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Five or Ten Tonnes? Point-of-Origin Audit Triggers, Global Used Cooking Oil Trade, and the Integrity of UCO-Based Sustainable Aviation Fuel

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ABSTRACT

Used cooking oil (UCO) has become a strategically important feedstock for hydroprocessed esters and fatty acids (HEFA)-based sustainable aviation fuel because it combines technological maturity with the circular-economy appeal of recovering a waste lipid. Its climate value, however, depends on whether the feedstock is genuinely used oil, accurately quantified, traceable to its point of origin, and protected against duplication or substitution. This qualitative literature review examines differences between the point-of-origin requirements of International Sustainability and Carbon Certification for the European Union and for the Carbon Offsetting and Reduction Scheme for International Aviation. It clarifies that the frequently cited 5- and 10-metric-tonne figures are not limits on trade, certification eligibility, or SAF production. They are risk-based triggers determining which non-individually certified points of origin enter the population for sample-based on-site auditing. ISCC EU applies a 5-tonne monthly or 60-tonne annual trigger based principally on volume supplied, whereas the publicly accessible ISCC CORSIA provisions apply a 10-tonne monthly or 120-tonne annual trigger based on volume generated. The lower EU trigger potentially strengthens fraud deterrence and market confidence but enlarges the audit population, increases transaction costs, and may disadvantage fragmented suppliers. The higher CORSIA trigger supports proportionality but leaves more medium-sized generators outside routine on-site sampling. The article concludes that interoperability, persistent point-of-origin identifiers, cross-collector volume aggregation, digital traceability, plausibility testing, auditor competence, and transparent national UCO balances are more important than numerical harmonization alone.

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Introduction
Background

Aviation remains one of the most difficult transport sectors to decarbonize because commercial aircraft require high-energy-density fuels, compatibility with global infrastructure, stringent safety characteristics, and reliable performance over long distances. Battery-electric propulsion may contribute to short-distance and small-aircraft applications. At the same time, hydrogen could eventually serve selected markets, but neither currently provides a complete substitute for liquid hydrocarbon fuel in the global long-haul fleet. Consequently, sustainable aviation fuel, or SAF, has become a central component of aviation decarbonization strategies, alongside improvements in aircraft technology, air-traffic management, operational efficiency, and demand-side measures [1].

This strategic role has increasingly been institutionalized. The European Union's ReFuelEU Aviation framework introduced a minimum SAF share of 2 percent in 2025, progressing to 6 percent in 2030 and 70 percent in 2050. At the international level, the International Civil Aviation Organization's Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA, permits aircraft operators to reduce their offsetting obligations by claiming verified emission reductions from CORSIA-eligible fuels. Such fuels must originate from producers certified by a sustainability certification scheme approved by the ICAO Council. ISCC is included among the currently approved schemes [2,3].

Among the available SAF pathways, hydroprocessed esters and fatty acids, commonly known as HEFA, occupy a prominent near-term position. HEFA technology converts lipid feedstocks—including vegetable oils, animal fats, and UCO into hydrocarbons suitable for aviation-fuel blending. Its relative commercial maturity, compatibility with existing refinery capabilities, and ability to produce a drop-in fuel make it attractive to policymakers, fuel producers, investors, and airlines. However, HEFA expansion is constrained by the quantity, quality, price, and sustainability of eligible lipid feedstocks. It also competes with renewable diesel, biodiesel, oleochemical, lubricant, and other markets for the same materials [4].

UCO appears especially attractive because it is a secondary material generated after edible oil has fulfilled its original food-related function. Recovering it can reduce inappropriate disposal into sewerage systems, lower demand for virgin lipid feedstocks, create value from a dispersed waste stream, and support circular-economy objectives. Depending on system boundaries, collection patterns, processing energy, hydrogen sources, transportation, and counterfactual treatment, UCO-derived fuel can also achieve substantial life-cycle greenhouse-gas savings relative to fossil fuel and many crop-based alternatives [5].

These benefits are not automatic. UCO is physically heterogeneous and geographically dispersed. Its composition depends on the original oil, cooking temperature, number of frying cycles, food type, storage conditions, contamination, water content, and collection practices. The value of UCO as a policy-favored waste feedstock also creates information asymmetry: a downstream buyer or auditor cannot directly observe whether all material described as UCO was genuinely generated through cooking. As the market value of a "waste" designation rises, so do incentives to inflate quantities, substitute virgin or insufficiently used oil, duplicate sustainability claims, create fictitious points of origin, or split supplies among collecting points to remain below audit thresholds [6].

Sustainability certification is therefore not an administrative appendage to the UCO-based SAF market. It is part of the market's underlying infrastructure. Certification establishes which feedstocks qualify, how traceability begins, which entities must hold certificates, what declarations accompany a consignment, how mass balance is controlled, how greenhouse-gas information is transferred, and which entities are audited. These rules affect environmental credibility, access to regulated markets, contractual risk, financeability, and the distribution of compliance costs across the value chain [7-9].

The Point-of-Origin Threshold Problem

The initial issue in this study is a difference between ISCC EU and ISCC CORSIA: 5 metric tonnes per month under ISCC EU and 10 metric tonnes per month under ISCC CORSIA. Its central observation is directionally useful, but its terminology and concluding interpretation require qualification.

First, the figures are not maximum volumes that a restaurant, factory, or other point of origin may produce, sell, export, or have certified. They do not limit UCO trade or determine whether a consignment can be converted into SAF. Instead, they are **risk-based point-of-origin sample-audit triggers**. When a non-individually certified point of origin reaches the applicable trigger, it enters the population from which on-site audit samples are calculated under the certification of a collecting point or central office.

Second, the comparison is more complex than "5 tonnes versus 10 tonnes." Current ISCC EU documentation operationalizes the relevant threshold mainly according to the volume of a specific waste or residue **supplied** by the point of origin, while the publicly accessible ISCC CORSIA provisions refer to the amount **generated**. The annual equivalents-60 tonnes and 120 tonnes based on rolling averages also matter. Moreover, treatment below a threshold is not an absolute exemption: self-declarations remain necessary, access must be granted to auditors, and evidence or indications of non-conformity can trigger verification regardless of volume.

Third, the lower ISCC EU trigger supports a defensible conclusion that ISCC EU is **more audit-intensive at this particular control point**. It does not establish that ISCC EU is categorically or universally "stricter" across every sustainability criterion, chain-of-custody requirement, greenhouse-gas calculation rule, or assurance procedure.

The distinction is economically consequential. A collecting point supplied by many establishments in the 5–10-tonne monthly range can face a larger sampling population under ISCC EU than under the publicly accessible ISCC CORSIA rules. That difference can affect audit planning, travel, documentation, supplier selection, contracting, internal controls, certification costs, and the relative attractiveness of serving EU or CORSIA-related markets. It may also influence consolidation, vertical integration, multi-certification, trade routing, and opportunities for regulatory arbitrage.

Research Aim, Questions, and Contribution

This article aims to critically examine how the different point-of-origin audit triggers under ISCC EU and ISCC CORSIA shape sustainability assurance, global UCO trade, and the development of UCO-based SAF. The review is guided by five interrelated questions. It asks how the volume-based audit triggers are defined and operationalized; which legal, institutional, market-incentive, and risk-governance factors explain their divergence; how that divergence affects compliance costs, supplier inclusion, supply-chain consolidation, certification strategies, trade routing, and fraud risk; what the implications are for feedstock bankability, life-cycle-emission credibility, and SAF scaling; and which governance reforms can improve interoperability without diluting environmental integrity or excluding legitimate small points of origin.

The article contributes by linking three bodies of literature that are often treated separately: research on UCO valorization and SAF production; literature on sustainability certification, traceability, and auditing; and studies of international biofuel markets and aviation decarbonization. Its central proposition is that a volume trigger is not merely a technical auditing parameter. By changing the population subject to routine on-site verification, it can indirectly reorganize commercial relationships throughout a transnational value chain.

Literature Review

UCO as a Circular-Economy Resource

UCO is generated by households, restaurants, hotels, institutional kitchens, catering services, food manufacturers, industrial fryers, and other operations in which edible oils are heated and used in food preparation. Although the terms UCO and waste cooking oil are frequently used interchangeably, the exact material included in a commercial or certification category may vary. Distinctions are required among UCO, trap grease, brown grease, animal fats, acid oils, food waste containing lipids, and virgin oils that have not fulfilled an authentic cooking function. Classification matters because sustainability status, default life-cycle values, conversion requirements, and policy incentives can differ among these materials [7-8].

