ISCC GUIDANCE: THREE-POINT VERIFICATION FRAMEWORK FOR AUDIT OF PROCESSING UNITS: Biodiesel plant

ISCC
International Sustainability & Carbon Certification
EU

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Table of abbreviations

Abbreviation	Full form
CAS RN	Chemical Abstracts Service Registry Number
CB	Certification Body
CP	Collection Point
EC	European Commission
FAAE	Fatty Acid Alkyl Esters
FAME	Fatty Acid Methyl Esters
FAEE	Fatty Acid Ethyl Esters
FFA	Free Fatty Acid
GHG	Green House Gas
HVO	Hydrotreated Vegetable Oil
ISCC	Internation Sustainability and Carbon Certification
POME	Pome Oil Mill Effluent
REACH	Registration, Evaluation, Authorisation and Restriction of CHemicals
RED	Renewable Energy Directive
SCADA	Supervisory Control and Dara Acquisition
SOP	Standard Operating Procedures
TVF	Three-point Verification Framework
UCO	Used Cooking Oil
UVCB	Unknown or Variable composition, Complex reaction products or Biological origin
VVO	Virgin Vegetable Oil

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1. Introduction

Certification credibility depends on technically plausible sustainability claims

Renewable fuels play an important role in decarbonising the transport sector and other supply chains by replacing fossil fuels, wholly or partly. Certification provides a framework for renewable supply chains to demonstrate compliance with applicable sustainability requirements as defined by the corresponding regulatory framework or other voluntary standards. However, the credibility of certification depends on the plausibility, transparency and integrity of the sustainability claims made by the certified entities.

The Three-point Verification Framework links sustainability claims to production reality

To strengthen the robustness of certification and improve existing audit procedures, ISCC introduces the Three-point Verification Framework (TVF) for audit of processing units (i.e. fuel industries) that produce renewable fuels. The TVF aims to evaluate the technical plausibility of processing units through a data-driven approach that links the sustainable fuel claims to the technical reality of the production facility.

Technical verification is based on three core documents

The technical evaluation of sustainable fuel quantities claimed by a processing unit shall be performed with the help of the following three documents:

1. Substance Inventory
2. Technological Balance
3. Process Description

Together, the three documents provide a comprehensive basis for assessing the technical plausibility of biodiesel production and support a consistent evaluation of processing facilities during ISCC audits. A schematic overview of the TVF is shown in Figure 1.

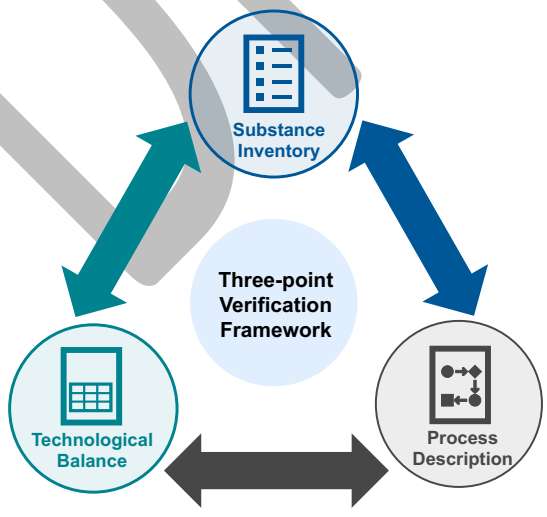

Figure 1: Schematic representation of the Three-Point Verification Framework (TVF) for ISCC processing units

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2. Scope and normative references

This guidance applies to ISCC EU biodiesel production facilities

This guidance document aims to support the implementation of the TVF for biodiesel production facilities certified or awaiting certification under ISCC EU. This guidance applies to processing units that produce biodiesel from renewable feedstocks such as vegetable oils, animal fats, used cooking oil (UCO), etc. This document provides requirements and guidance for the preparation, maintenance and verification of three technical documents that support the assessment of biodiesel production facilities during certification and recertification audits. The guidance in this document shall be applied both to first certification and recertification audits of biodiesel plants under ISCC EU.

The TVF is designed as a process technology -independent verification framework

Although this guidance focuses exclusively on the implementation of the TVF for biodiesel production, the underlying verification principles have been developed as a generic approach for assessing the technical plausibility of renewable fuel production facilities. The same principles will be applied to other renewable fuel pathways, such as hydrotreated vegetable oil (HVO), biogas, bioethanol, co-processing facilities and other renewable fuel production technologies, with relevant modifications, in the future.

