Aircraft operators:** Must uplift 90% of annual fuel needs at Union airports to prevent tinkering. Note that, under EU ETS, only SAF physically entering the airport fuel system count toward SAF-related emission reductions, which may be challenging during the flexibility period.[3]
- **Penalties for non-compliance:** Fuel suppliers face a fine of at least twice price gap between conventional aviation fuel and SAF and must make up the volume shortfall the following year.[3] Penalties also apply to aircraft operators.
- **Eligible SAF types:** Defined by RED II and its Delegated Acts and include: synthetic fuels (RFNBOs or low-carbon aviation fuels from non-fossil sources), RCFs, and aviation biofuels made from feedstocks approved under RED II (listed in Part A and Part B of Annex IX). Any biofuels listed as eligible under ReFuelEU Aviation but produced from feedstocks not listed in Annex IX of RED II cannot count for more than 3% of total aviation fuel supplied.[4]

Implications for the Norwegian airline industry

Since 2020, a national aviation fuel blending mandate has been in place, requiring at least 0.5% of annual aviation fuel volumes to be advanced biofuels or fuels from used cooking oil or animal fats. RFNBOs, RCFs and low-carbon fuels do not yet count towards the mandate. The industry has long called for incorporating RED II and ReFuelEU Aviation to ensure regulatory clarity, long-term predictability and equal competitive conditions.

In June 2025, the Norwegian Parliament **approved the incorporation of RED II** and its supporting Delegated Regulation (EU) 2022/759 into the EEA Agreement, aligning Norway with EU sustainability and emission criteria for renewable fuels.[5] This helps strengthen the credibility of Norwegian fuel production and ensures a level playing field with EU-based competitors.

Furthermore, **ReFuelEU Aviation** will be incorporated into Norwegian law no later than 2027. In the meantime, the national blending mandate for biofuels will increase to 2% from 1st January 2026 in line with the regulation.[6] While the decision has been made in principle, the adaptation to Norwegian law is currently under consultation, led by the Ministry of Transport and the Ministry of Climate and Environment, with shared responsibility for enforcement held by the Norwegian Environment Agency and the Civil Aviation Authority.[7]

The incorporation of RED II also enables access to the EU's Union Database (UDB): a central digital system for tracking the origin and lifecycle emissions of biofuels and renewable fuels to ensure traceability, prevent double counting, and support regulatory compliance across the EU. Under the ETS, UDB data can be used to "zero-rate" emissions from the use of eligible fuels, meaning they are exempt from surrendering allowances for those emissions provided other conditions are met. Note that this is already possible through national systems, according to NHO Aviation. Currently, economic operators certified under the ISCC EU scheme have successfully been onboarded the UDB to provide real-time certificate status updates. The database is gradually being rolled out, although the deadline for mandatory use remains to be decided.[8]

Source: 1) Report from the Commission to the European Parliament and the Council The ReFuelEU Aviation SAF flexibility mechanism; 2) European Council, "Infographic – Fit for 55"; 3) SkyNRG, Disentangling ReFuelEU: How will it shape the SAF market?; 4) European Comisstion, ReFuelEU Aviation FAQ; 5) Stortinget, Prop. 137 S (2024-2025), Innst. 424 S (2024-2025); 6) Regjeringen, Regjeringen skjerper kravene til biodrivstoff fra 2026 ;7) Regjeringen, Europeisk omsetningskrav på bærekraftig drivstoff til luftfart; 8) ISCC, Union Database (UDB);

2. The physical SAF journey

Logistics pathways from production to the wing

The physical SAF journey
Introduction and key take-aways

The physical product journey of SAF involves several key stages – from production to aircraft fuelling. This section outlines the logistics pathways from production to the wing, how suppliers currently integrate SAF to meet blending mandates, and key considerations for future SAF integration in Norway.

Key take-aways

- Today, aviation fuel suppliers in Norway meet blending mandates by importing SAF that has already been blended with Conventional Aviation Fuel (CAF) at refineries abroad
- Norway's only refinery, Mongstad, is currently not equipped to produce, upgrade, or blend SAF. This means companies aiming to produce SAF domestically must either invest in their own refining and upgrading infrastructure or export semi-finished SAF intermediates for further processing and blending elsewhere
- However, with relatively limited investments – such as reallocation of tanks and targeted facility upgrades – Mongstad could be adapted to support both co-processing and blending of SAF. According to Equinor, this could enable cost-effective pre-blending or blending-at-hub solutions using existing infrastructure for CAF
- There are several possible integration points for SAF in the Norwegian fuel supply chain. While later-stage blending (closer to the point of fuelling) can simplify sustainability traceability, it often requires dedicated infrastructure, as unblended SAF is not certified for use in existing aviation fuel systems
- To enable domestic use of Norwegian-produced SAF – rather than exporting intermediate products – infrastructure investments will be needed in refining to jet fuel quality, blending with CAF, and downstream fuel transport