Repeated heating changes an oil's physical and chemical properties. Hydrolysis raises free-fatty-acid concentrations, oxidation forms peroxides and secondary compounds, and polymerization increases viscosity. Food particles, moisture, salts, metals, cleaning chemicals, and other contaminants may enter the oil during use, storage, or collection. UCO from a controlled industrial fryer may therefore differ significantly from mixed oil aggregated from hundreds of restaurants. These variations affect transport, storage stability, processing yields, catalyst life, hydrogen consumption, and final-product economics [10-12].

Pretreatment is consequently central to UCO valorization. Depending on feedstock condition and the downstream process, pretreatment can include screening, settling, centrifugation, filtration, dehydration, degumming, adsorption, neutralization, esterification, solvent extraction, and removal of trace contaminants. Mechanical filtration and sedimentation can be performed early in the collection chain, whereas more intensive upgrading is normally conducted before conversion. Poorly controlled pretreatment increases operational disruptions and may transfer environmental burdens from feedstock collection to chemical, energy, and waste-treatment stages [13-14]

The collection system is as important as the conversion process. UCO generation is dispersed and often individually modest. Economically viable recovery requires route planning, standardized containers, scheduled pickup, contamination control, weighing, documentation, storage, and aggregation. In cities with extensive informal economies, collectors may operate outside formal waste-management or food-safety systems. Formalization can improve traceability and occupational safety, but it can also impose costs that small collectors and generators are poorly equipped to absorb [15].

Local characteristics strongly influence environmental performance. A Bogotá case study found that collection, transportation, and downstream conversion materially affected the sustainability profile of UCO valorization and that local production and use could reduce several impacts compared with an export-oriented configuration. Studies of household UCO similarly show that spatial mapping, collection density, participation, and logistics determine how much theoretical waste supply becomes practically recoverable.

UCO also has an opportunity cost. It can be converted into biodiesel, renewable diesel, SAF, lubricants, surfactants, soaps, resins, plasticizers, and other chemicals. Allocation to aviation can be justified because aviation has fewer near-term alternatives than road transport, yet directing UCO to SAF may displace existing users. The resulting environmental effect depends on what those users adopt as a substitute. A circular-economy assessment should therefore consider whether SAF creates additional collection, diverts material from lower-value disposal, or reallocates an already utilized resource.

Conversion of UCO into SAF

HEFA production generally begins with pretreatment followed by hydrogenation and deoxygenation of triglycerides and fatty acids. Oxygen is removed through hydrodeoxygenation, decarboxylation, and decarbonylation reactions, producing hydrocarbon intermediates. Subsequent hydrocracking, isomerization, and fractionation adjust carbon-chain distributions and low-temperature properties to generate jet-range fuel, renewable diesel, naphtha, and gaseous co-products. The precise configuration affects jet yield, hydrogen consumption, capital requirements, energy use, and life-cycle emissions.

UCO's relatively high free-fatty-acid and impurity levels can be managed technologically, but not without cost. Contaminants can poison catalysts, accelerate fouling, increase pressure drops, reduce operating time, and require more intensive pretreatment. Variable feedstock can also complicate procurement specifications and plant design. Long-term SAF projects therefore need not only a nominal quantity of UCO but a reliable stream meeting contractual quality ranges. Certification of origin and quality assurance address different questions, but both influence whether a feedstock is commercially bankable.

Techno-economic studies show that UCO-based aviation fuel costs depend heavily on feedstock price, hydrogen source, process scale, product yields, plant utilization, capital cost, financing assumptions, and co-product credits. A process that performs favorably under low-cost waste-oil assumptions can become uncompetitive if policy-driven demand raises UCO prices or if feedstock scarcity lowers plant utilization. Integration with existing refineries may reduce some costs, although competition with renewable diesel production can alter product optimization [16].

Life-cycle assessment adds another layer of uncertainty. Under many waste-based accounting approaches, burdens associated with producing the original edible oil are not allocated to UCO because the oil's primary function occurred before it became waste. Emissions from collection, transportation, pretreatment, hydrogen production, conversion, storage, distribution, and combustion nevertheless remain relevant. Results also depend on the counterfactual fate of UCO, co-product allocation, displacement assumptions, electricity mix, and whether avoided-waste-management credits are applied.

Waste designation is therefore not a purely semantic matter. If material classified as UCO was actually virgin oil deliberately routed through a nominal or insufficient cooking step, assigning zero upstream production emissions would understate its carbon intensity. It has been shown that decisions about whether a feedstock is a waste, by-product, or primary product can materially change its calculated carbon footprint. This makes origin verification a direct component of life-cycle integrity rather than merely an anti-fraud administrative exercise.

The wider SAF literature confirms both the importance and limitations of HEFA. HEFA is commercially advanced and can support early deployment, but finite lipid availability prevents it from constituting a complete long-term solution. Alcohol-to-jet, Fischer–Tropsch pathways based on biomass or waste-derived synthesis gas, and power-to-liquid fuels produced from renewable hydrogen and captured carbon will be required to diversify supply. Excessive policy dependence on currently available lipid pathways may lock in competition for scarce fats and oils and delay investment in technologies that are more scalable over the long term [17].

Global UCO Trade and Market Integrity

UCO generation and SAF demand are geographically mismatched. Major aviation-fuel markets and conversion facilities may be located far from dense food-service sectors or export-oriented collection regions. International trade connects these areas, enabling material generated in one country to be collected, pretreated, shipped, blended, or converted elsewhere. Certification is often essential because the environmental value of the consignment cannot be inferred from its physical appearance alone.

The global UCO market is shaped by several interacting factors: domestic food-oil consumption; collection rates; informal reuse; government waste policy; transport costs; quality discounts; customs treatment; biofuel mandates; tax credits; double-counting provisions; and premiums for certified waste feedstock. These factors can make the same physical oil more valuable in one destination or regulatory program than another. Sustainability attributes therefore influence trade patterns in addition to conventional price and logistics variables.

Trade data are imperfect. Customs classifications may combine UCO with other oils, mixtures, residues, or feedstocks. Material can be re-exported or processed before crossing another border, while reported exports may not be easily reconciled with plausible domestic generation. These limitations make national material-balance analysis essential. A country's legitimate exports should be examined against edible-oil consumption, food-service activity, industrial frying, collection efficiency, domestic use, imports, inventory changes, and processing losses.

The economic premium attached to UCO status produces moral hazard. Potential integrity failures include exaggerating generation, falsifying self-declarations, adding virgin oil, relabelling other lipid streams, assigning the same origin evidence to multiple consignments, fabricating restaurants or industrial sites, and moving attributes independently of physical quantities. It has been emphasized that feedstock competition and certification integrity become increasingly important as biofuel policy raises demand for UCO. Similar problems arise whenever a regulatory category generates a substantial price advantage that cannot be verified through simple visual inspection.

Certification cannot eliminate all fraud. Audits are periodic, sample-based, and dependent on records created by the supply chain itself. A sophisticated assurance system therefore combines documentary verification, on-site observation, plausibility checks, material testing, mass balance, risk assessment, auditor competence, whistleblowing, registry controls, and sanctions. Data analytics can identify implausible generation, duplicate declarations, sudden volume increases, unusual routing, or multiple collecting points reporting supplies from the same POO.

Sustainability Standards as Global Value-Chain Governance

Voluntary sustainability standards are frequently described as private or hybrid governance instruments that translate broad environmental and social objectives into operational rules for producers, processors, traders, and buyers. Their effects extend beyond labeling. By determining evidence requirements, audit procedures, acceptable chain-of-custody systems, and market claims, they can influence who participates in a supply chain and under what conditions.

Research on global agrifood supply chains demonstrates that standards can improve practices and information availability, but they may also exclude smaller suppliers, concentrate market power, or impose costs that are not equitably distributed. Compliance outcomes depend on monitoring quality, local institutions, buyer commitment, incentives, and whether certified supply receives adequate commercial rewards [18-19].

Supplier audits are similarly heterogeneous. Standardization can reduce duplication and improve comparability, but divergent schemes may reflect different regulatory goals, risk tolerances, commodities, and stakeholder expectations. Audit effectiveness is also affected by the independence and competence of certification bodies, the quality of sampling, time allocation, access to evidence, and the treatment of identified non-conformities [20].

Digital traceability can strengthen the architecture but is not a substitute for governance. Blockchain or other distributed-ledger systems can make recorded transactions difficult to alter, yet they cannot guarantee that false information was not entered initially. Effective systems require credible identity verification, measurement, data standards, interoperability, access rules, correction procedures, and links between digital records and physical audits [21-22].

International Governance of UCO-Based SAF

The EU framework and CORSIA serve related but non-identical policy purposes. EU renewable-energy legislation governs the contribution of fuels toward Union targets and contains rules on sustainability, greenhouse-gas savings, traceability, certification, mass balance, and auditing. ReFuelEU Aviation then creates a demand framework for progressively increasing SAF supply at EU airports. CORSIA is an international aviation mechanism under which eligible fuels can reduce aircraft operators' offsetting obligations, subject to ICAO sustainability and life-cycle requirements.