The TVF complements existing ISCC verification requirements

The TVF aims to support the Certification Bodies (CBs) and their auditors in assessing whether the volumes of claimed certified outputs are technically plausible and consistent with the infrastructure and operational conditions of the certified facility. The framework complements existing ISCC requirements and audit procedures by establishing a structured approach for evaluating technical and operational information relevant to renewable fuel production. The provisions of this document shall be applied in addition to the existing ISCC traceability requirements as established in the ISCC EU 203 document[1].

3. Terms and definitions

A brief explanation of the technical terms is provided below:

Process Description: A Process Description is a documented explanation of how renewable feedstocks are converted into products, co-products and waste streams within a processing facility. It shall provide a clear overview of the process by combining written explanations, plant layouts and process flow diagrams. The Process Description shall describe the relevant material handling activities, unit operations, material flows and quality control measures applied by the

[1] *ISCC EU 203 Traceability and Chain of Custody*

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System User. Where applicable, it can reference the Standard Operating Procedures (SOPs) used for specific operational activities.

Substance Inventory: A Substance Inventory provides a structured list of all material inputs and outputs that interact with the system boundary defined for the biodiesel plant of interest. It enables the identification and characterisation of feedstocks, intermediates, products, by-products, waste streams and relevant auxiliary substances. The Substance Inventory serves as the basis for the Technological Balance and Process Description.

System boundary: A system boundary is an imaginary space that defines the limits of the processes and activities included within the assessment (i.e. the biodiesel production process). The system boundary can encompass a) the entire biodiesel plant (global system boundary); or b) a specific processing step or unit operation (local system boundary).

Technological Balance: A Technological Balance refers to quantitative accounting of all material inputs, material outputs, accumulations and losses associated with a defined system boundary during a specified period. It supports the assessment of the technical plausibility of the biofuel production facility by demonstrating consistency between material inputs, outputs and losses. The Technological Balance is based on the principle of conservation of mass, which can be expressed mathematically as follows:

$$\sum \text{Mass}_{\text{in}} = \sum \text{Mass}_{\text{out}} + \text{Accumulation} + \text{Losses}$$

Where,

$\sum Mass_{in}$	Total mass of all material inputs that enter the system boundary
$\sum Mass_{out}$	Total mass of all material outputs that leave the system boundary
Accumulation	Mass retained in the system, such as materials that settle and accumulate during processing
Losses	Mass leaving the system as wastewater, exhaust gases, and fugitive emissions, or other process losses

4. Biodiesel production process

What is biodiesel?

Biodiesel is a renewable fuel made up of Fatty Acid Alkyl Esters (FAAE) produced from biogenic lipid feedstocks such as vegetable oils, animal fats and waste feedstocks like UCO. Fatty Acid Methyl Ester (FAME) is the most common form of biodiesel produced globally. Due to its similarity to petroleum diesel, in terms of important fuel properties such as carbon chain length (as illustrated in Figure 2), kinematic viscosity,

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cetane number and cold-flow characteristics, biodiesel is widely used as a renewable alternative to conventional diesel fuel.[2]