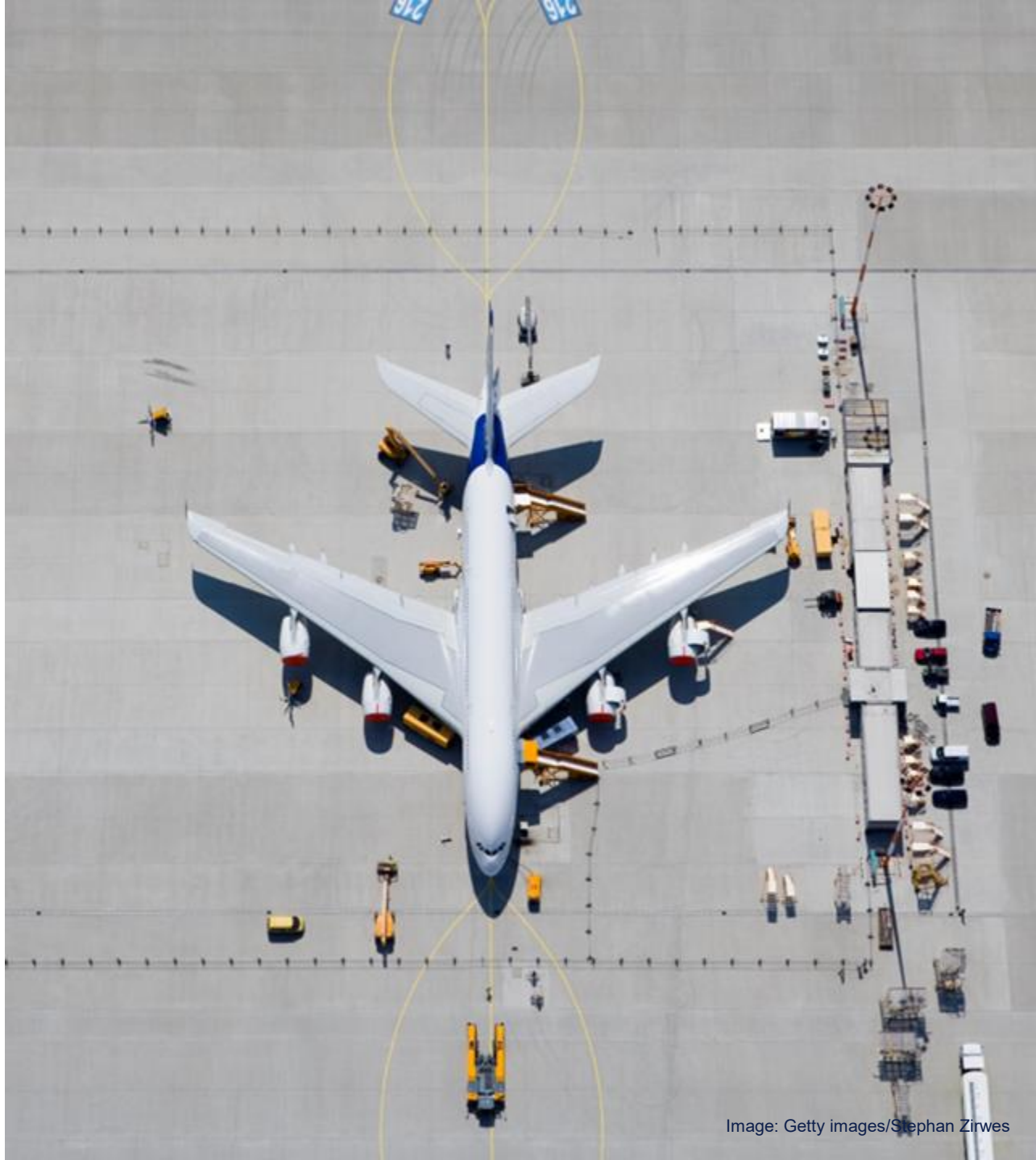


Image: Getty images/Stephan Zirwes

The Norwegian fuel supply chain consists of several assets and owners

The aviation fuel supply chain in Norway involves several steps as illustrated in Figure 2, and includes oil companies, logistics companies, fuel suppliers, airport operators (Avinor), and Into-Plane (ITP) providers. Currently, aviation fuel supplied in Norway is partly produced at Mongstad (the only refinery in Norway) and partly imported. The capacity at Mongstad is sufficient to cover around 80% of the jet fuel demand in Norway.

For OSL Gardermoen, which accounts for 60% of the aviation fuel supply in Norway, the fuel is mainly supplied internationally and from Mongstad from four different suppliers. The assets, operators, and ownership in the fuel supply chain are illustrated in Figure 3. The jet fuel supplier owns the fuel through the supply chain until the airliner takes over ownership at aircraft refuelling. The transport ships are owned and operated by logistics companies, and the harbour terminal and storage is owned by terminal companies. The jet fuel suppliers (as a Joint Venture) owns the fuel train transport and the storage tanks at the airport, while Avinor owns the airport hydrant network and an ITP provider owns the aircraft refuelling equipment.

For the other airports in Norway, the fuel is mainly supplied from Mongstad using a single supplier per airport. The value chain is similar to that of OSL, although the asset and fuel ownership, as well as the fuel distribution to and at the airport, are different.

Figure 2: Aviation fuel supply chain in Norway (Source: Avinor)

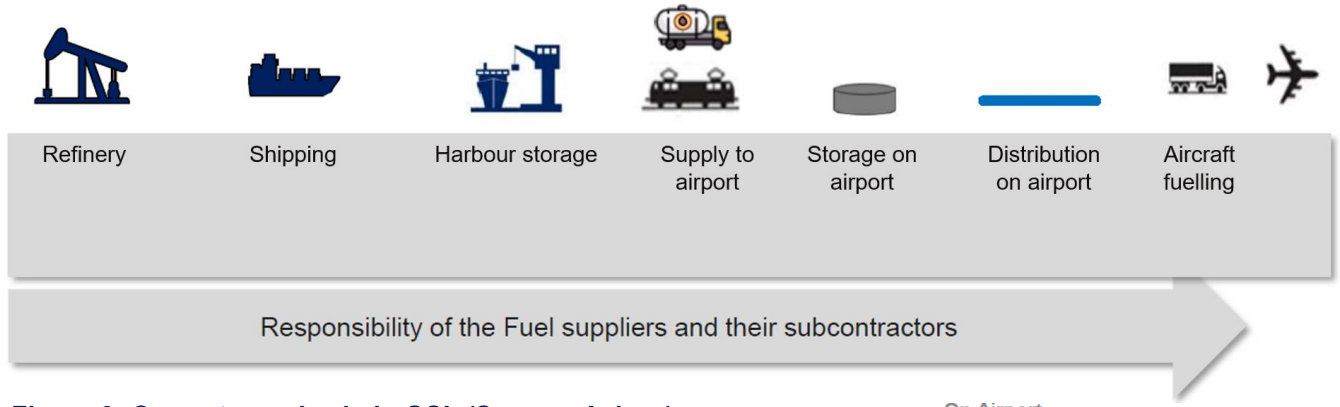
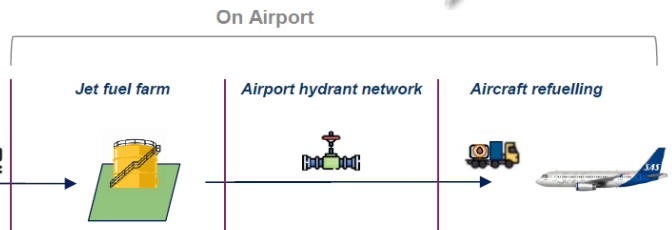


Figure 3: Current supply chain OSL (Source: Avinor)



Type of asset	Tanker ship	Harbour fuel terminal and storage tanks	Fuel train	Fuel storage tanks	Hydrant pipeline and pumps	*Into Plane aircraft refuelling*
Asset owned by	Logistic Company	JV terminal companies	JV Owned by OC/Jet fuel provider	JV Owned by OC/Jet fuel provider on land owned by Avinor	Avinor	ITP company
Asset operated by	Logistic Company	Joint Venture terminal companies Capacity rented by OC	JV Owned by OC/Jetfuel provider	JV Owned by OC/Jetfuel provider	JV Owned by OC/Jetfuel provider	ITP company
Fuel ownership	Oil Company/Jet Fuel Provider					Airliner

The Norwegian blending mandate can be met in different ways

To meet the SAF blending mandate in Norway, fuel suppliers must make sure that at least 0.5% of the total annual aviation fuel volume is biofuels (increasing to 2% from January 1st 2026). This means that there is no requirement that SAF must be blended into all aviation fuel sold. There is high flexibility in how the blending mandate is implemented in practice.

To meet the blending mandate, suppliers can choose to blend in SAF in their aviation fuel in a short period during the year, such as one month. SAF in its pure form is not compatible with aircraft and the current aviation fuel infrastructure due to aromatics content. To be approved for use, SAF must be blended with CAF to a certain blending limit. The maximum SAF share is normally between 10% and 50%, depending on the SAF production pathway. The blending mandate can be met by each fuel supplier or collectively by several suppliers.

The fuel chain of custody is mass balance. This means that fuel with different sustainability characteristics can be mixed, and the characteristics can be allocated to different output batches. This gives flexibility in when and where in the supply chain SAF is blended into the CAF, as long as blended volumes and sustainability characteristics are traced. The mass balancing principle and requirements for documenting compliance with the blending mandate is further described in chapter 3.

The proposed implementation of ReFuelEU Aviation in Norway could affect the current flexibility of blending mandate compliance, as the regulation requires all aviation fuel supplied to Union Airports to be blended with SAF from 2035[1]. Norway has 10 airports[2] meeting the criteria for Union Airports, equating more than 85% of the total fuel sale to Avinor's airports.[3]

Image: Getty/Scharfsinn86

Source: 1) Report from the Commission to the European Parliament and the Council The ReFuelEU Aviation SAF flexibility mechanism; 2) Oslo, Bergen, Trondheim, Stavanger, Tromsø, Bodø, Ålesund, Kristiansand, Harstad/Narvik, Torp; 3) Avinor

SAF can enter the fuel supply chain at various stages

As mentioned, SAF must be blended with CAF to be approved for use in aircraft and aviation fuel infrastructure. The blending of SAF and CAF can occur at various stages in the fuel supply chain as illustrated to the right, all with their unique advantages and disadvantages which are further investigated in the following slides.