CORSIA-eligible fuels must be produced by economic operators certified by an ICAO-approved sustainability certification scheme. ICAO's framework covers sustainability criteria, default and actual life-cycle calculations, certification-scheme requirements, and reporting. The ISCC CORSIA system translates those international requirements into certification rules for economic operators and supply-chain elements.

The two regulatory settings overlap because a fuel or feedstock supply chain may seek both EU-market recognition and CORSIA eligibility. They nevertheless differ in legal scope, institutional mandate, market incentives, and geographic application. Such differences can produce either useful specialization or costly fragmentation. The challenge is to preserve environmental integrity while avoiding duplicative controls that add little assurance.

Theoretical Framework

Five complementary perspectives guide the analysis. First, risk-based assurance explains the threshold as a mechanism for allocating finite audit resources. Universal on-site auditing of every restaurant would be prohibitively expensive. A trigger concentrates routine on-site sampling on POOs presumed to present greater material risk, while retaining the ability to investigate smaller entities when red flags arise.

Second, **information asymmetry and moral hazard** explain why waste classification requires verification. The generator knows more than the collecting point, fuel producer, airline, regulator, or consumer about how the oil originated. When waste status generates additional economic value, the informed party may have an incentive to misrepresent the material.

Third, **transaction-cost economics** predicts that assurance rules alter organizational structure. When contracting with many medium-sized POOs becomes expensive, collecting points may prefer larger suppliers, vertically integrated networks, standardized franchises, or group-certification arrangements.

Fourth, **global value-chain governance** treats certification as market-access infrastructure. Different requirements can segment supply chains, create certification premiums, or shift bargaining power among POOs, collectors, traders, and processors.

Fifth, **regulatory interoperability** focuses on the interaction of multiple schemes. Full numerical harmonization is one option, but equivalence, mutual recognition, shared data standards, and application of the more demanding control to higher-risk claims may offer more effective solutions.

Method

Qualitative Literature Review Design

This study employs a qualitative literature review rather than a systematic literature review. Its purpose is interpretive and concept-centric: to integrate technical research on UCO and SAF with legal provisions, certification documents, auditing theory, trade analysis, and sustainability-governance literature. Qualitative reviews are appropriate when the evidence base is heterogeneous and the research question requires explanation of concepts, mechanisms, institutional differences, and policy implications rather than a pooled effect estimate [23-27]

The review does not claim exhaustive retrieval, PRISMA compliance, meta-analysis, or formal risk-of-bias scoring. Search and selection were iterative and purposive. The objective was conceptual saturation around the article's principal themes rather than computation of a complete publication universe.

Source Identification and Selection

Peer-reviewed literature published from January 2020 through August 2026 was prioritized, and the searches combined five thematic clusters of terms. The feedstock cluster covered "used cooking oil," "waste cooking oil," and "UCO"; the technology cluster included "sustainable aviation fuel," "biojet," "HEFA," and "renewable jet fuel"; and the assurance cluster combined "point of origin," "collecting point," "traceability," "mass balance," "self-declaration," and "audit." The institutional cluster used "ISCC EU," "ISCC CORSIA," "CORSIA eligible fuel," "RED III," and "ReFuelEU Aviation," while the market-integrity cluster covered "global trade," "certification integrity," "fraud," "waste designation," "double counting," and "sustainability standards."

The literature base covered journal platforms and indexing services associated with Scopus, Web of Science, ScienceDirect, SpringerLink, Wiley Online Library, Taylor & Francis, and other scholarly publishers. Backward and forward citation chaining was used to identify relevant studies not captured by identical terminology.

Inclusion emphasized work addressing at least one of the following: UCO properties and pretreatment; collection and reverse logistics; UCO conversion into biofuel or SAF; life-cycle and techno-economic assessment; SAF policy and pathways; sustainability standards; auditing and traceability; feedstock classification; certification integrity; or global biofuel trade. Engineering articles concerned exclusively with engine testing or catalyst optimization were not emphasized unless they contributed to understanding feedstock quality, sustainability, or economic feasibility.

Evidence Hierarchy and Analytical Procedure

A hierarchical approach was used to prevent secondary literature from substituting for controlling rules. EU legislation, ICAO documents, and current ISCC system documents were treated as primary sources for normative claims. Peer-reviewed research provided the technical, environmental, economic, and governance analysis. Institutional reports were used selectively for current context.

The analysis proceeded through five interconnected stages. First, the study extracted the relevant POO, collecting-point, self-declaration, sampling, and chain-of-custody requirements clause by clause. Second, it compared the numerical triggers, annual equivalents, measurement bases, exceptions, and audit formulas. Third, the literature and normative evidence were coded thematically under integrity, proportionality, transaction costs, supplier inclusion, trade segmentation, arbitrage, SAF bankability, and life-cycle credibility. Fourth, causal-mechanism mapping was used to connect POO requirements with trade and SAF outcomes. Finally, stakeholder impacts were assessed across POOs, collectors, collecting points, traders, certification bodies, SAF producers, airlines, regulators, and exporting countries.

Trustworthiness, Version Control, and Limitations

Triangulation was used by comparing certification documents with legislation and peer-reviewed scholarship. Negative cases were considered, including circumstances in which additional auditing may produce limited integrity gains or discourage legitimate collection.

Version control is particularly important. The principal ISCC EU comparator is ISCC EU System Document 203, version 4.2, valid from 21 May 2025. The publicly accessible CORSIA comparison uses ISCC CORSIA System Documents 201-1, 203, and 206, version 2.0. On 23 July 2026, ISCC announced that ICAO had approved an updated set of ISCC CORSIA documents, with voluntary application through 22 October 2026 and mandatory application from 23 October 2026. The public update lists several revisions but does not expressly identify an amendment to the POO volume trigger. Accordingly, the 10-tonne analysis is based on the publicly inspectable version-2.0 provisions, and any operational use after the transition should be checked against the then-applicable documents and audit procedures.

The study cannot establish that observed trade changes were caused solely by the threshold difference. Feedstock prices, tax credits, mandates, customs measures, quality, freight rates, refinery capacity, competing uses, and exchange rates also affect trade. The analysis therefore identifies mechanisms and plausible implications rather than estimating a single causal coefficient.

Results

The UCO-to-SAF Chain and the Position of POO Controls

UCO-based SAF production involves multiple economic operators. The origin of the waste must be connected to downstream physical and documentary flows even when the material is aggregated, stored, pretreated, processed, blended, and transported across borders. Under both systems, the collecting point plays a central role because it receives material directly from POOs and manages the upstream supplier base.

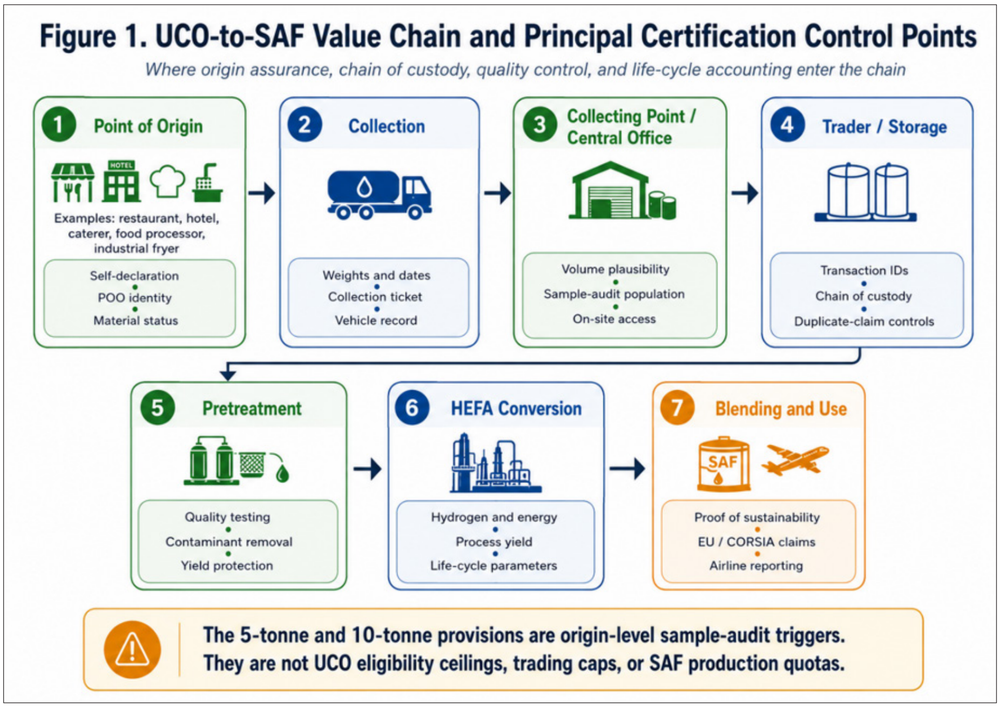

Figure 1: Locates the poo Audit Trigger Within the Wider Uco-to-Saf value Chain. The Placement is Important because it Demonstrates that the Trigger Controls Origin Assurance near the Beginning of the Chain Rather than Limiting output from the Hefa Plant or the Amount of Saf that can be Traded.

