SAF Midstream - Refinery retrofitting and pathway readiness

Regional SAF Training for Rwanda

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Global Gateway

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Day 2: Session 9

Topic

SAF Downstream part I: Certification, Deployment and Market Uptake, from Refinery to Runway

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CBR Sustainability Partners

Project Manager

Raphaela Spielberg is a highly experienced professional in the field of sustainable finance, with a strong track record in strategy development and the execution of impactful projects and climate technologies. Her expertise extends to thematic investment consulting and climate risk management, particularly in overseeing ESG-compliant initiatives while driving sustainable financial solutions.

She is experienced in assessing and developing business cases in the PtX field, analysing global climate challenges, executing the financial modelling and conducting deep-dive research of risk and sensitivity.

Consulting Focus @ CBR Sustainability Partners

- Project management and business planning, e.g., application support for EU funding programs for the demonstration of innovative low-carbon technologies (EU Innovation Fund)
- Sustainability (CSR) and ESG concept development and implementation (strategy, roadmaps, reporting, labels)

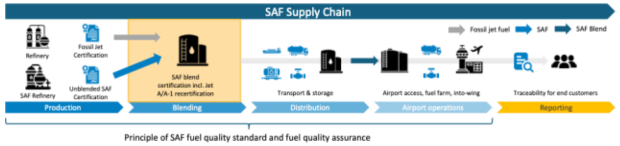
Education

Sustainability & Climate Risk Professional, GARP

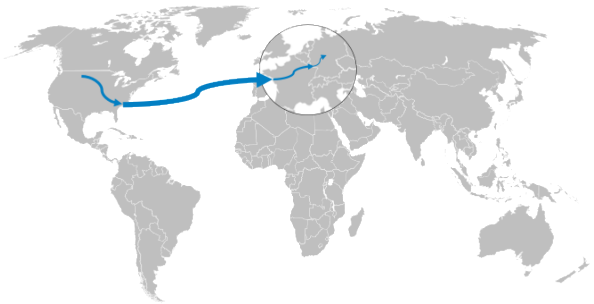
Master in Sustainable Finance, NOVA SBE, Lisbon

EASA

Guiding questions



What are the key activities and actors of SAF downstream value chain?



What are different modes of SAF logistics and their preference based on flexibility and capacity?

RED III

CORSIA

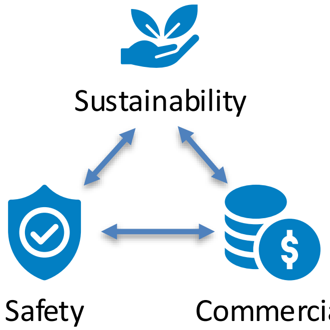
energy institute

JIG

ISCC International Sustainability & Carbon Certification

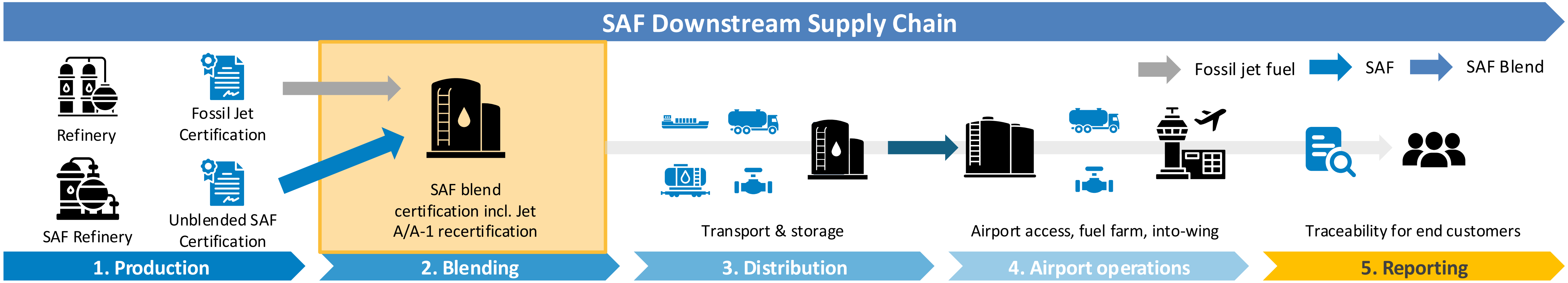
RSB CERTIFIED

What are various certification types and quality standards? Which organizations are involved?