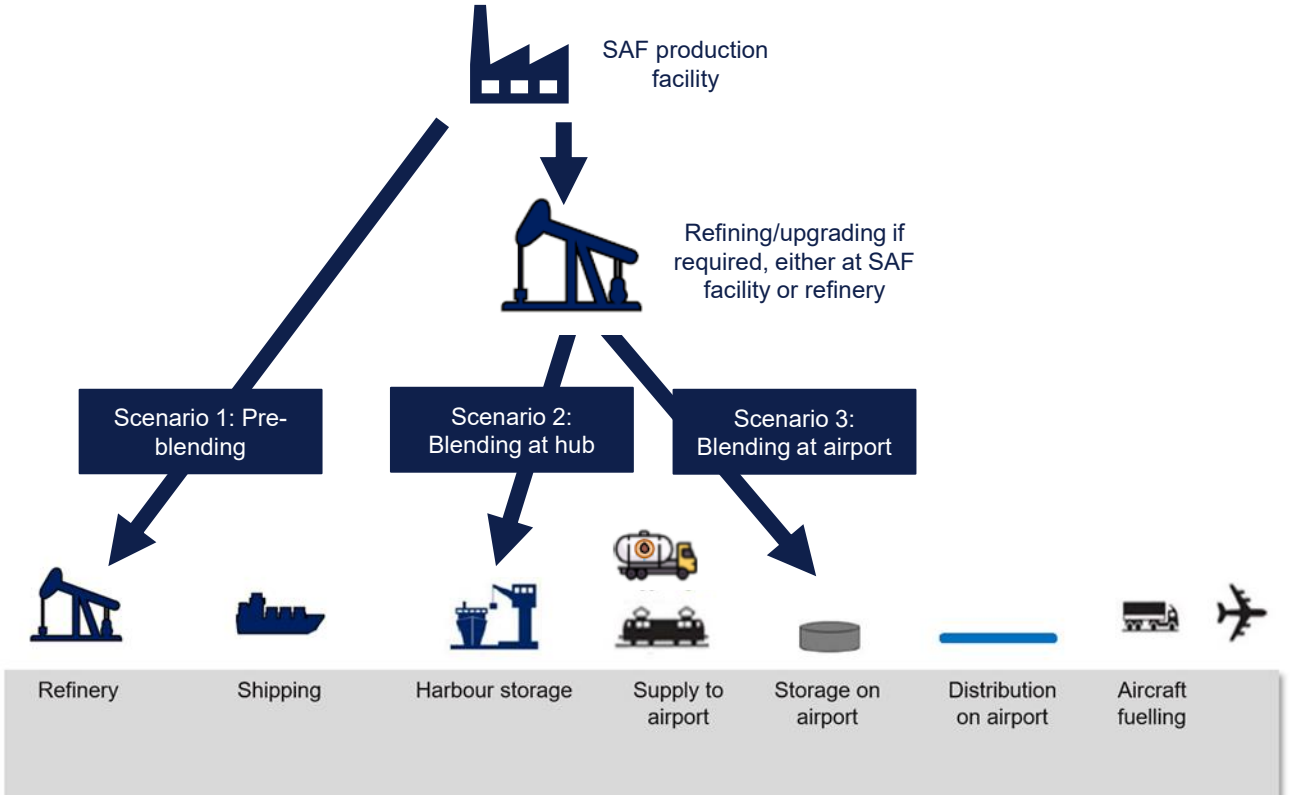
In short, there are three main alternatives:

1. **Pre-blending:** This is typically blending at a refinery producing CAF. The SAF is either produced at the refinery (if the refinery has SAF production capabilities) or at a SAF production plant at another location. A synthetic hydrocarbon production plant may typically supply a “crude oil” to the refinery which may co-process the crude with fossil fuels to aviation fuel quality, and then blend further with CAF if necessary. Pre-blending can also happen if CAF produced at a refinery is sent to a SAF production facility which has required blending infrastructure.

2. **Blending at hub:** Pure CAF and pure SAF are transported separately to an intermediate location, such as a fuel terminal/storage, where they are blended.

3. **Blending at airport:** Pure CAF and pure SAF is transported separately to the airport where it is blended. There must be blending infrastructure at the airport.

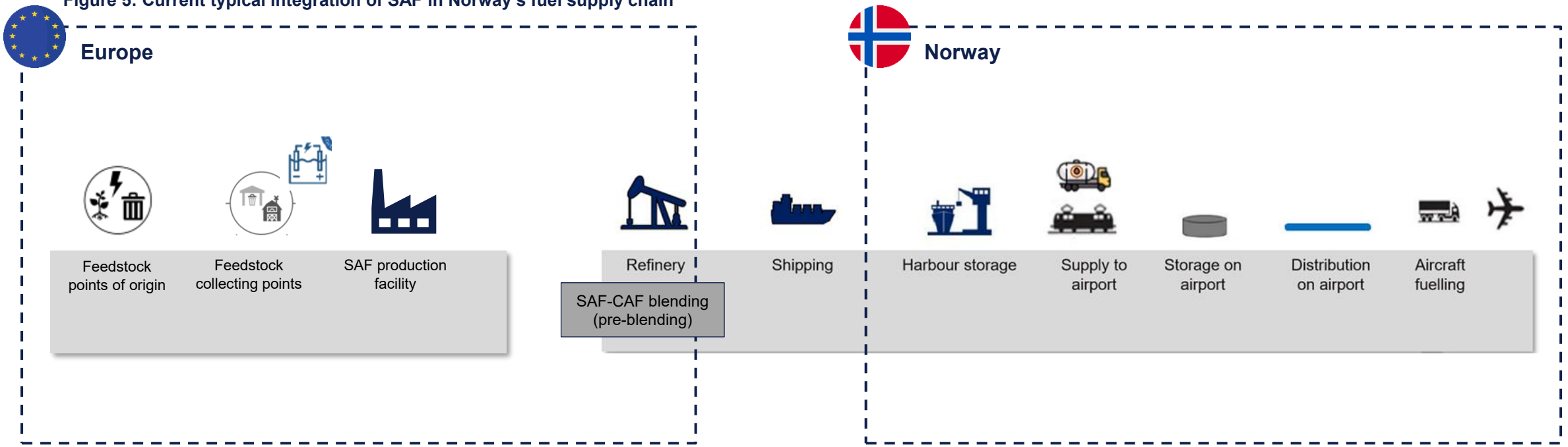
Figure 4: Illustration of three SAF-CAF blending scenarios



Today pre-blended SAF is imported to Norway

In Norway, the standard practice today is to import a pre-blended fuel from Europe – typically from Sweden, Finland, Germany or the Netherlands – at fuel terminals, before transporting the fuel to Norwegian airports. The pre-blended fuel is certified for use in existing infrastructure and contains up to 50% SAF. The fuel is typically transported in batches, usually to the larger airports, and used during a shorter time-period. To ensure the annual blending mandate is met, each supplier keeps track of the SAF volumes using the mass balancing principle.

Figure 5: Current typical integration of SAF in Norway's fuel supply chain



A domestic SAF supply chain requires infrastructure

Upgrading and blending SAF

Producing kerosene that meets SAF specifications requires strict quality standards and approved infrastructure. While it is technically possible to refine and blend SAF with CAF at the production facility, this requires large investments – often commercially unviable for small to medium-scale producers.

As a result, many SAF producers opt to outsource the final upgrading, blending and logistics. Semi-finished products – such as intermediate kerosene, renewable diesel and gasoline, or lower-grade feedstocks like “bio-crude or “e-crude” – are sold to refineries that complete the upgrading and blending processes required to meet jet fuel quality standards.

In DNV’s experience, this hub-and-spoke concept is preferred by several planned bio- and e-hydrocarbon producers in Norway*, who aim to export semi-finished products to refineries abroad (e.g., Sweden) with existing co-processing and blending capacity.

Optimised SAF production processes often generate by-products and heavier fractions suited for other sectors (e.g., maritime or road transport). The decision on how much SAF to produce versus other fuels is typically made by the refinery, based on market demand, offtake agreements, and cost-efficiency. Some of the heavier fractions can be further refined into lighter fractions like SAF, but this requires additional energy and hydrogen input and comes at a higher cost.

To summarize, most of the volumes produced in Norway will likely be sold to refineries abroad or directly to fuel suppliers, who will determine where and how the fuel is refined, blended, and distributed.

Considerations for blending locations

Blending SAF with CAF must be done at certified facilities that meet strict technical and quality requirements. Today, such capabilities are typically limited to refineries and specialised fuel terminals. Most suppliers in Norway typically import SAF as a pre-blended product from abroad – an approach that has proven to be reliable in practice. In the short to medium term, it is unlikely that the volumes from planned domestic production will be sufficient to meet national demand, and as mentioned it is likely that most of it will be exported. As such, Norway will still be highly dependent on imports.