Source: Author's synthesis based on ISCC EU and ISCC CORSIA system documents.

The threshold operates where the collecting point's supplier list is translated into an audit population. Downstream certification remains necessary for other economic operators, but a 5- or 10-tonne trigger is not a plant-capacity restriction. An HEFA plant may process volumes far exceeding these figures. The question is whether a particular non-individually certified restaurant, food processor, or other POO is included in sample-based on-site verification.

Shared Foundations of ISCC EU and ISCC CORSIA

Both systems define a POO as the operation where the waste or residue occurs or is generated. Both permit POOs to participate without individual certification by issuing a signed self-declaration to an appropriately certified collecting point. Both allow individual or group certification, and both require the supply chain to preserve traceability through identification, delivery records, sustainability documentation, and chain-of-custody controls.

A self-declaration is not merely a statement that material is available. It confirms compliance with applicable requirements, identifies the material, and grants auditors access to verify conformity. Under ISCC EU, collecting points may accept material as sustainable from a non-individually certified POO only when the required self-declaration is in place. ISCC CORSIA similarly requires a signed self-declaration and allows auditors access irrespective of whether the POO normally falls below the routine sampling trigger.

Both systems also use risk-based group sampling. Under the applicable version-2.0 CORSIA group-certification document and current ISCC EU documentation, the minimum sample size is calculated using Equation (1).

$$s = ceil(r \times \sqrt{n}) \quad (1)$$

In Equation (1), s denotes the sample size, n is the relevant POO population, and r is the applicable risk factor. The risk factor is 1.0 for regular risk, 1.5 for medium risk, and 2.0 for high risk. The function ceil(·) indicates that the calculated value is rounded upward to the next whole number, although the auditor may enlarge the sample when additional evidence is required to achieve an appropriate level of confidence. Thus, the POO trigger affects n, whereas the broader risk assessment determines.

The Exact Difference: 5 Tonnes versus 10 Tonnes

Under Commission Implementing Regulation (EU) 2022/996, POOs supplying five or more tonnes per month of wastes or residues listed in Parts A and B of Annex IX to the Renewable Energy Directive must be subject to an on-site audit for biofuels and bioliquids. ISCC EU System Document 203 operationalizes the 5-tonne monthly and 60-tonne annual trigger in its POO and collecting-point requirements [24].

Current ISCC EU language treats POOs supplying less than 5 tonnes per month, or less than 60 tonnes annually on a rolling-average basis, as generally low risk because the material quantity is marginal. Routine on-site auditing is normally unnecessary unless there is evidence or an indication of non-conformity. POOs at the trigger fall within the on-site requirement under the controlling EU regulation, while higher-volume POOs are expressly incorporated into the ISCC sample-audit population unless they select individual certification.

The publicly accessible ISCC CORSIA System Document 203 states that a sample of POOs generating an average of 10 metric tonnes or more per month of a specific waste or residue—or 120 tonnes or more per year—must be audited within the collecting-point audit. Document 201-1 describes entities below those levels as generally low risk while preserving the right to audit them when evidence or indications of non-conformity arise [25-26].

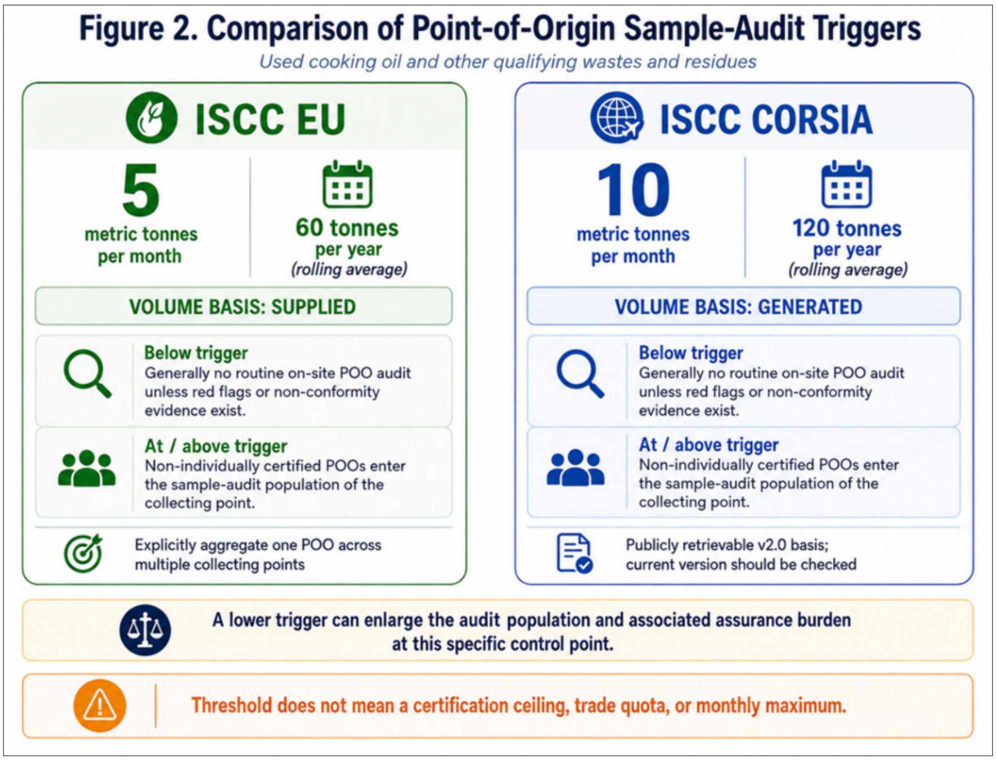

Figure 2: Presents the Comparison in a Form that Avoids the Potentially Misleading Expression "Volume Threshold." It Identifies the Figures as POO Sample-Audit Triggers and Distinguishes Supplied Volume Under ISCC EU from Generated Volume under the Publicly Accessible ISCC CORSIA Provisions.

Source: Author's synthesis based on ISCC EU 203 v4.2, and publicly accessible ISCC CORSIA documents v2.0.

Figure 2 shows that the most defensible comparison is not simply that one system is "strict" and the other "lenient." ISCC EU draws more medium-volume POOs into routine sample auditing. ISCC CORSIA applies a higher numerical entry point but retains documentation, auditor access, risk assessment, and red-flag auditing. Overall assurance also depends on how the supplier register is constructed, how risk is assessed, whether records are credible, and how non-conformities are treated.

Supplied Volume, Generated Volume, and Cross-Collector Aggregation

The difference between supplied and generated volume deserves attention. A POO may generate more UCO than it supplies into a certified chain. Some material may be retained, disposed of, sold outside the scheme, or transferred to another collecting point. A generated-volume test focuses on the total waste arising at the operation, whereas a supplied-volume test focuses on the quantity entering the relevant certified supply relationship, subject to aggregation requirements.

Current ISCC EU rules explicitly prevent a POO from avoiding the sample trigger by dividing supplies among multiple collecting points. The scheme's example describes a POO supplying 4.9 tonnes per month to each of two collecting points. Because the overall monthly supply from that POO is 9.8 tonnes, a sample audit is required. This provision is important because a threshold without cross-collector aggregation could be circumvented through artificial fragmentation.

Operational implementation requires a mechanism for a collecting point or certification system to identify that the same POO is supplying multiple buyers. Names and addresses may be insufficient because legal names, spelling, ownership, franchises, or business registrations can change. Persistent identifiers linked to legal registration, tax information, waste permits, and physical location are therefore necessary to make aggregation enforceable.

A generated-volume approach can theoretically capture the POO's whole waste-generation profile, but it requires evidence of total generation rather than only certified deliveries. This may require purchasing records for virgin cooking oil, food-production data, fryer capacities, operating days, waste-storage information, non-certified sales, and stock reconciliation. A supplied-volume approach may be easier to connect to transaction records but depends heavily on cross-recipient visibility. Neither metric is inherently fraud-proof.

Illustrative Effect on the Audit Population

The difference becomes clearer through a hypothetical distribution of 100 non-individually certified POOs within a collecting-point network. In this illustration, 55 POOs supply or generate less than 5 tonnes per month, 25 fall between 5 and less than 10 tonnes per month, and 20 generate at least 10 tonnes per month. For comparability, the supplied and generated volumes are treated as identical, all POOs are assumed to be otherwise eligible for group sampling, and the group is classified as regular risk.