What are the risks associated in the downstream value chain?

6 major actors are involved in 5 key steps of SAF downstream value chain



Key activities

1. Neat SAF production at dedicated SAF refineries (certified drop-in fuel)
2. SAF blending with conventional Jet A/A-1 (blend ratio up to 50% SAF in compliance with ASTM D7566 (SAF) and ASTM D1655 (Jet A/A-1); higher blends under development)
3. Distribution of blended fuels through various transport methods, including terminals, pipelines, trucks
4. Airport fuel farm receipt and aircraft fueling operations
5. Sustainability reporting based on certification schemes (e.g. ISCC, CORSIA) and lifecycle emissions accounting

Key stakeholders

- Refiners
- Airports
- Blenders
- Certification bodies
- Logistics providers
- Airlines

Source: CBR, 2025; IATA, 2025; Europe aviation environmental report, 2025.

Selection of logistics is dependent on two factors: Volume & distance

	Favourable factors	Potential limitations
Pipeline	Most efficient (land) Large quantity	High CAPEX
Bulk tankers	Most efficient (sea) Large reach	Large capacity
Coaster	Coastal areas	Limited reach
Barges	Inland waterways	Limited capacity
Rail	Large total quantity	Limited availability
Truck	Operational flexibility	Limited capacity High OPEX
ISO tanks	Intermodal Intermediate storage	Low capacity Higher contamination risk

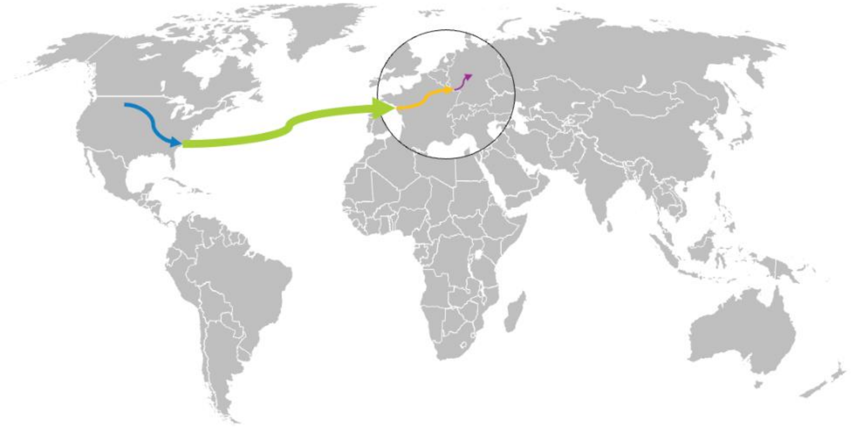
Flexibility

Capacity

The **GHG emission factor** is a critical criterion when selecting the transport mode, as the **total emissions are dependent on both distance** and **modality of transport**. Before entering the formal certification process, it can be an option to perform a high-level LCA as a pre-certification step to obtain an initial estimate of the SAF's carbon intensity.

Source: SKYNRG, CBR 2025

5 key criteria to determine a location's suitability for blending



Distance / volume	Modality (often)
Large / high	Shipping
Medium / high	Pipeline
Medium / medium	Rail
Short / low	Truck

1. Product

- **Fuel characteristics** and **certification requirements** define infrastructure design and blending strategy (upstream vs downstream).
- SAF pertaining higher-risk of contamination require assessment for **segregated** vs. **fungible fuel handling.**

2. Location

- **Blending closer to demand** can increase **flexibility** to compliance. Conversely, it can lower unit cost.
- **Local regulations, inspection/QC practices, sustainability verification** need to be determined **by jurisdiction**.

3. Capacity

- Capacity identifies **bottle-necks**, limits **achievable SAF blend rates** and defines investment requirements for **volume scale-up.**
- Big tank farms limits constraint on peak flows of CAF flow, with adequate throughputs.

4. Equipment

- High-control equipment enables **precise, repeatable blends** and faster **changeovers.**
- Availability of **QC infra-structure** limits risk of low quality blends. Determines CAPEX intensity, operational reliability.

5. Modality

- Only few transport modes **tolerate grade-switching** without strict segregation.
- Depending on the required SAF blend types, fueling systems, transport modes will be selected, ultimately determining the **resilience of SAF logistics** network.