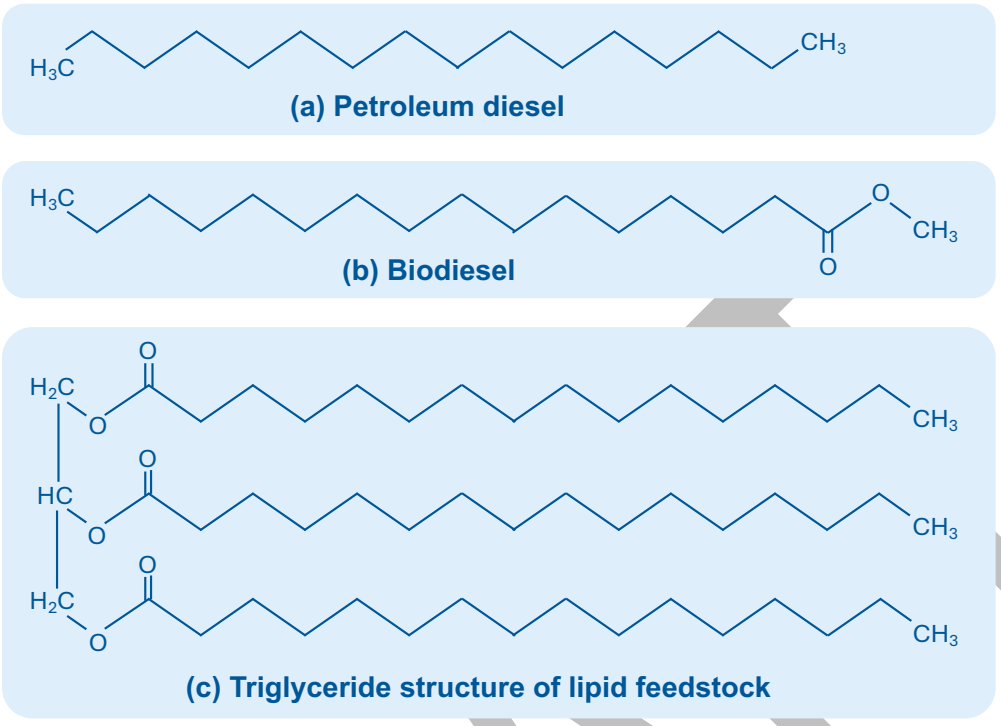

*Figure 2 Illustrative molecular structure of (a) triglyceride molecule (b) biodiesel and (c) vegetable oil; *Illustrative molecular structures only; fuels typically comprise a range of molecules rather than a single defined compound.*

Biodiesel production converts lipid feedstocks through a series of processing steps

Biodiesel production is a multi-step industrial process comprising several processing steps (or unit operations) that convert different lipid feedstocks into biodiesel. The most important step in biodiesel production involves the transesterification of vegetable oils, animal fats or other lipid-based feedstocks with an alcohol in the presence of a base catalyst. A typical industrial biodiesel production process includes the following processing steps:

1. Characterisation of feedstocks:

Feedstock quality determines processing requirements and biodiesel yield

Characterisation of feedstocks is essential for determining the quality of the feedstock received, planning the required processing steps and defining the quantity of processing inputs (methanol, catalyst, steam, etc.) required to produce biodiesel. Chemical characteristics such as triglyceride content, Free Fatty Acid (FFA) content, fatty acid profile, water content etc. are usually determined when renewable feedstocks are delivered to a biodiesel plant. The type and depth of feedstock characterisation are specific to a biodiesel plant.

2. Pre-treatment of feedstocks:

[2] *Gerhard Knothe, November 2004 edition, Introduction: What Is Biodiesel? The Biodiesel Handbook.*

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Pre-treatment removes contaminants and prepares feedstocks for conversion

Based on the feedstock characterisation results, the lipid feedstock may undergo one or more pre-treatment steps before the transesterification step. The purpose of pre-treatment is to remove contaminants, reduce undesirable constituents and improve process efficiency. Depending on the feedstock quality and the process technology employed, pre-treatment may include:

- removal of particulates and sediments;
- removal of excess water;
- degumming of crude vegetable oils;
- esterification of free fatty acids;
- neutralisation of residual acids; and
- other feedstock-specific treatment steps.

For example, UCO and other low-quality feedstocks may contain elevated concentrations of FFA, moisture and impurities that can negatively affect biodiesel yield and product quality if left untreated.

3. Transesterification step:

Transesterification is the core biodiesel production process

Methanol is the most used alcohol to produce FAME. However, ethanol can also be used to yield Fatty Acid Ethyl Esters (FAEE). Various factors such as the nature of the alcohol, alcohol to oil molar ratio, catalyst, reaction time, temperature, pressure, FFA content of the feedstock etc., affect the yield of biodiesel. Especially, base catalysed transesterification of UCO is highly sensitive to FFA and water content in the feedstock. Various virgin or waste lipid feedstocks such as virgin vegetable oils (VVO), UCO, animal fat, palm oil mill effluent (POME) oil can be used for biodiesel production. Depending on their origin and quality, different feedstocks may require specific processing conditions or pre-treatment steps. For example, UCO can contain a mixture of mono-, di- and triglycerides, which influence the methanol requirement compared to the processing of VVO.