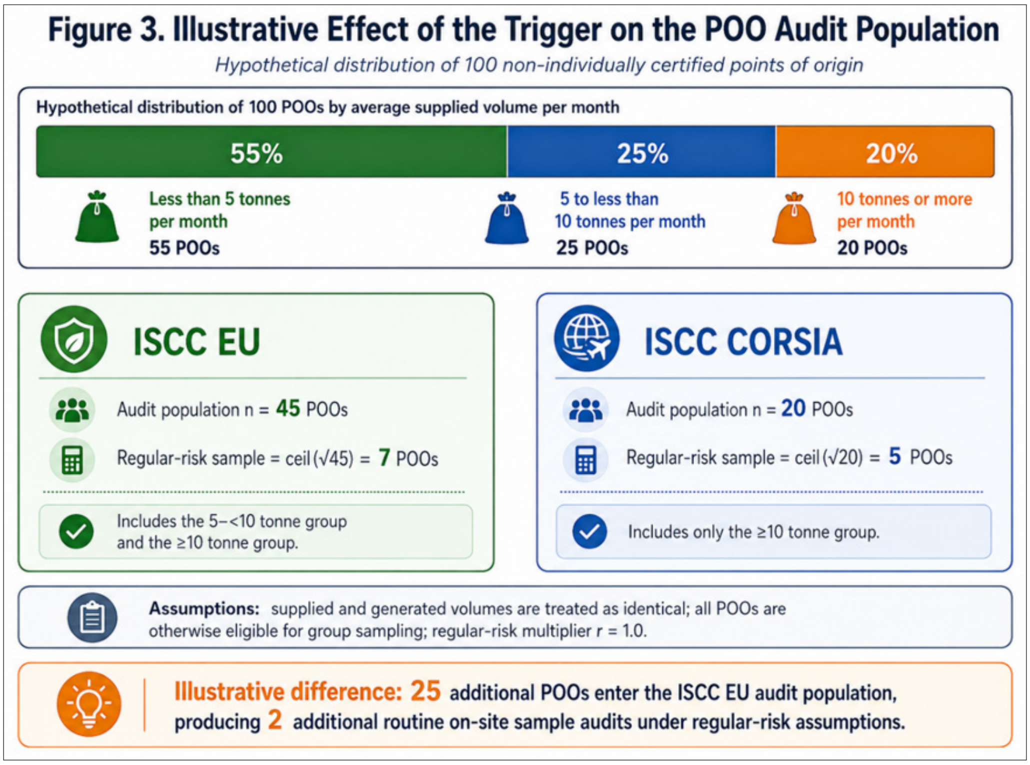

Figure 3: Illustrates How the Numerical Trigger Changes the Sampling Population Even When the Same Square-Root Sampling Formula is used. The Example is Analytical Rather than an Empirical Estimate of a Particular Country or Collecting Point.

Source: Author's hypothetical calculation using the published sampling formula.

The figure demonstrates two distinct effects. First, the lower trigger expands the population whose members can be selected. Second, because sampling follows a square-root function, the number of additional audits grows more slowly than the population itself. The cost effect will nevertheless exceed the direct number of site visits because the collecting point must identify, register, screen, document, and prepare the broader supplier population. Medium- or high-risk multipliers would enlarge the sample under both schemes.

Why Do the Triggers Differ?

EU Legal Alignment and Incentive Risk

The most clearly documented reason for the 5-tonne EU trigger is legal alignment. Commission Implementing Regulation 2022/996 expressly establishes the on-site audit requirement for POOs supplying five or more tonnes per month of relevant Annex IX waste or residue. ISCC EU, as a recognized voluntary scheme operating within that legal framework, must translate the requirement into its certification system.

The EU context also contains strong economic incentives for qualifying waste and residue fuels. Depending on the instrument and Member State implementation, feedstocks may contribute differently toward renewable-energy targets, transport obligations, or other benefits. ISCC EU System Document 203 expressly notes that higher fraud risk may apply to materials eligible for additional incentives, including double counting, and identifies Annex IX materials as relevant.

A lower trigger is therefore consistent with a regulatory setting in which misclassification can produce significant policy value. This is a reasoned interpretation supported by the legal structure and ISCC's own risk commentary. It should not be presented as an official ISCC statement that the threshold was selected through a quantified comparison of marginal fraud losses and audit costs.

CORSIA Proportionality and Global Application

ISCC CORSIA operates globally across jurisdictions with highly variable administrative capacity, business structures, collection systems, and audit costs. Its waste-and-residue document explicitly states that ISCC considers different risk levels to preserve the integrity of CORSIA claims while avoiding unnecessary obstacles and administrative burdens. It also links this approach to diversification of sustainable raw materials.

This language supports an interpretation that the 10-tonne trigger reflects a proportionality objective. Auditing every medium-sized restaurant or processor across geographically dispersed supply chains could impose significant costs and impede participation. The CORSIA group-certification framework similarly recognizes that individual auditing of every producer may impose disproportionate financial effort and that group approaches can reduce certification burdens.

Again, no official side-by-side document has been identified that states: "ISCC EU uses 5 tonnes for reason X, while ISCC CORSIA uses 10 tonnes for reason Y." The institutional explanation is therefore a synthesis rather than a direct quotation of a formally declared comparative rationale.

Institutional Path Dependence

The schemes also reflect institutional path dependence. ISCC EU evolves within changing EU legislation, Commission recognition, Member State implementation, Union-database requirements, and market incentives. ISCC CORSIA evolves through ICAO's international governance, approved sustainability criteria, life-cycle methodologies, and certification-scheme evaluation.

Different legal starting points can generate different terminology, thresholds, audit procedures, and documentation even when the systems share an underlying logic. The July 2026 announcement that revised ISCC CORSIA documentation would be aligned more comprehensively with the terminology and structure of ISCC EU and ISCC PLUS illustrates continuing convergence, but structural alignment does not necessarily imply identical quantitative requirements.

Operational Effects on Collecting Points and POOs

A lower trigger can increase audit-related expenditures in several ways. Certification bodies require more information about the supplier base, auditors must select and visit additional POOs, and collecting points must coordinate access, translate requirements, retrieve records, resolve discrepancies, and implement corrective actions. Geographic dispersion can make travel time more important than the duration of the site inspection itself.

Supplier onboarding also becomes more intensive. Contracts may need clauses requiring accurate declarations, notification of sales to other collecting points, access to purchase and waste records, consent to cross-system identity checks, retention of documents, and sanctions for misrepresentation. A collecting point must determine not only whether the supplier exists, but whether reported UCO generation is plausible.

For legitimate medium-sized POOs, the audit itself may not be financially prohibitive if costs are pooled through a collecting point. Indirect burdens can nevertheless be material. Restaurants and food processors may have weak recordkeeping, high staff turnover, inconsistent weighing, or limited familiarity with certification. They may also regard disclosure of purchasing and production data as commercially sensitive.

This creates a distributional risk. Large chains and industrial food manufacturers generally possess centralized procurement, standardized processes, digital records, and compliance staff. Independent restaurants and small regional businesses may face higher compliance costs per tonne. A lower trigger can therefore improve verification while unintentionally favoring larger, more formalized suppliers.

Collecting points may respond by reducing the number of suppliers, preferring POOs below the trigger, selecting larger individually certifiable operations, creating vertically integrated collection networks, or establishing central-office group arrangements. These responses can lower administrative complexity but increase concentration and reduce market opportunities for independent collectors.

Implications for Global UCO Trade

Certification Premiums and Market Segmentation

When a UCO consignment satisfies the documentation and assurance requirements of a high-value destination, it may command a certification premium. Divergent POO controls can consequently segment the market into material suitable for EU claims, material suitable for CORSIA claims, material with multiple certifications, and material serving non-regulated or less demanding markets.

Such segmentation need not imply that one category is physically superior. It reflects differences in documented origin, audit coverage, chain-of-custody status, and claim eligibility. Two chemically similar UCO consignments can therefore have different commercial values because only one has the evidence required by a target market.

Multi-Certification and Duplicative Compliance

A supplier serving both EU and international aviation markets may seek dual or multiple certifications. Where controls are substantially equivalent, duplicate documentation and auditing add cost without proportional assurance gains. Where rules differ materially, however, simple recognition of the less demanding requirement can weaken integrity.

The threshold difference illustrates this problem. A POO generating 7 tonnes per month may be below the public CORSIA routine audit trigger but inside the EU trigger. A collecting point intending to preserve both claims should apply the 5-tonne control to that material or clearly segregate the claim architecture. Otherwise, material initially assured under the higher trigger could later be marketed into an EU context without the required upstream audit treatment.

Trade Routing and Scheme Shopping

Economic operators may route UCO toward the destination offering the best combination of price, certification cost, feedstock eligibility, and regulatory premium. Such optimization is not inherently improper. It becomes problematic when material is routed through jurisdictions or schemes to obscure origin, reset documentation, duplicate claims, or avoid a control that should apply to the final market assertion.