Conclusion

- 5 criteria are defined from product quality, safety and viability of process.
- **Centralized blending occurs at hub terminals/ ports**, producing finished SAF grades for distribution.
- **Decentralized blending** enables **offtaker flexibility.**

Source: CBR 2025
QC - Quality Control, CAF – Conventional Aviation Fuel,

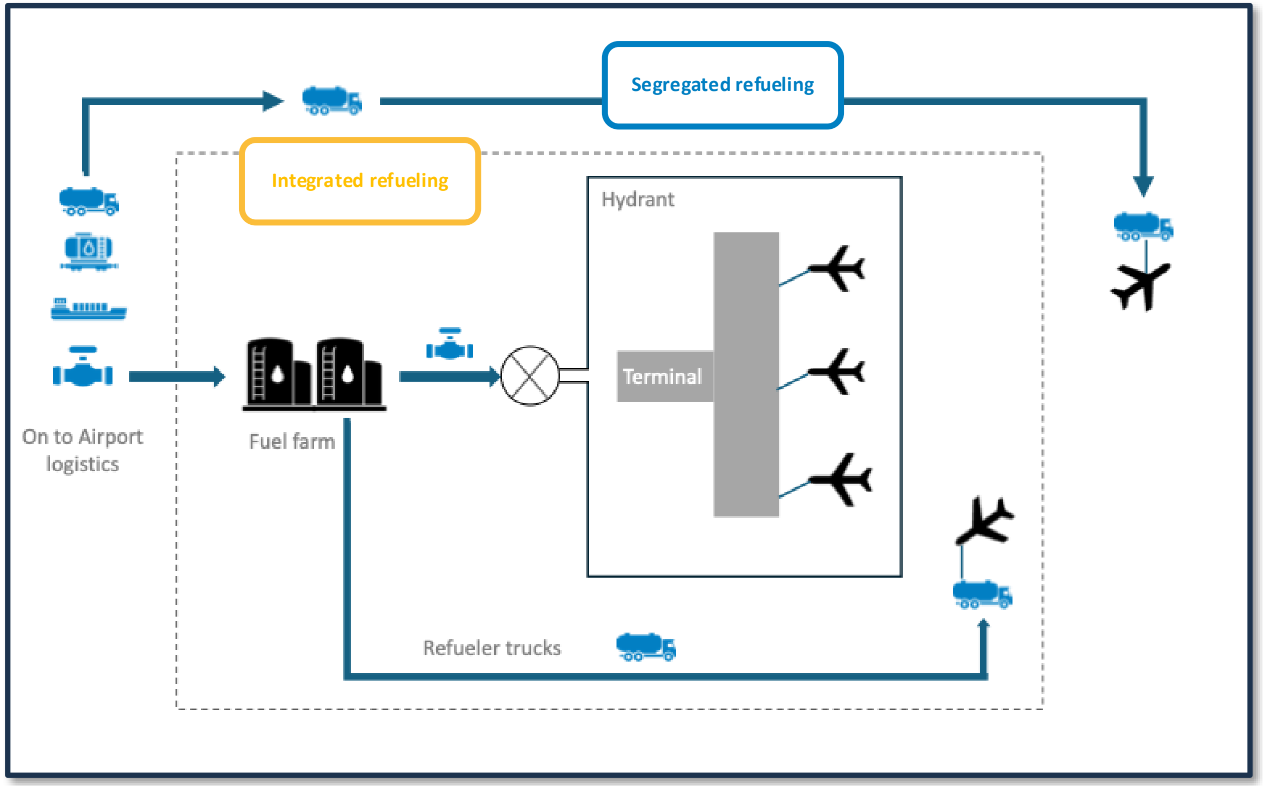
Exemplary model of physical supply of SAF blended aviation fuel onto the airport and into wing

Integrated

- SAF blended before the transport to airport, entering the common fuel farm
- All aircraft receive the same blended fuel through hydrant system or refueler trucks, **SAF benefits tracked via mass-balance accounting**
- This method is considered most **efficient** and **scalable**, minimizing extra infrastructure, cost and safety risks

Segregated

- **Dedicated SAF storage** and trucks, **physically separated** from the main jet fuel system
- Majorly used for **specific flights needing known SAF blend shares**, trials or branded services
- It involves **higher cost** and **operational complexity**, with additional equipment and stricter handling controls



Source: SKYNRG, CBR 2025

Aviation fuel handling is heavily regulated by fuel quality standards and assurances to ensure safety and compatibility with standardised infrastructure.