Blending SAF domestically is possible, provided sufficient infrastructure and expertise are available. However, pure SAF cannot be transported using conventional aviation fuel infrastructure unless approved and accounted for. This is due to aircraft limitations on SAF blending ratios (typically capped at 50%) and compatibility with existing refuelling systems. Therefore, purpose-built infrastructure is required if unblended SAF is to be transported and blended later in the supply chain.

Blending SAF with CAF earlier in the chain can offer economies of scale and simplify logistics, but this depends heavily on the size and location of SAF production assets. More advantages and disadvantages with the various blending options are discussed further in coming slides.

The key requirements for blending facilities include:

- Sufficient space for infrastructure
- Environmental permits in place
- Certified blending systems and processes
- Storage tanks, transfer systems, and load/offload racks
- Facilities for fuel certification and testing
- Access to transport infrastructure

Sites with existing permits and infrastructure – such as refineries or large fuel terminals – have a natural advantage for SAF integration. In Norway, Mongstad is a potential candidate. While the refinery is currently not set up to produce, upgrade, or blend SAF, it could support both co-processing and blending with a few targeted modifications, such as tank reallocation and connections to blending stations. According to Equinor, this could enable pre-blending or blending-at-hub solutions using existing infrastructure for CAF, offering a cost-effective alternative to establishing entirely new blending hubs. Blending could also take place at fuel terminals, SAF production sites, or selected airports, though these options would typically require more extensive infrastructure investments.

** As of December 2025, there are seven publicly known SAF projects in Norway: four biofuel projects and three e-fuel projects.*

Each blending scenario has its own advantages

Each of the three main blending scenarios has a unique set of advantages and disadvantages, as illustrated below. In short, the further down in the supply chain you blend, the easier it will be to trace sustainability. However, this will likely require a larger share of SAF-specific infrastructure. For centralized, large-scale SAF production, pre-blending would be advantageous, while for de-centralized SAF production (such as smaller plants spread across Norway), blending at regional hubs or even at airports could be a preferred solution, depending on location.

	The Norwegian context	Advantages	Disadvantages
Pre-blending Typically blending at a refinery producing CAF, with the SAF either produced at the refinery or received from a separate SAF production plant. The SAF is both upgraded to aviation fuel quality (pure SAF) and blended with CAF here.	This is the option used for SAF in Norway today, where pre-blended fuel is imported to Norway (produced and blended in other countries) In order to establish pre-blending in Norway, modifications to parts of the infrastructure or new required infrastructure must be installed at Mongstad.	Blending at refinery: • Refining and blending infrastructure available • Can use existing infrastructure downstream on terminals and airports • Experience in fuel handling • Large volumes can be blended, enabling economies of scale Blending at SAF production site: • Can facilitate a full supply chain in Norway and increase security of supply	Blending at refinery: • For Norwegian SAF production, this currently means exporting the fuel – which creates risk related to security of supply • Can be difficult to trace the product and keep control of SAF share and to get the whole SAF supply chain certified • Might have to transport SAF extra distance Blending at SAF production site: • Need to invest in expensive refining and blending infrastructure • Must have access to CAF
Blending at hub Pure CAF and pure SAF are transported separately to an intermediate location, such as a fuel terminal and storage, where they are blended.	Can use existing harbour storages/terminals or new dedicated blending hubs (in Norway), if investing in required infrastructure.	• Larger volumes can be blended compared to blending at airport • Available fuel infrastructure and permits • Experience in fuel handling • Can supply several airports • More flexibility and control of volumes and qualities (incl. tracing, reporting and documentation) compared to blending at refinery • Can facilitate a full supply chain in Norway and increase security of supply	• Requires SAF specific infrastructure to hub and at hub, including blending infrastructure (and requires upgrading/refining infrastructure prior to blending) • System needed to track fuel to different airports • Can still be challenges related to traceability
Blending at airport Pure CAF and pure SAF are transported separately to an airport, where they are blended. This requires blending infrastructure at the airport.	For Norway with many small airports this option is in general not favorable, but can be relevant for some large airports and/or if SAF is produced close to airport	• Can be advantageous if SAF is produced close to the airport • Enables physical delivery of SAF to aircraft • Easier to trace products and reduces possibilities of «cheating» on sustainability requirements • Positive for highlighting climate impact at specific locations • Can facilitate a full supply chain in Norway and increase security of supply	• Requires SAF-specific infrastructure to airport and at airport, including blending infrastructure (and requires upgrading/refining infrastructure prior to blending) • Permits and infrastructure for blending and storage required

Security of supply: Why a domestic SAF value chain matters

Today, all SAF used in Norway is imported as a pre-blended product. In the short to medium term, domestic production is unlikely to meet national demand – and most semi-finished products will likely be exported for final refining and blending. This leaves Norway highly dependent on international SAF supply chains.

At present, Mongstad is the only Norwegian refinery producing jet fuel. While it has the capacity to meet most domestic demand – and could co-process and blend SAF with some modifications – this centralised model represents a clear vulnerability.

Outside Mongstad, both civil and military aviation rely fully on imports. In the event of geopolitical crisis or war, accessing critical fuel supplies – not only SAF – could become a serious challenge, with implications for both defence and emergency preparedness.

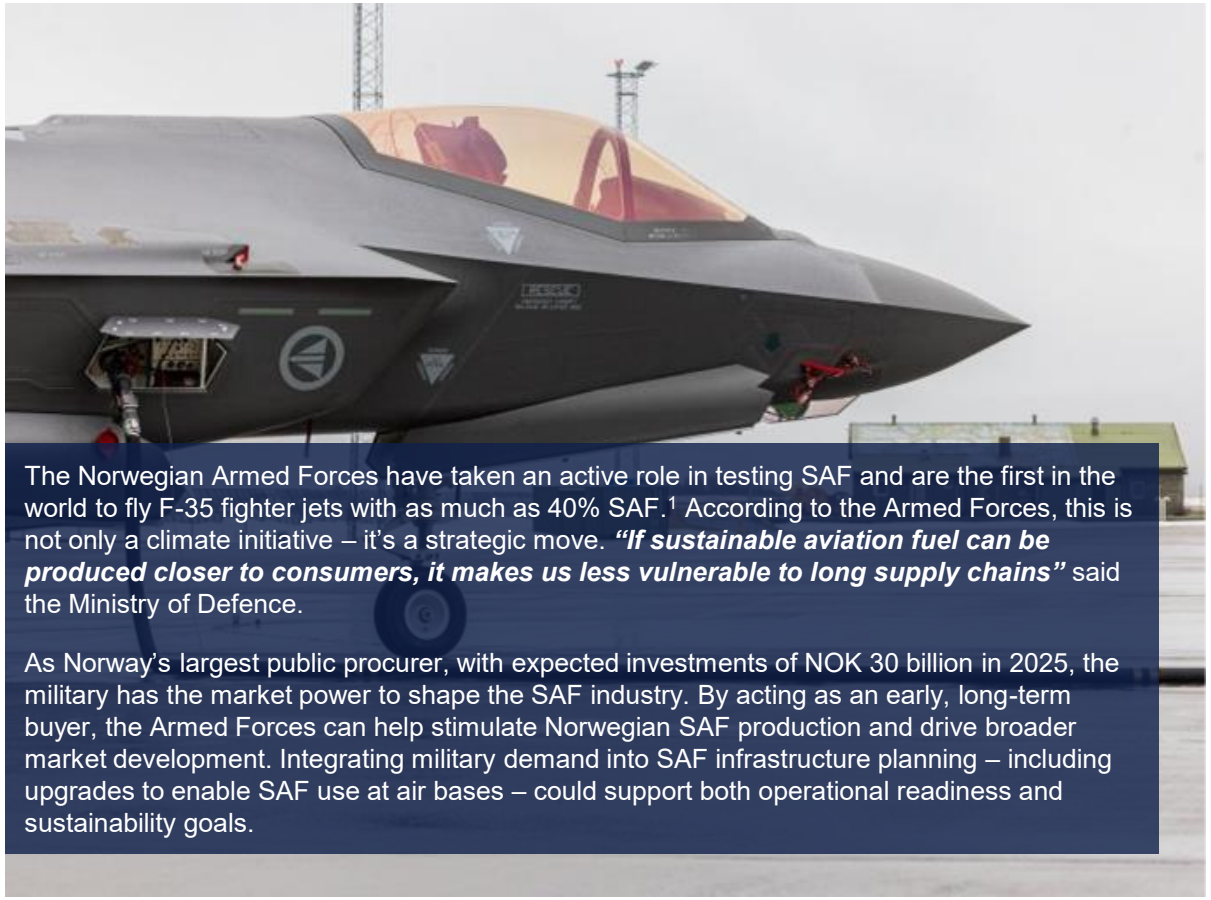
Why invest in domestic capacity?