Scheme shopping can also occur at the certification level. Suppliers may favor the certification route with lower audit intensity while seeking downstream recognition of equivalent sustainability. This risk is greatest when buyers focus on possession of a certificate rather than the precise scope, feedstock, chain-of-custody history, and claim basis.

Artificial Fragmentation

Thresholds can create incentives to remain just below the trigger. A POO could split contracts among affiliated legal entities, divide one site into nominal operations, or report deliveries through multiple collecting points. Current ISCC EU's explicit aggregation example addresses one version of this behavior, but implementation requires cross-buyer information.

Artificial fragmentation differs from legitimate decentralized generation. A hotel group may operate genuinely independent kitchens, while a centralized industrial facility may use multiple legal entities at one physical site. Audit systems should therefore combine legal identity, beneficial ownership, physical location, operational control, and actual generation processes.

Fraud Displacement

Stronger assurance in one market may displace questionable material rather than eliminate it. Suppliers unable to support an EU claim may redirect UCO to a CORSIA-related, road-fuel, oleochemical, or unregulated destination. This is not necessarily evidence that the alternative market is weak; it demonstrates that integrity is a system-wide problem.

Preventing displacement requires information exchange among schemes, regulators, certification bodies, and major buyers. A POO excluded for material misrepresentation under one scheme should not be able to re-enter another certified chain immediately under a slightly different name.

Developing-Country Exporters

The effects are particularly significant in developing economies where food-service activity is extensive but collection is fragmented. These countries may possess considerable theoretical UCO resources while lacking formal waste registries, reliable weighing, persistent business identifiers, or experienced auditors. Export access can stimulate formal collection and income generation, but certification costs can also act as a de facto non-tariff barrier.

Standards research shows that compliance burdens frequently fall disproportionately on smaller upstream actors even when downstream firms capture much of the market premium. Capacity building, shared digital systems, pooled auditing, and transparent allocation of certification costs are therefore necessary to prevent sustainability assurance from excluding legitimate suppliers (Meemken et al. 2021; Marx et al. 2024).

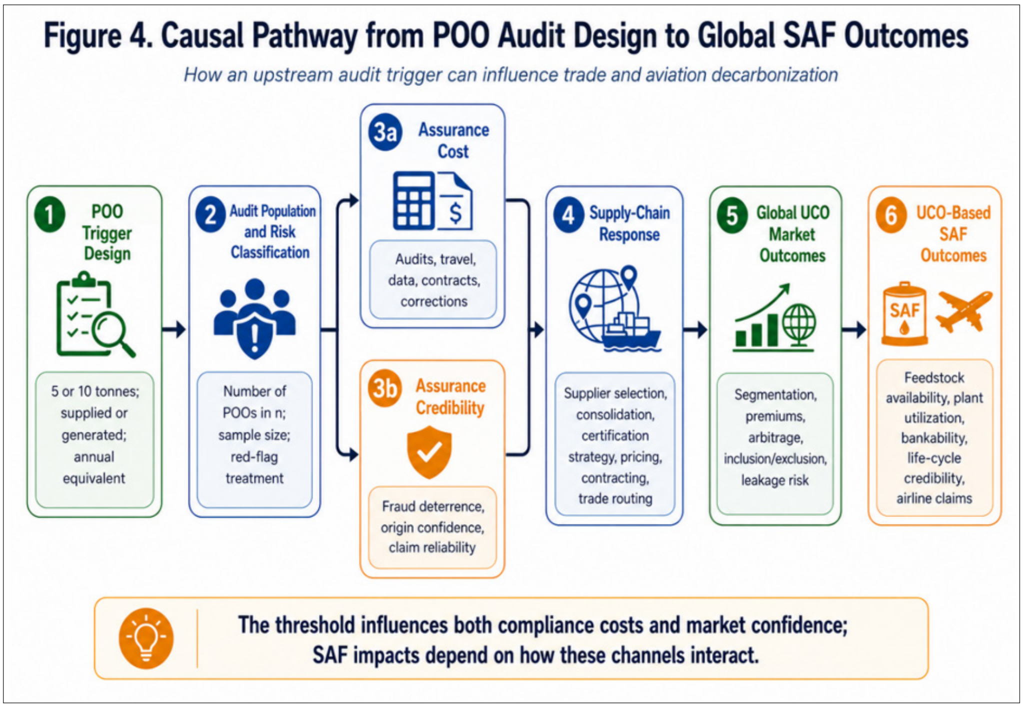

Figure 4: Synthesizes the Causal Mechanisms through which an Apparently Narrow POO rule can Influence International Trade and SAF Development. The Pathway makes Explicit that Audit Design Affects outcomes through both the Cost of Assurance and the Credibility of Sustainability Claims.

Source: Author's synthesis.

The figure highlights a central finding: the threshold has two opposing channels. It increases compliance costs while potentially increasing credibility. The final effect on SAF depends on which channel dominates and how the system mitigates distributional burdens. A lower trigger that produces poor-quality audits may be less effective than a higher trigger combined with strong data systems and targeted risk analysis.

Implications for UCO-Based SAF Development

Feedstock Availability and Bankability

A SAF project requires credible evidence that sufficient feedstock will be available throughout the financing and operating period. Nominal supply estimates are inadequate when part of the reported UCO may be uncollectable, already committed, of unsuitable quality, or based on implausible waste-generation assumptions.

Stronger origin assurance can improve bankability by reducing the probability that feedstock contracts become invalid, certification is suspended, or output loses access to premium markets. Lenders, investors, insurers, and offtakers can place greater confidence in volume projections when supplier identity, generation plausibility, and chain-of-custody records have been independently tested.

At the same time, a lower trigger can reduce the immediately accessible certified supply base if legitimate POOs are unwilling or unable to participate. Project developers may then face higher procurement costs or slower aggregation. The relevant policy objective is therefore not maximum audit intensity, but maximum reliable supply after accounting for assurance costs.

Life-Cycle-Emission Credibility

UCO-based SAF can receive favorable life-cycle treatment because genuine waste oil is generally assigned no upstream burden from cultivation and original edible-oil production at the waste-production step. CORSIA documentation nevertheless requires emissions from collection, recovery, transport, and processing to be included, and applicable fuel pathways must satisfy CORSIA life-cycle requirements.

If the origin claim is false, the carbon result may be materially understated. A virgin vegetable oil relabelled as UCO carries production and potentially land-use effects that are absent from a zero-burden waste assumption. Origin assurance is therefore inseparable from greenhouse-gas credibility.

LCA uncertainty also remains after genuine origin is established. Hydrogen derived from fossil natural gas, long-distance transportation, energy-intensive pretreatment, and unfavorable co-product allocation can reduce savings. It has been demonstrated that life-cycle results for oil-based SAF are sensitive to methodological and parameter uncertainty [28].

Airline Claim and Reputational Risk

Airlines purchasing SAF or claiming CORSIA reductions depend on upstream evidence they do not generate themselves. A defective UCO origin claim can invalidate emission reductions, create financial liabilities, disrupt reporting, and damage reputations. The risk is amplified when environmental claims are communicated to customers or investors [29-30].

Contractual protections warranties, audit rights, indemnities, data-access clauses, and replacement obligations can allocate financial consequences but cannot fully repair public trust. Airlines and fuel suppliers therefore have an interest in system-level assurance beyond minimum certificate checking [31].

Scale-versus-Integrity Tension

Rapid SAF growth can increase pressure to certify additional UCO. If collection expands by formalizing genuinely unused waste, environmental and economic benefits can increase. If reported supply grows faster than plausible edible-oil consumption and waste generation, however, integrity risks escalate [32].

A supply-constrained market can also produce a paradox. Strong mandates increase the price of certified waste oil, which makes collection more attractive but simultaneously raises the incentive to manufacture or misclassify the “waste.” Certification must therefore evolve as market value increases; assurance adequate for a low-value residue may be inadequate once the same material supports valuable regulatory claims [33].

HEFA Lock-In and Pathway Diversification

UCO-based HEFA should be treated as an important bridge and portfolio component, not the sole destination of aviation decarbonization policy. Studies of SAF capacity, economics, and roadmaps consistently warn that lipid feedstocks are insufficient to meet projected long-term demand [1].

Overreliance can lock projects, infrastructure, and policy incentives into a scarce feedstock class. It may also transfer UCO away from established uses that then turn to virgin oil. Governments should therefore combine rigorous UCO assurance with investment in alcohol-to-jet, Fischer–Tropsch, and power-to-liquid pathways [34-35].