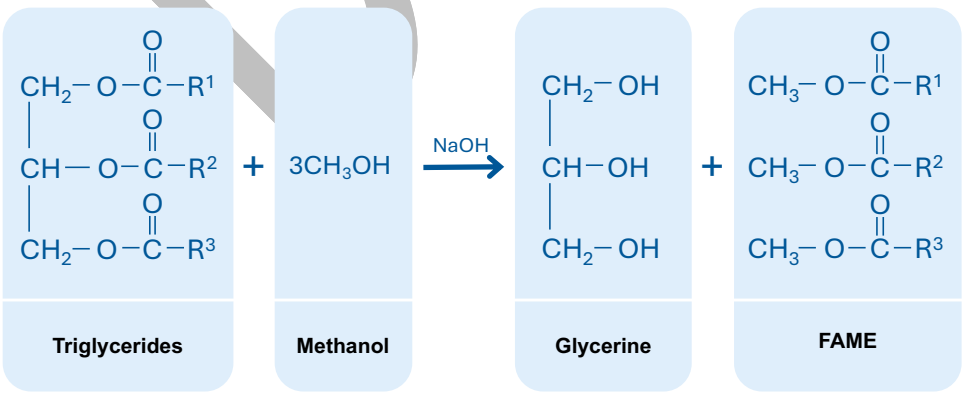

Figure 3 Chemical reaction involved in the transesterification of lipid feedstock to biodiesel[3]

[3] The essential chemical industry – online, Biofuels, https://www.essentialchemicalindustry.org/materials-and-applications/biofuels.html

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4. Phase Separation:

Reaction products are separated into biodiesel and glycerine phases

Following transesterification, a reaction mixture containing biodiesel and glycerine is produced. The mixture is allowed to settle or is centrifuged to separate it into two immiscible phases based on differences in density and polarity. The upper phase consists primarily of biodiesel, while the lower phase is rich in glycerine and contains most of the catalyst, soaps, water and other polar impurities. Both phases retain residual methanol and trace amounts of the other phase, which may require further downstream purification depending on desired product quality.

5. Methanol recovery:

Recovered methanol is recycled back into the production process

Residual methanol is recovered from both the biodiesel and glycerine streams, typically by flash evaporation or distillation. Recovered methanol is recycled to the transesterification process. The percentage of methanol recovered in turn reduces the need for fresh methanol for the esterification/transesterification step and therefore improves the economics of biodiesel production.

6. Biodiesel purification:

Final purification ensures compliance with fuel specifications

Crude biodiesel is purified to remove residual methanol, glycerine, catalyst, soaps, water and other contaminants. Purification may involve water washing or dry-washing technologies, followed by drying and filtration to produce biodiesel that complies with the required fuel quality specifications (e.g. EN 14214 or ASTM D6751).

7. Glycerine refining:

Crude glycerine can be upgraded into higher value products

Crude glycerine from transesterification is refined by removing residual methanol, catalyst, soaps, water, salts and other impurities. Depending on the desired product quality, refining may include acid neutralisation, evaporation, filtration, ion exchange and/or vacuum distillation to produce purified glycerine suitable for industrial or higher-value applications. The purity of glycerine sold by the industry determines the type of crude glycerine processing steps required.

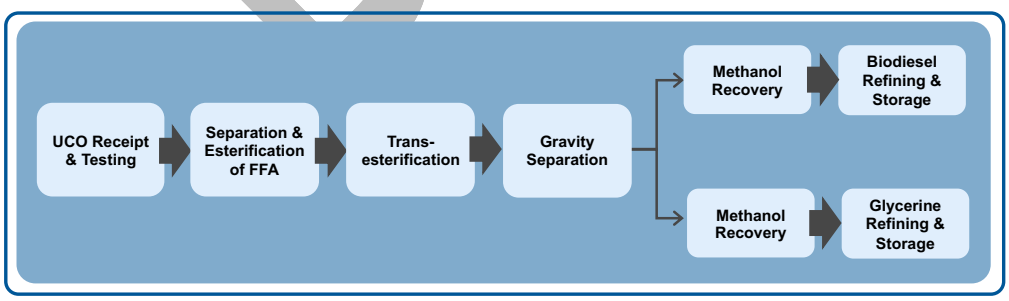

Figure 4 Example process flow diagram for biodiesel production process from UCO

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Based on the biodiesel plant infrastructure of the System User, some of the above-mentioned process steps could be combined into a single process step. A simple process flow diagram (also known as block flow diagram) of biodiesel produced from UCO is shown in Figure 4. In some cases, some processing steps shall be excluded, or additional steps can be added as well. For example, some biodiesel plants do not use a glycerine refining step and sell crude glycerine.