In addition to strengthening national control and improving crisis resilience, investing in domestic production, refining and blending infrastructure could bring broader long-term benefits:

- Job creation and regional value generation
- Reduced emissions from long-haul fuel transport
- Greater traceability and control of fuel sustainability credentials

This raises a key strategic question: Should Norway build out a full domestic SAF value chain – or continue to rely on global optimisation?

While we do not claim to have the final answer, we can help shed some light on the options.



The Norwegian Armed Forces have taken an active role in testing SAF and are the first in the world to fly F-35 fighter jets with as much as 40% SAF.[1] According to the Armed Forces, this is not only a climate initiative – it's a strategic move. ***"If sustainable aviation fuel can be produced closer to consumers, it makes us less vulnerable to long supply chains"*** said the Ministry of Defence.

As Norway's largest public procurer, with expected investments of NOK 30 billion in 2025, the military has the market power to shape the SAF industry. By acting as an early, long-term buyer, the Armed Forces can help stimulate Norwegian SAF production and drive broader market development. Integrating military demand into SAF infrastructure planning – including upgrades to enable SAF use at air bases – could support both operational readiness and sustainability goals.

Source: 1) Forsvaret, Først i verden med biodrivstoff

Security of supply: Why a domestic SAF value chain matters

To evaluate whether – and if so, how – to build a more secure SAF value chain, it is useful to compare three potential supply chain structures:

A centralised model: The status quo

This is the current model, relying on one main refinery (Mongstad) and imports of pre-blended SAF. While this is a cost-effective model, utilising economies of scale and existing infrastructure, it leaves Norway vulnerable to a single point of failure and global supply shocks, with limited flexibility and responsiveness in times of crisis.

Fully distributed model: Maximum resilience

In this model, smaller-scale refining and blending capacity is established at or near distributed production sites or airports. Unlike conventional fossil fuel, next-generation SAF – particularly advanced biofuels and e-fuels – can be produced in a more decentralised and modular manner, located close to the source of feedstock and power as well as point of use.

This solution would offer improved redundancy and traceability, reduced emissions due to shorter supply chains, while stimulating regional value creation. However, it requires significant investment not only in production facilities, but in purpose-built infrastructure for handling and blending SAF, resulting in higher capital and operational costs. This solution also requires broad political support and coordination.

A hybrid hub-and-spoke model: Efficiency meets flexibility

An alternative to a fully distributed supply chain that still enables resilience could be a hub-and-spoke model. In this model, smaller collection points or processing sites (the "spokes") gather intermediate products, which are then transported to a larger, central facility (the "hub") for further upgrading and blending (e.g. Mongstad or other refineries). This supports domestic production and offers flexibility in the system (if one spoke is down, others can still supply the hub), while also offering economies of scale at the upgrading hubs.

A strategic fit for Norway?

Given Norway's geography, distributed airport network, and increased focus on security of supply, a hybrid supply chain for SAF – combining regional nodes with strategic hubs such as Mongstad – could provide a good strategic balance between national resilience, cost-efficiency, and reduced climate footprint, while supporting industrial developments.

While this transition would require long-term commitment, cross-sectoral coordination, and clear policy signals, it could future-proof Norway's aviation fuel supply in an increasingly uncertain world.

3. The SAF paper trail

Ensuring compliance with sustainability criteria

The SAF paper-trail
Introduction and key take-aways

For fuel suppliers to demonstrate compliance with blending mandates, they need to document that their fuel meets sustainability criteria. This section investigates how this can be done in practice across a fuel supply chain.

Key take-aways

- Fuel suppliers in Norway must document to the Norwegian Environmental Agency that they meet the SAF blending mandate, both in terms of volumes and sustainability criteria
- Suppliers can choose to report through voluntary certification schemes such as ISCC or through self-declaration
- For a fuel to obtain ISCC certification, all economic operators that handle sustainable material in the fuel supply chain must be individually certified
- For SAF blended early into the fuel supply chain it can be challenging to trace sustainability. The later that SAF is blended into the supply chain, the fewer economic operators to certify
- New developments such as updated ISCC mass balance rules and Norway's access to the EU Union Database can improve traceability and enable certification even in complex supply chains with shared infrastructure

SAF requires certification for both quality and sustainability

Sustainable aviation fuel must be certified on quality to be approved for use, and on sustainability to qualify as sustainable according to sustainability schemes and/or regulation.

Quality certification

For aviation fuel to be approved for use in aircraft engines, quality certification by ASTM International is required. The ASTM standard for conventional jet fuel is ASTM D1655, and ASTM D7566 for SAF.

SAF conversion processes are evaluated and approved by ASTM International. There are currently 11 approved conversion processes for SAF production (including 3 co-processing pathways) and 11 are currently under evaluation.[1] Each batch of jet fuel needs to be certified prior to usage, to the specification requirements listed in the D7566 Annex corresponding to the SAF production pathways.

The ASTM standards specify limits on some compounds that a fuel must have to be certified as aviation fuel. To meet these, SAF must be blended with CAF. The blending limits are dependent on production pathway. After blending SAF with CAF the blend must be re-certified, and is then considered a drop-in fuel which can be handled, stored, refuelled and used in the same way as conventional aviation fuel.

Sustainability certification

There are international guidelines and regional or national requirements and definitions to qualify as sustainable (aviation) fuel. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) has defined CORSIA Eligible Fuels (CEF), while the EU RED II has defined criteria to qualify as different sustainable fuels in the EU.

CORSIA is the first global market-based measure scheme for an industry sector, developed by the International Civil Aviation Organization (ICAO). It aims to ensure carbon-neutral growth in international aviation by assigning emission offsetting requirements to individual airline operators when emissions exceed a given baseline. Participation in CORSIA is voluntary until 2027, after which most countries (and hence the majority of airlines) will be affected by the scheme.

Airline operators can reduce their emissions (and thereby their offsetting requirements) through the use of CEF. The two CEF types include SAF and Lower Carbon Aviation Fuels (LCAF).

The CORSIA requirements for greenhouse gas (GHG) emissions to qualify as these fuels are far less strict than the EU RED requirements for biofuels, RCF and RFNBOs.

Compliance with EU RED II and CORSIA can be shown through sustainability certification schemes. The ISCC and the Roundtable on Sustainable Biomaterials (RSB) have certification schemes for actors in the SAF supply chain to show compliance with both. In addition to these two, there are several other voluntary and national certification schemes recognised by the European Commission to show compliance with EU RED II. **This report focuses on ISCC.**

Scheme provider	Compliance with ICAO CORSIA	Compliance with EU RED
ISCC	ISCC CORSIA	ISCC EU
RSB	RSB ICAO CORSIA	RSB EU RED

Source: 1) ICAO, SAF Conversion processes; *2)* CORSIA Approved Sustainability Certification Schemes; Transport & Environment, "Why ICAO and Corsia cannot deliver on climate" (September 2019); IATA, "CORSIA Fact Sheet"

ISCC EU can certify SAF in line with RED II and III

The International Sustainability and Carbon Certification (ISCC) is an approved certification scheme under the EU. Within the EU, ISCC offers both the ISCC EU, recognised by EU RED II and III to demonstrate compliance with RED, as well as ISCC Plus, a voluntary certification scheme for all non-regulated markets (no mandatory legal sustainability criteria).