Discussion and Analysis

Answering the Research Questions

The answer to the first research question is precise. The difference between ISCC EU and the publicly accessible ISCC CORSIA rules is a difference in the trigger for routine sample-based auditing of non-individually certified POOs. ISCC EU applies a 5-tonne monthly or 60-tonne annual trigger, operationally focused on volume supplied and supported by an explicit cross-collector aggregation rule. Public ISCC CORSIA documentation applies a 10-tonne monthly or 120-tonne annual trigger based on volume generated. Both retain self-declarations, auditor access, individual or group certification options, risk factors, and red-flag verification [36,37].

The second question concerns explanation. The lower EU trigger is directly grounded in Commission Implementing Regulation 2022/996 and operates in a policy environment where qualifying wastes and residues can carry significant regulatory value. CORSIA’s higher public trigger sits within a globally applicable system that explicitly seeks to balance integrity with avoidance of unnecessary administrative burdens. The conclusion that incentive density and global proportionality help explain the difference is analytically plausible, but it is not an officially published side-by-side rationale [38-40].

For the third question, the difference influences trade through assurance costs and credibility. The lower trigger can increase audits, onboarding, documentation, and coordination. It may induce collecting points to consolidate suppliers or prioritize entities with stronger records. At the same time, it can enhance confidence and enable access to premium EU markets. Divergence encourages multi-certification, claim-specific routing, market segmentation, and potential scheme shopping [41-43].

For the fourth question, the effect on SAF is similarly dual. Stronger origin assurance supports life-cycle credibility, investment, offtake, and regulatory claims. Excessive or poorly designed compliance burdens may reduce legitimate feedstock participation and slow formal collection. The objective should therefore be an assurance architecture that maximizes genuine, auditable UCO supply rather than merely maximizing the number of site visits [44].

The fifth question requires policy design beyond choosing between 5 and 10 tonnes. Interoperable identities, volume aggregation, digital records, plausibility testing, auditor quality, cross-scheme information exchange, and proportionate support for small POOs can improve integrity without requiring every jurisdiction to adopt identical numerical rules [45,46].

The Integrity Proportionality Frontier

The central policy problem can be described as an integrity–proportionality frontier. Moving toward more intensive verification can reduce information risk, but each additional audit consumes resources. At some point, auditing progressively smaller POOs may generate limited marginal assurance, particularly when their documentation is weak or the auditor lacks access to system-wide data.

A lower trigger is most valuable when three conditions hold. First, the newly included POOs represent a material share of total supply. Second, on-site auditing provides evidence that cannot be obtained reliably through remote or documentary verification. Third, identified non-conformities lead to corrective action, expanded sampling, exclusion, or sanctions.

Conversely, a higher trigger can be defensible when small and medium POOs contribute little aggregate risk, audit travel is exceptionally costly, and robust alternative controls exist. These alternatives may include verified business registration, digital collection records, automated volume plausibility, tax or waste-management data, laboratory testing, and risk-triggered inspections.

The threshold should therefore be regarded as one parameter within a multilayered control system. It cannot compensate for poor auditor competence, conflicts of interest, incomplete POO registers, weak mass balance, or lack of sanctions. Nor should a higher threshold be equated automatically with weak assurance if other controls are strong.

Why "ISCC EU Is Stricter" Is an Inadequate Overall Conclusion

The initial issue that ISCC EU is stricter "in terms of the volume threshold" can be retained only with careful wording. ISCC EU is more audit-intensive at the POO sample-entry stage because its trigger is lower. That statement is supported by the rule comparison.

An overall judgment would require comparison of sustainability criteria and eligible feedstocks, greenhouse-gas calculation methodologies, assurance levels, chain-of-custody requirements, surveillance frequency, auditor qualifications, treatment of non-conformities, database and transaction-reporting requirements, group-certification rules, and claim-cancellation procedures. These dimensions collectively determine the practical rigor of a certification scheme and cannot be reduced to a single numerical trigger.

A certification system may be more demanding on one control and less demanding on another. Broad rankings also ignore differences in regulatory purpose. ISCC EU supports EU renewable-energy compliance, whereas ISCC CORSIA supports an international aviation mechanism. A meaningful evaluation should therefore assess fitness for purpose, consistency, and risk reduction rather than simply counting more demanding clauses.

Regulatory Fragmentation and Interoperability

Divergent certification requirements create costs when firms must configure separate management systems, train employees, maintain multiple material classifications, undergo overlapping audits, and issue different downstream declarations. Yet harmonization is not automatically beneficial. Harmonizing around the least demanding rule can reduce integrity, while harmonizing around the most demanding rule can impose disproportionate burdens in low-risk contexts.

A more promising approach is functional equivalence. Two controls can be recognized as equivalent when they address the same risk with comparable assurance, even if their procedures differ. For example, a reliable national waste registry connected to tax, licensing, and transaction data could justify reduced physical sampling if it provides assurance equivalent to on-site verification.

Mutual recognition should also be claim-specific. Where material enters a claim system with higher upstream assurance requirements, the additional requirement should be satisfied before that claim is made. Material certified under a 10-tonne trigger should not automatically inherit EU eligibility when the relevant POO would have required treatment under the 5-tonne rule.

Interoperability is therefore primarily a data and governance problem. Schemes should be able to identify the same POO, shipment, collecting point, and sustainability attribute across systems while preserving confidentiality. Common data fields do not require identical databases, but they do require compatible identifiers and rules for exchanging high-risk information.

Distributional and Global-South Considerations

Compliance costs are rarely neutral. Large integrated fuel companies can spread certification expenditure over high volumes and employ specialist teams. Independent collectors and medium-sized restaurants cannot. A lower threshold may consequently shift value toward larger intermediaries even when small POOs generate genuine UCO.

This outcome would be counterproductive if it leaves legitimate waste uncollected, pushes transactions into informal channels, or allows dominant collectors to capture most of the certification premium. Sustainability standards should therefore incorporate inclusion measures rather than treating distributional effects as external to environmental integrity.

Developing-country exporters need infrastructure as much as rules. National or municipal systems can establish standard containers, licensed collectors, calibrated weighing, digital receipts, business registration, and transparent ownership records. Certification bodies can then rely on higher-quality evidence, reducing the cost of each audit.

Group certification can also pool costs, but it requires capable internal management. Internal audits must not become ceremonial. Group managers need independence, training, member registers, corrective-action processes, and incentives to remove non-compliant suppliers even when this reduces volume.

Proposed Policy and Certification Reforms

Establish a Harmonized Minimum Assurance Floor

ISCC EU, ISCC CORSIA, other ICAO-approved schemes, regulators, and industry stakeholders should define minimum origin-assurance elements applicable to all internationally traded UCO. These should include verified POO identity, material definition, self-declaration, auditor access, transaction records, generation plausibility, cross-collector aggregation, mass balance, and sanctions.

The minimum floor need not impose an identical numerical trigger. Jurisdictions could apply different risk thresholds while satisfying common core controls.

Introduce Persistent POO Identifiers

Each POO should have a persistent identifier linked to its legal entity, physical site, beneficial ownership where relevant, business registration, waste permits, and geographic coordinates. Changes in business name should not create a new unconnected identity.

The identifier should be used across self-declarations, collection receipts, audits, collecting-point registers, and sustainability transactions. Privacy safeguards can limit public disclosure while permitting authorized duplicate and risk checks.

Aggregate Volumes across Collecting Points and Schemes

All supplies from the same POO should be aggregated when determining whether a trigger has been reached. This requires the POO to disclose all certified collecting relationships and the system to test the disclosure.

Cross-scheme aggregation is more difficult but important. A POO should not be able to remain below multiple thresholds by distributing volumes among several certification schemes.

Apply Digital Measurement, Reporting, and Verification

Digital measurement, reporting, and verification systems should connect self-declarations, oil-purchase or production records, collection dates and weights, calibrated weighing devices, vehicle and route information, invoices and payment records, storage movements, mass-balance accounts, sustainability declarations, and certificate and non-conformity status. Integrating these records would create a coherent evidence trail across the physical and documentary chain while enabling automated checks for omissions, duplication, and implausible volume patterns.

Technology should support, rather than replace, professional judgment. The objective is to give auditors a coherent evidence trail and enable automated identification of anomalies.

Strengthen Plausibility Testing

Reported UCO should be compared with operational indicators such as edible-oil purchases, menu and production type, fryer capacity, meals served, operating days, historical recovery rates, storage capacity, and collection frequency. Benchmarks should be ranges rather than rigid universal coefficients because frying practices vary. Material deviations should trigger explanation, additional documentation, or an on-site visit.

Use Risk-Adaptive Sampling

Volume should remain one risk indicator, not the only one. Other factors should include sudden growth, changes of ownership, high UCO prices, multiple collecting points, proximity to virgin-oil supply, previous non-conformities, unusual composition, high-risk jurisdictions, and discrepancies between purchase and waste records. A small POO with strong fraud indicators may warrant an audit, while a larger POO operating under a verified government waste system may justify modified procedures when equivalence is formally recognized.