Production configurations vary between biodiesel plants

5. Substance Inventory

Materials processed within industrial facilities are often identified using internal naming systems, trade names or commercial designations. The use of different names for the same substance can create ambiguity and hinder clear understanding of material flows. In addition to this, seemingly unique names like UCO or brown grease could refer to substances of varying physico-chemical characteristics. This is especially relevant because the physio-chemical characteristics of the lipid feedstocks define the processing steps required to produce biodiesel. These characteristics also determine the yield of biodiesel. For example, a UCO batch with a 5% FFA content would require an esterification step before transesterification compared to a UCO batch with 0.2% FFA.

Consistent material identification is essential for technical verification

To ensure a consistent and transparent description of the materials processed within a biodiesel plant, the System User shall develop and maintain a Substance Inventory. The Substance Inventory shall list all the incoming materials and outgoing materials along with their physico-chemical characteristics. The names used for all material entries shall be used consistently across all three technical documents, i.e. the Substance Inventory, the Technological Balance and the Process Description. Use of consistent terminology across all three documents shall facilitate easy technical verification and enable auditors to establish clear links between material inputs, process infrastructure and material outputs. The objective of the Substance Inventory is not to document individual deliveries or batches, but to identify the substances that are received, processed and produced by the biodiesel plant for technical validation.

The Substance Inventory establishes a common material reference

A standard Excel-based template for developing a Substance Inventory is made available on the ISCC website. System Users shall use this standard template and adapt it only where necessary to reflect the specific characteristics of the biodiesel plant. Section 5.1 provides detailed guidance on the different elements and requirements of the Substance Inventory and how a System User can develop a Substance Inventory relevant to their biodiesel plant.

The System Users shall use the ISCC Substance Inventory template

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5.1 General requirements for the Substance Inventory

The Substance Inventory shall include all relevant material flows

The Substance Inventory shall contain all material inputs and outputs entering and leaving the biodiesel production process respectively. In case a System User operates a refinery complex with a biodiesel production facility (as shown in Figure 4), only the material inputs that enter the biodiesel production facility shall be considered. The System User could develop multiple Substance Inventories, each for individual processing steps (i.e. one Substance Inventory for the esterification step and another for the transesterification step). If a System User operates multiple biodiesel production facilities (e.g. plant 1, plant 2 etc.), each production facility shall have its own Substance Inventory. In addition to feedstocks, intermediates, products and by-products, the Substance Inventory shall also include waste streams and process emissions. Each material entry shall be accompanied by the following additional information:

- Internal tracking ID or numbering system
- Internal naming for substance used within the company
- Scientific name of the substance (i.e. IUPAC)
- Point of origin of the substance (if relevant)
- Chemical Abstracts Service Registry Number (CAS RN - if applicable)
- Composition of the substance
- Certification status (certified or non-certified)

This information forms the basis for evaluating whether the declared feedstocks, process technologies and outputs are technically plausible and consistent. For completeness, the System User shall also add any energy inputs used by the process, such as steam, heat, electricity, cooling water, or other energy carriers to the Substance Inventory.

5.2 Specific requirements for different substance types of the Substance Inventory

All materials shall be classified according to substance type

To ensure the correct identification of materials entering and leaving a biodiesel production facility, different substance types shall be described according to their chemical composition and degree of characterisation. In line with established chemical classification systems (e.g. REACH), the inputs and outputs associated with the biodiesel production shall be classified into either of the following three substance types:

- mono-constituent substances;
- multi-constituent substances; or
- UVCB (substances of **U**nknown or **V**ariable composition, **C**omplex reaction products, or **B**iological origin) substances.

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A mono-constituent substance is a substance composed predominantly of a single chemical species. The main constituent accounts for at least 80% (w/w) of the total composition, while the remaining 20% may consist of impurities or stabilisers that do not significantly alter the identity of the substance. For mono-constituent substances, the System User shall specify the concentration of the main constituent. Where a single concentration value cannot be provided, a typical concentration range shall be indicated. Methanol and sulphuric acid are examples of mono-constituent substances that are used in biodiesel production.

Mono-constituent substances are defined by a dominant constituent

A multi-constituent substance is a substance composed of several defined constituents, none of which individually accounts for more than 80% (w/w) of the total composition. The System User shall describe multi-constituent substances by specifying the typical concentrations of all relevant constituents. Where exact concentrations are not available, reasonable concentration ranges, based on data from procurement, can be provided.