Who needs certification?

Any participant (or economic operator) in the SAF supply chain needs to be individually certified to ensure both traceability and chain of custody:

The ISCC regulations state that *"all economic operators that handle sustainable material (e.g. produce or generate, collect, process, store or trade) have to be covered by an ISCC certification. In the ISCC system the term 'economic operator' refers to a specific site (spatial entity) of a company where sustainable material is handled."*[1] Hence, supply chain elements subject to certification include farms and plantations, points of origins, first gathering points, central offices, collecting points, traders, storage facilities and processing units.

Who is exempt from certification requirements?

- Transportation of SAF between two economic operators does not require its own certification. This is covered within transportation emissions for the certification scope of the relevant economic operator.
- A SAF or SAF-blend storage provider, if they take no ownership of the product and make no changes to the product. However, if this is an intermediate storage provider for an economic operator, the economic operator must include this storage as part of their certification scope.
- A blender for SAF blending services who does not take ownership of the product. But the service must be included in the certification scope for the economic operator using the service.

Source: 1) ISCC EU 201 System Basics; 2) ISCC EU 203 Traceability and Chain of Custody

Note that a SAF reseller who purchases SAF to then sell to airlines takes ownership of the product and therefore needs to be certified.

Sustainability Declarations

In terms of declaring the sustainability of the product, the ISCC comments that *"evidence of the sustainability characteristics of a sustainable material is documented and forwarded through the supply chain by using 'Sustainability Declarations' (…) Recipients of sustainable material have to ensure that their supplier was certified at the date of the physical dispatch of the material. All of the valid certificates are displayed on the ISCC website."*[2]

The ISCC document on traceability and chain of custody[2] establishes that traders (with or without storage) receiving and delivering final biofuels needs to state information of GHG emissions and savings on the Sustainability Declaration. This information includes GHG information for transport and distribution of the final product up to the final market/filling station, and is calculated and provided by the producer of the final product

ISCC scope	ISCC tracking model
Sustainable fuels used for transport, electricity, heating and cooling and the production of electricity, heating and cooling from biomass in the European Union. Covering biofuels, bioliquids, biomass fuels, advanced fuels, low ilUC risk fuels, RFNBOs* and RCFs*. **The European Commission Officially recognised ISCC EU for the certification of RFNBOs and RCFs and forest biomass in December 2024*	• Mass balance allows the physical mix of sustainable materials with different sustainability and GHG emissions saving characteristics and non-sustainable materials. • Physical segregation means that materials with different properties are kept physically separated from each other on their journey through the supply chain. • According to RED II economic operators shall use a mass balance system.

ISCC EU can certify SAF in line with RED II and III

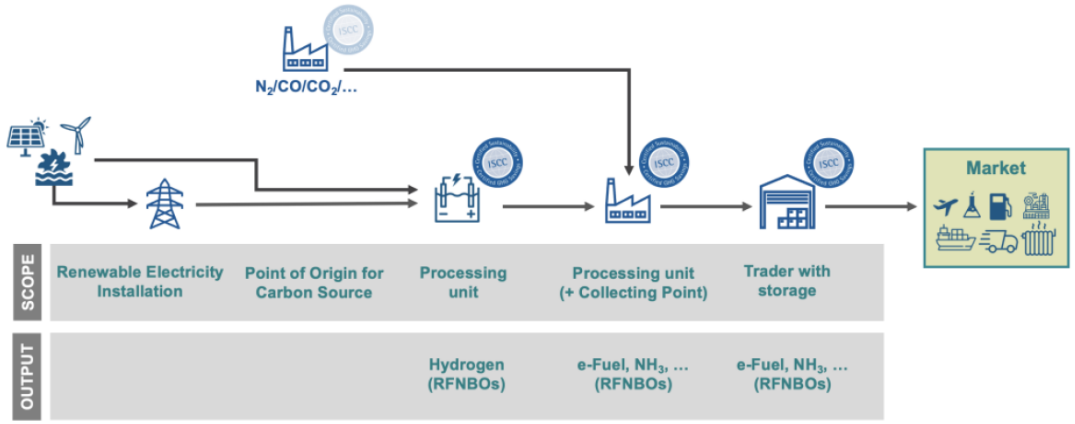
The “next generation” of sustainable fuels, RFNBO and RCF, was defined in RED Delegated Acts in 2021 (Adopted in 2023), but no approved schemes existed to certify these until December 2024, when ISCC EU was recognised by the European Commission for the certification of these fuels. ISCC has recently published separate guidance documents on RFNBO’s, RCFs and forest biomass, in addition to other ISCC EU guidance documentation.[1]

The traceability of RFNBOs starts at the producer of the renewable electricity and covers the entire downstream supply chain. Traceability is achieved by applying an appropriate chain of custody method (e.g. mass balance or physical segregation) as well as relevant documentation. This includes Self-declarations and Sustainability Declarations, ensuring that all relevant information, such as the country of origin (i.e. the country where the renewable electricity was generated), the amount of fuel, and the respective GHG emissions of a material can be clearly identified at each level of the supply chain.

The entire supply chain of RFNBOs must be covered by certification. The first element of the supply chain requiring individual certification is the economic operator producing hydrogen out of renewable electricity (i.e. electrolyser certified under the scope processing unit). The producer of the renewable electricity shall provide a signed self-declaration to the certified hydrogen producer.

For RCFs, the first element of the supply chain requiring individual certification is the economic operator collecting the RCFs feedstock from the point of origin and becoming the owner of the material. This economic operator is called “collecting point”. The point of origin for the RCF feedstock shall provide a signed self-declaration to the collecting point.

Figure 6: RFNBO supply chain covered by ISCC certification[1]



Source: 1) ISCC EU 202-6 Renewable Fuels of Non-Biological Origin(RFNBOs) and Recycled Carbon Fuels (RCF)

Certification bodies verify compliance

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Third-party independent certification bodies are responsible for verifying compliance with the requirements that are set by the voluntary certification scheme. The certification body needs to be accredited by the certification scheme. The ISCC process is illustrated in Figure 7.

Auditors are individuals that work for the certification body, verifying compliance with the requirements of the applied voluntary certification scheme.

If the audit proves compliance with the criteria laid out in the certification scheme, a sustainability certification is issued. The owner of the certificate can sell the product with the certification logo.

Certifications are valid for a 12-month period, and audits will be performed annually for re-certification

Figure 7: The four steps to achieving ISCC certification[1]

Source: 1) ISCC EU 201 System Basics

Sustainability in Norway must be documented to the Norwegian Environment Agency

In Norway, Chapter 3 of «Produktforskriften»* (the Norwegian Product regulation) sets requirements for the annual share of biofuels sold in road transport, maritime transport, aviation and other purposes. The regulation also contains sustainability criteria and documentation requirements.