Support Legitimate Small and Medium POOs

Simplified digital onboarding, standardized self-declarations, multilingual guidance, pooled audit costs, group training, and technical assistance can reduce exclusion. Where governments benefit from SAF investment or export revenue, public support for traceability infrastructure is justified.

Cost allocation should be transparent. Requiring small POOs to absorb all certification costs while downstream firms capture regulatory premiums undermines participation and fairness.

Develop Transparent National UCO Mass Balances

Governments should publish transparent national UCO mass-balance estimates. At minimum, the accounting identity should reconcile domestic generation and imports with domestic use, exports, stock changes, and losses, as expressed in Equation (2).

Domestic generation + Imports = Domestic use + Exports + Stock changes + Losses (2).

The estimates should distinguish household, commercial, and industrial generation and disclose uncertainty. Persistent gaps between plausible supply and certified output should trigger investigation rather than being normalized as data noise.

Improve Auditor Competence and Independence

Auditors need technical understanding of food operations, waste generation, lipid characteristics, mass balance, logistics, and fraud patterns. Audit planning should allocate sufficient time for upstream verification rather than focusing principally on collecting-point paperwork. Certification bodies should monitor auditor performance, rotate personnel where necessary, manage conflicts of interest, and analyze patterns of unusually low non-conformity reporting.

Create Cross-Scheme Non-Conformity and Duplicate-Claim Controls

Confirmed fictitious POOs, deliberate virgin-oil substitution, repeated volume inflation, and duplicate declarations should be communicated through controlled inter-scheme mechanisms. Due process and correction procedures are essential, but confidentiality should not enable excluded suppliers to migrate immediately to another program.

Preserve the Higher Requirement for Higher-Risk Claims

Mutual recognition should follow a “higher requirement for the higher-risk claim” principle. When UCO is marketed into a framework requiring the 5-tonne trigger, upstream evidence should demonstrate compliance with that trigger even if earlier certification occurred under a 10-tonne framework.

Diversify the SAF Portfolio

Governments should avoid designing mandates and subsidies in ways that imply unlimited availability of UCO. Support for HEFA should be combined with mechanisms for alcohol-to-jet, Fischer–Tropsch, and power-to-liquid investment. Feedstock diversification reduces scarcity premiums and, indirectly, the incentive to falsify UCO status.

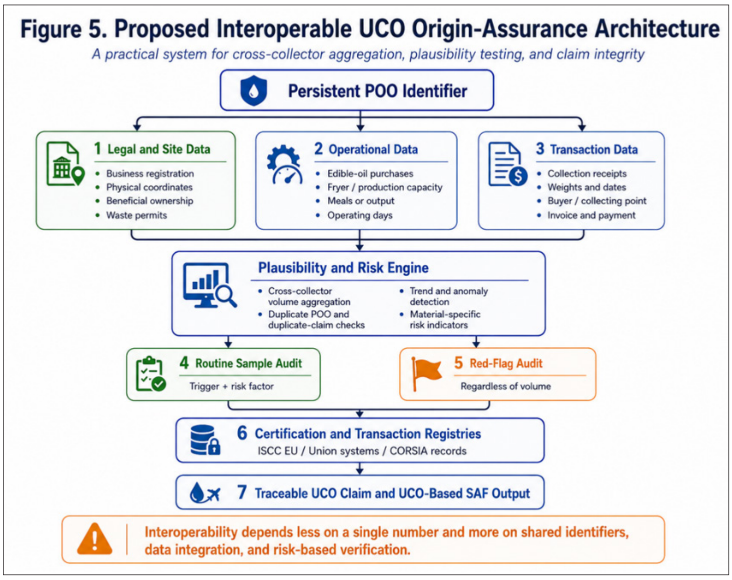

Figure 5: Presents an Integrated Assurance Architecture that Translates these Recommendations into a Data and Audit System. Its layered Design Links Persistent POO Identification and Interoperable Records with Routine Sampling, Red-Flag Auditing, and Downstream Claim Integrity.

Source: Author’s proposal.

The architecture addresses a weakness that numerical harmonization alone cannot solve. Even a universal 5-tonne trigger would be ineffective if the same POO could adopt multiple identities or sell through unconnected collecting points. Conversely, a persistent identifier and integrated plausibility system can strengthen a 10-tonne framework by identifying high-risk POOs below the routine trigger.

Implications for Theory

The analysis extends risk-based auditing theory by showing that an audit trigger is also a market-shaping instrument. It changes expected compliance costs and thereby affects supplier selection, organizational boundaries, and trade destinations.

It also integrates information asymmetry with global value-chain governance. The physical commodity cannot carry its complete sustainability history. Credibility depends on institutionalized information attached to the commodity through certification. When certification rules differ, the commodity acquires different market identities even when its chemical properties are similar.

Finally, the comparison demonstrates that assurance intensity has a distributional dimension. A rule may improve aggregate confidence while redistributing market access toward larger firms. Environmental governance should therefore evaluate not only whether a control reduces fraud, but who bears its costs and whether it encourages or suppresses legitimate waste recovery.

Future Research

Empirical research should measure the incremental cost of moving from a 10-tonne to a 5-tonne trigger across different supplier distributions and geographies. This would require data on POO size, travel time, audit duration, certification fees, preparation costs, non-conformity rates, and corrective actions.

Trade studies should test whether changes in audit requirements alter UCO export destinations, price differentials, or certification premiums. Customs data could be combined with certificate registers and policy changes, while recognizing classification limitations.

Fraud-detection research should compare the predictive performance of volume benchmarks, laboratory methods, transaction-network analysis, geospatial data, and machine-learning anomaly detection. The objective should be better targeting, not automated exclusion without human review.

Distributional research should examine whether medium-sized restaurants and collectors exit certified markets after assurance requirements change. Gender, informality, cooperative organization, and rural–urban differences may be relevant in developing-country collection systems.

Finally, comparative work should extend beyond ISCC to other ICAO-approved schemes. A complete evaluation of interoperability requires comparison of feedstock definitions, POO treatment, sampling, assurance levels, mass balance, registry integration, and sanctions across certification systems.

Conclusion

This article has examined the difference between the point-of-origin volume-based audit triggers applied to UCO under ISCC EU and the publicly accessible ISCC CORSIA provisions. Its most important conclusion is conceptual: 5 and 10 metric tonnes are not limits on UCO generation, certification, trade, export, or conversion into SAF. They are triggers for including non-individually certified POOs in the population for sample-based on-site auditing.

ISCC EU applies the lower trigger: 5 tonnes per month or 60 tonnes annually, principally measured through supplied volume and accompanied by explicit aggregation of one POO's supplies across collecting points. Publicly accessible ISCC CORSIA documentation applies 10 tonnes per month or 120 tonnes annually, measured through generated volume. Both systems retain self-declarations, auditor access, risk-based sample multipliers, individual or group certification options, and the authority to investigate suspected non-conformity regardless of volume.

The lower EU trigger makes ISCC EU more audit-intensive at this particular upstream control. It can broaden fraud deterrence, improve origin credibility, and support confidence in high-value EU sustainability claims. It also increases audit populations, transaction costs, and the risk that fragmented suppliers will be excluded or absorbed into more concentrated collection networks.

The higher CORSIA trigger supports proportionality across a globally diverse supplier base. It can reduce unnecessary auditing of relatively small generators, but it leaves more POOs in the 5–10-tonne range outside routine on-site sampling. Its effectiveness consequently depends on self-declarations, plausibility checks, risk-based intervention, auditor quality, and reliable chain-of-custody systems.

The difference can segment global UCO trade, encourage multi-certification, affect destination choices, and create opportunities for artificial fragmentation or scheme shopping. For UCO-based SAF, stronger assurance improves feedstock bankability and life-cycle credibility, while excessive compliance burdens may slow legitimate collection and constrain supply.

Policy should not focus exclusively on whether the common number should be 5 or 10. The more consequential reforms are persistent POO identifiers, cross-collector volume aggregation, digital measurement and reporting, national UCO mass balances, risk-adaptive sampling, stronger auditor oversight, duplicate-claim detection, and equitable support for small and medium suppliers. Mutual recognition should reduce duplicative compliance only where controls provide equivalent assurance, and the more demanding upstream requirement should apply when a higher-risk regulatory claim is made.

UCO-based HEFA can make a meaningful near-term contribution to aviation decarbonization, but its legitimacy depends on authentic waste origin and credible traceability. It should therefore be developed as one element of a diversified SAF portfolio rather than treated as an unlimited feedstock solution. The long-term integrity of the SAF transition will depend not only on converting molecules, but also on governing the information, incentives, and international value chains attached to those molecules.

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