WHAT?

Quality standards

- Specify **what** quality requirements need to be met
- Specifications to ensure it's fit-for-purpose
- Most widely used standards
  – **ASTM**: American Society for Testing and Materials
  – **DefStan**: UK Defence Standards
- Other standards exist on country-level
- Application of standards is dependent on the airport and country, where fuel is delivered

WHY?

Benefits of regulation

- **Safety**: Reliable fuel quality is vital to ensure the safety of all personnel and passengers
- **Global compatibility**: Shared global SAF necessitate uniform supply procedures and standardised infrastructures
- **Accountability**: In case of a safety incident, standardized processes ensure traceability for determining liability

HOW?

Quality assurance

- Specify **how** the fuel quality is ensured
- Procedures to handle, monitor and evaluate fuel quality
- Most common global guidelines;
  – **JIG**: Joint Inspection Group
  – **EI**: Energy Institute
- Other global and national guidelines exist
- Application of guidelines is dependent on the airport and country, where fuel is delivered

EASA

Source: SKYNRG, CBR 2025

Certification schemes ensure sustainability criteria as well as safety aspects of sustainable aviation fuel

Sustainability certification for SAF

- **EU RED II criteria**: ≥50% GHG reduction vs. 94 gCO_2e/MJ baseline; it varies by feedstock
  - waste-based 60–80% reduction
  - crop-based 15–40% reduction
  - e-SAF up to 80% reduction
- **ISCC CORSIA**: Traceability & Chain of Custody (Doc 203), Risk Assessment (Doc 204), 5 accredited certifiers globally; ISCC CORSIA and ISCC EU
- **RSB**: RSB CORSIA
- ICAO CORSIA baseline methodology

Regulations/initiatives RED III CORSIA

Certifying bodies RSB CERTIFIED ISCC International Sustainability & Carbon Certification

ASTM approval for SAF

Technical certification and **handling standards** assuring that the **chemical properties** of the fuel are adequate and compliant with the use as jet fuel.

- **ASTM D1655**: Key specification for JetA/A-1.
- **ASTM D7566**: Quality standard required for each SAF production pathway, defining which feedstock must be used, the associated process and the properties and the output of each pathway.
- **ASTM D4054**: the process for approval of new SAF production pathways.
- **JIG standards**: e.g., JIG 1, JIG 2, JIG 4
- **EI standards**: e.g., EI 1533, EI/ JIG standard 1530
- **DEF STAN 91-91** (UK Standard for aviation turbine fuel)

energy institute ASTM INTERNATIONAL JIG

Source: CBR 2025

Standards guarantee fuel quality control & technical compliance

Non-exhaustive

Document / Standard	Short Description of Role
ICAO 9977 (Manual on Civil Aviation Jet Fuel Supply)	Global guidance on how jet fuel (including SAF) is supplied, stored, handled, and quality-controlled from refinery/terminal to aircraft; focuses on safety, cleanliness, and specification compliance rather than GHG or feedstock sustainability.
EI/JIG Standard 1530	Energy Institute & JIG standard that sets quality-assurance requirements for manufacture, storage, and distribution of aviation fuels up to airport receipt; covers sampling, testing, filtration, tank management, documentation, and contamination control.
JIG 1	Standard for into-plane fuelling operations at airports (refueller trucks, hydrant dispensers, operator training, inspections); ensures that fuel meeting ASTM specs is delivered safely and cleanly to aircraft.
JIG 2	Standard for airport storage and hydrant operations (fuel farms, tanks, hydrant systems); defines procedures for water draining, filter management, routine testing, and record-keeping.
API 1543	Recommended practice focused on documentation, monitoring, and laboratory testing for aviation fuel handling and quality control along the supply chain; underpins technical compliance with fuel specifications.
API 1595	Guidance for design, construction, operation, maintenance, and inspection of aviation fueling facilities (terminals, tank farms, hydrant systems); addresses engineering and safety aspects of jet/SAF infrastructure.
ATA-103	Standard for jet fuel quality control at airports (widely used in North America); sets detailed procedures for airport storage and into-plane fuelling, similar in scope to JIG 1/2.