Fuel suppliers looking to claim contribution towards the blending mandates are required to document to the Norwegian Environment Agency that the fuel used to fulfil the biofuel mandates meets the sustainability requirements given in the regulation. This can be done in two ways: (1) certification by an approved voluntary scheme, or (2) self declaration. According to the Norwegian Environment Agency, around 50-60% of the biofuel volumes reported since 2020 has chosen option 2.[1]

An important update was made to the regulation and its guidance document ("Veileder M-10") 1st January 2025: the requirement to document sustainability in **all parts of the value chain** when using the "self declaration" option. This was done to align with ISCC requirements, where *"all economic operators that handle sustainable material (e.g. produce or generate, collect, process, store or trade) have to be covered by an ISCC certification."*

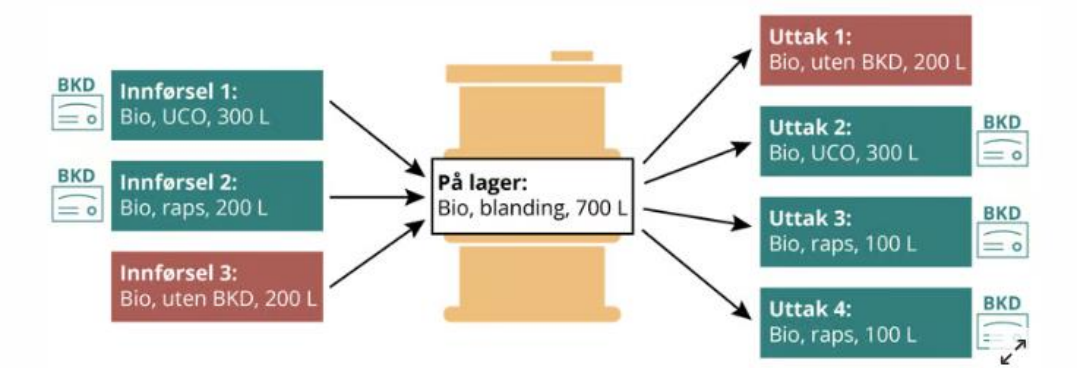
Like ISCC, a mass balancing system should be used when reporting on the fulfilment of sustainability criteria to ensure that information is not double-counted. This system allows batches of fuels with different sustainability characteristics to be mixed, and allocation of these sustainability characteristics to different output batches, as shown in Figure 8.

The point of reporting is from the fuel supplier's storage. From that point the mass balancing principle does not have to be followed, and the supplier can use a "book and claim" principle. This means that suppliers can sell a batch of "100% SAF", if the SAF is not double counted. This is in line with the EU RED II rules.

To comply with ISCC and RED II GHG calculation methodology, which includes emissions from transport and distribution of the fuel to the end user, the Sustainability Declaration from the supplier must include GHG information on the transport and distribution to the recipient of the fuel. This must be calculated and provided by the fuel producer. The Norwegian requirements for self declaration are aligned with this.

The Norwegian Environment Agency has further proposed amendments to the Sustainable Products Act to implement sustainability and emission reduction criteria from RED II, also establishing the legal basis for blending mandates for alternative fuels and for implementing obligations under ReFuelEU Aviation.[3]

Figure 8: Illustration of the mass balancing principle (BKD = Sustainability documentation)[2]



** The Regulation of 1 June 2004 no. 922 relating to restrictions on the manufacture, import, export, sale and use of chemicals and other products hazardous to health and the environment*

Source: 1) Miljødirektoratet (2024), Høringsnotat og konsekvensvurdering: Endringer i produktforskriften kapittel 3; 2) Miljødirektoratet (2025), M-10 Omsetningskrav for biodrivstoff; 3) Miljødirektoratet (2025), Høring - forslag til endringer i lov om bærekraftige produkter

All economic operators in the SAF supply chain must be certified

All economic operators handling sustainable material in the SAF supply chain – from feedstock collection to final storage before delivery – must be individually certified under ISCC or equivalent schemes. In Norway, suppliers may alternatively choose the self-declaration route, but in this case, they must provide documentation covering each step of the supply chain and the sustainability information must be passed from one actor to the next to ensure full traceability.

Across all blending scenarios – whether pre-blended, blended at hub, or blended at the airport – the quality certification of the SAF-CAF blend (according to ASTM D1655) is required after blending. Regardless of where blending occurs, the supplier's storage site is the last element that requires sustainability certification. Emissions from transportation and distribution to the end user must also be included in the final Sustainability Declaration.

A key difference between the blending scenarios lie in how and where the sustainability attributes are documented. Generally, the fewer steps involved in the SAF supply chain, the easier it is to trace and verify the fuel's sustainability. However, this simplification could come with higher costs, particularly where purpose-built infrastructure is required to transport and handle the SAF to the point of blending.

The following slides illustrate three different blending scenarios and their respective "paper trail". The "paper trail" refers to the documentation required at each stage and the transfer of ownership. This ensures the chain of custody – or chain of ownership – can be clearly traced and verified. Each transaction must maintain clear records of ownership as well as the fuel's quality and sustainability attributes.

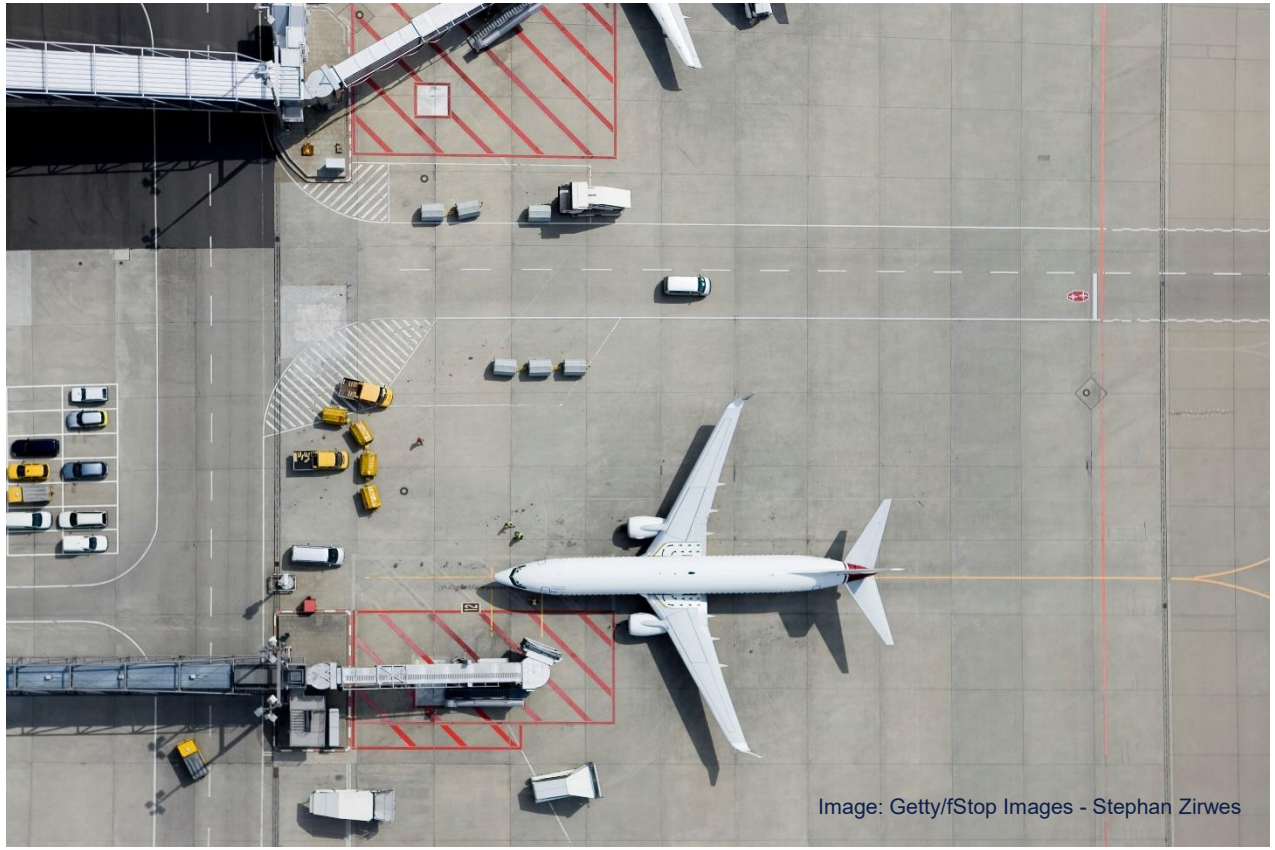


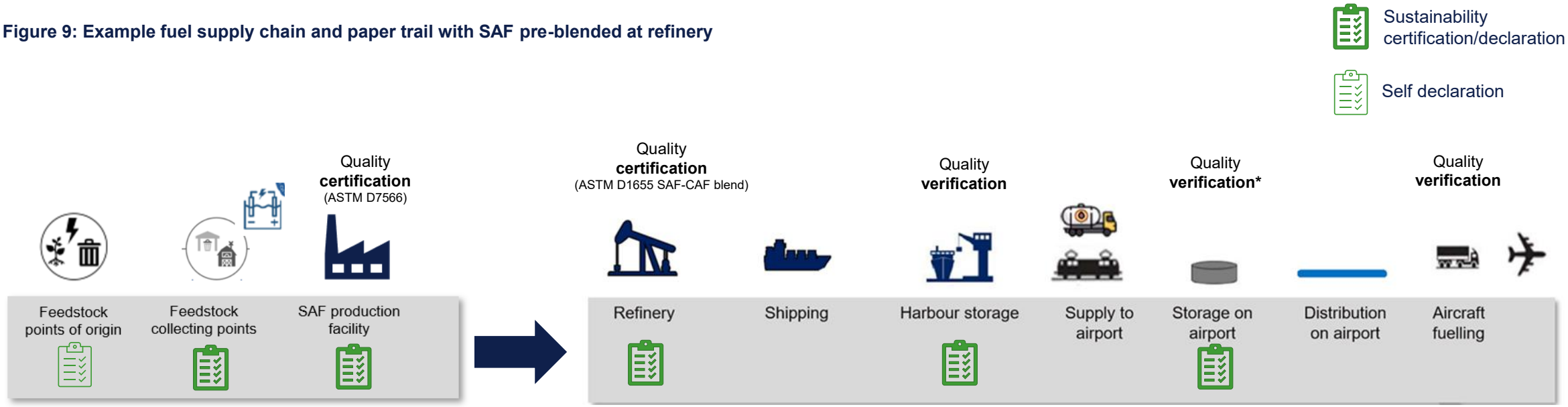
Image: Getty/fStop Images - Stephan Zirwes

Requirements for different blending scenarios

Blending at refinery: Standard paper trail

When SAF is pre-blended at the refinery, the refinery becomes an economic operator handling sustainable material and must therefore be individually certified. The sustainability certification must follow the product through each subsequent transfer of ownership, ensuring that the entire paper trail – from feedstock to supplier storage – remains intact and verifiable. This is the most common setup today, but the number of actors in the chain increases the risk of breaking the certification chain if documentation is missing or unclear.

Figure 9: Example fuel supply chain and paper trail with SAF pre-blended at refinery



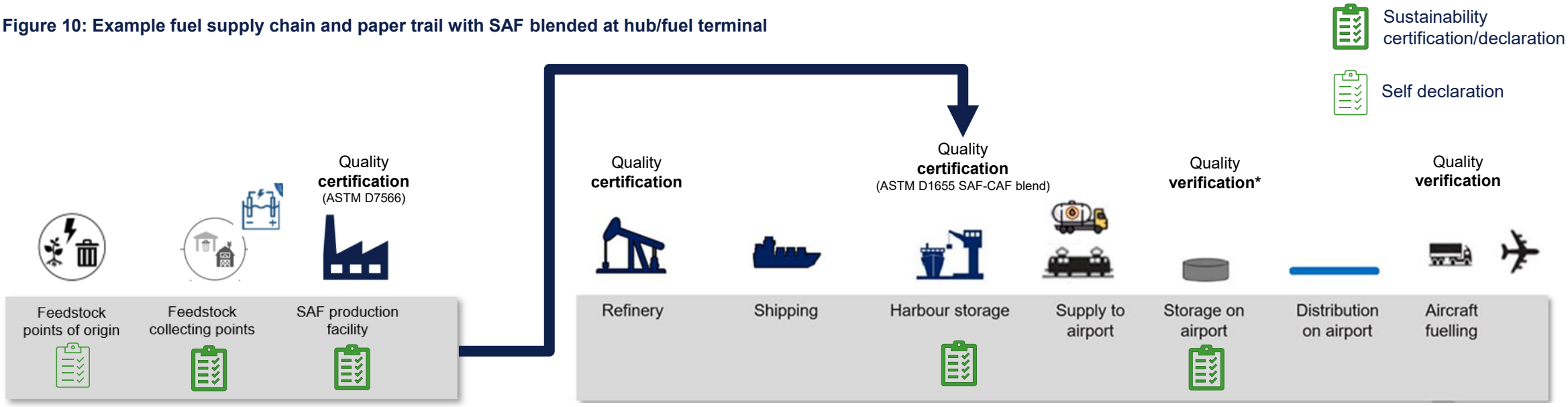
At OSL: Quality **certification is required after intermediate storage*

Requirements for different blending scenarios

Blending at hub: Certification moves downstream

If blending occurs at a central hub — such as a harbour terminal — the refinery no longer needs sustainability certification, removing one chain in the paper trail. The sustainability certifications and all supporting self-declarations are transferred directly from the production facility to the terminal operator. The terminal operator must then ensure all sustainability documentation and declarations are received and passed on accurately to the next owner.

Figure 10: Example fuel supply chain and paper trail with SAF blended at hub/fuel terminal



At OSL: Quality **certification is required after intermediate storage*

Requirements for different blending scenarios

Blending at airport: Simplified documentation, increased infrastructure demands

When SAF is blended at the airport, neither the refinery nor the harbour storage/fuel terminal requires sustainability certification. Instead, the certified fuel is delivered directly to the airport storage, where blending takes place. The transfer of sustainability certifications and self declarations also occur directly between the production facility and the owner of the airport storage. This reduces complexity in the documentation chain but demands dedicated SAF handling infrastructure along the supply chain and blending facilities at the airport.

Figure 11: Example fuel supply chain and paper trail with SAF blended at airport

Traceability challenges can be solved with new developments

New ISCC guidance can remove historical barriers to certification

Fuel suppliers have highlighted that tracing sustainability attributes through the SAF supply chain remains complex – particularly in shared terminals where multiple suppliers use the same infrastructure.

Up until earlier this year, shared fuel storage terminals – where fuels from multiple suppliers are co-mingled – could not be certified under ISCC's mass balance rules unless all physical balances at the terminal were known. This lack of transparency between suppliers made it difficult to maintain certification through the entire supply chain. As a result, suppliers in Norway utilising co-mingled storage terminals had to rely on self-declaration of their volumes rather than unified certification schemes.

To resolve this issue, ISCC has recently published a mass balance guidance which introduces two approaches to assigning sustainability characteristics: proportional and flexible allocation. The new guidelines allow each supplier to maintain and certify their own physical balances, even within co-mingled infrastructure. Each party will retain its own records and bookkeeping, and live blend ratios will be calculated per input and output to ensure traceability.[1] This change enable certification of shared terminals and maintain end-to-end sustainability certification, even in complex supply chains, significantly improving the feasibility of certifying SAF delivered through shared infrastructure.

The EU Union Database offers a harmonised traceability tool

In parallel, the EU Union Database (UDB) represents another key development to strengthen traceability across SAF supply chains. The database is a central digital platform for registering and tracking certified sustainable fuels through all stages of the supply chain. It facilitates verification of compliance with sustainability and greenhouse gas reduction criteria, and enables aviation operators to use sustainable fuels under the EU ETS without needing to surrender allowances ("zero-rating"), provided the fuel batches are properly registered and cancelled in the database.[2]

With the recent decision on incorporating RED II into the EEA Agreement, Norwegian players will now be eligible to participate in the UDB, marking a major step forward. This enables Norway to align with EU traceability practices, harmonise certification procedures, and strengthen control mechanisms. Once the UDB is fully operational and accessible, Norwegian verifiers and economic operators should be able to use the database to demonstrate compliance, improve auditability, and reduce administrative burden. It should nevertheless be noted that, according to NHO Aviation, it is possible to zero-rate emissions from the use of SAF under the ETS today using national systems.

A more feasible path toward end-to-end certification

In combination, the updated ISCC guidance and the implementation of the UDB offer a path toward resolving long-standing traceability barriers—particularly in complex supply chains involving shared infrastructure. These developments make it increasingly feasible to maintain robust, end-to-end sustainability certification for SAF in both the EU and Norway.

Source: 1) ISCC EU Mass Balance Document; 2) ISCC, Union Database (UDB)

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