Source: ECAC - Guidance on SAF

EI - Energy Institute (Technical standards and guidance for energy sectors), JIG - Joint Inspection Group (Aviation fuel supply standards and inspection practices from refinery/terminal to wingtip), API – American Petroleum Institute (Develops consensus standards for the broader oil and gas industry, including many foundational aviation fuel standards and facility design.

Robust quality control, transparency and regulatory certainty could derisk the downstream supply chain. (1/2)

Risk category	Risk	Impact	Remarks
Safety	Cross-contamination in multi-product pipelines	Very high	ASTM violation lead to fuel loss depending on the besides supply disruption, which could lead to financial loss by sending it for other industrial applications or for reconditioning process.
	Post-blending recertification bottleneck	High	Lab capacity constraints due to limited laboratories create supply chain delays and operational inefficiency, affecting deployment of SAF
	Fuel quality degradation in transport	Medium	Long term storage or the thermal stress led oxidation of the fuel trigger rejection of batch
Sustainability	Feedstock untraceability & fraud risk	High	Digital MRV is in pilot stage but not yet mandatory, creating a window for fraudulent GHG claims
	ILUC sustainability debate	Medium	EU RED II applies default ILUC penalties (i.e. reduced claimed GHG benefits by ~20%), creating uncertainty about emission savings from crop-based SAF when land-conversion impacts are accounted for
	Supply chain transparency gaps	Medium	Airlines might have to pay almost the double SAF premiums due to lack of the transparency

Source: CBR

Risk impact categories – Very high, High, Medium

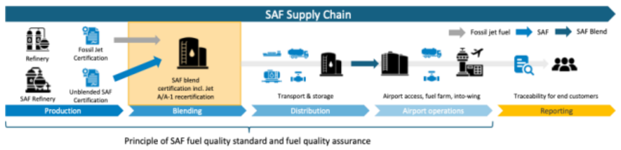
Robust quality control, transparency and regulatory certainty could derisk the downstream supply chain. (2/2)

Risk category	Risk	Impact	Remarks
Commercial	Infrastructure capex gap	Very high	Without capex mobilization to build blending hubs, pipelines, and testing labs, secondary and tertiary airports will lack SAF access, triggering mandate non-compliance and regulatory penalties by 2027–2028.
	SAF price premium	Very high	Cost of SAF is creating a fundamental economic barrier to airline adoption independent of supply-chain efficiency gains. Airlines cannot absorb these premiums without carbon pricing or mandated blending
	Supply concentration	High	Only 25 SAF suppliers serve 33 EU airports with 70–80% of current production concentrated in 3–4 major, which is vulnerable to supply disruption
	Regulatory uncertainty	Medium	EU ReFuelEU mandates (2%, scaling to 70% by 2050) are legally binding but compliance penalties, enforcement mechanisms, and sustainability criteria (e.g., potential tightening to ≥60% GHG reduction post-2030) are still under development, creating investment uncertainty for infrastructure developers

Source: CBR 2026

Risk impact categories – Very high, High, Medium

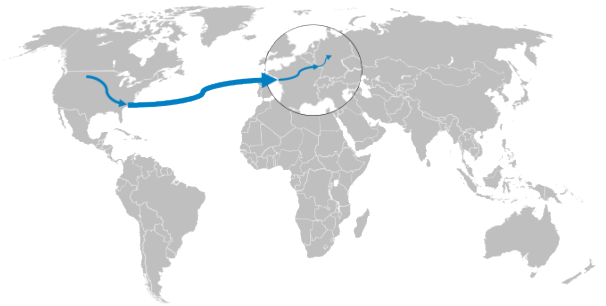
Key takeaways



All stakeholders play crucial role in defining the transparency and fuel quality of SAF downstream activities.

RED III

Transparency in SAF handling demands for sustainability chain of custody and quality certificates.



Different logistics options (pipeline, truck, rail, barge, etc.) are available available from refinery to aircraft.

Handling procedures and quality certificate standards are developed by various institutes worldwide.

Robust quality control, transparency and regulatory certainty could derisk the downstream supply chain.

Thank you for your attention!

easa.europa.eu/connect

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