Multi-constituent substances contain multiple defined constituents

Biogenic feedstocks (like vegetable oils, UCO etc.) and products (like FAME, HVO etc.) are referred to as UVCB substances. UVCB substances often exhibit more complex and variable compositions compared to the mono-constituent and multi-constituent substances and cannot be adequately characterised by composition alone. Due to their chemical complexity, UVCB substances shall be identified using a combination of:

UVCB substances require broader characterisation approaches

- composition;
- physical and chemical characteristics;
- relevant analytical parameters;
- origin; and
- information on any relevant pre-treatment or processing steps.

Unlike mono-constituent and multi-constituent substances, it is often not possible to identify each individual chemical species present in a batch of a UVCB substance. Therefore, the composition of representative constituent groups or pseudo-constituents can be used to define a UVCB instead of individual material composition. For example, UCO contains many chemically distinct substances, and it is not necessary to identify and quantify each individual compound. Instead, its complex and variable composition can be represented using suitable pseudo-components, such as saturated or unsaturated fatty acid derivatives, mono- and diglycerides, free fatty acids, and degradation products.

Pseudo-constituents provide a practical description of UVCB substances

For many commonly occurring UVCB substances, recognised names and inventory numbers are available in different databases such as the European Commission (EC) and CAS RN databases. Where applicable, System Users shall use these recognised names and numbers.

Recognised substance identifiers shall be used where available

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Analytical parameters support UVCB identification

In addition, the characteristics of the UVCB substances shall be substantiated using relevant analytical parameters. The analytical parameters selected shall be relevant to the substance and to the process technology applied by the biodiesel plant. Some of the analytical parameters are regularly monitored in biodiesel production facilities and are important for various operations like incoming goods inspection, feedstock acceptance procedures, process design and operation. For example, analytical parameters relevant for UCO include:

- FFA content;
- (mono-, di-, tri-) glyceride content;
- water content;
- iodine value;
- sulphur content;
- saponification value; and
- other process-relevant quality parameters.

Material origin contributes to substance identification and claim verification

The origin of substances, especially UVCBs, shall be described in sufficient detail to support their identification and to facilitate verification of sustainability claims. This is particularly important because substances originating from different sources may exhibit similar chemical compositions while being treated differently under regulatory provisions and ISCC requirements. For example, biodiesel from vegetable and animal origin, could exhibit similar chemical compositions, whereas the origin of the material influences the identification of materials and related ISCC sustainability claims. In addition, the origin of materials helps to evaluate the relevance of waste-based allowances like energetic double-counting under RED. Based on the complexity of supply chains, an exact definition of material origin could be difficult. Therefore, a generic definition of material origin (like UCO collected from restaurants) rather than a specific definition (like 500 kg of UCO from restaurant X) shall be sufficient.

Relevant feedstock pre-treatment steps shall be documented

Where applicable, the System User shall provide a brief description of in the Substance Inventory of any pre-treatment applied to UVCB feedstocks prior to delivery to the biodiesel plant. For example, in some instances UCO delivered to the biodiesel production facility may have been subjected to

- removal of free water;
- removal of coarse solids (> 5mm);
- filtration or centrifugation at the Collecting Point (CP); or
- removal of free fatty acids.

Product entries shall reflect the applied production pathway

In addition, the product entry (e.g. FAME) in the Substance Inventory shall also include a brief description of production pathway or process technology used. The System User shall include any information that is relevant for their supply chain. For example, biodiesel produced from used cooking oil shall be described as follows:

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"*Used cooking oil collected from private households, restaurants and fast-food establishments, purified and converted into FAME through esterification and transesterification with methanol".*

A few examples depicting the various elements of a Substance Inventory is shown in Annex I.

5.3 Guidance for developing the Substance Inventory

The following section provides general guidance for developing a Substance Inventory:

1. Definition of the system boundary:

The system boundary determines the scope of the inventory

The System User shall first define the system boundary applicable to their biodiesel production facility of interest. As a general principle, the system boundary shall include all processing steps from the point at which feedstocks enter the facility until products, by-products, wastes and emissions leave the facility. If the biodiesel facility is located inside a refinery complex, as shown in Figure 5 only the material flows and processes associated with biodiesel production are of relevance for the Substance Inventory.

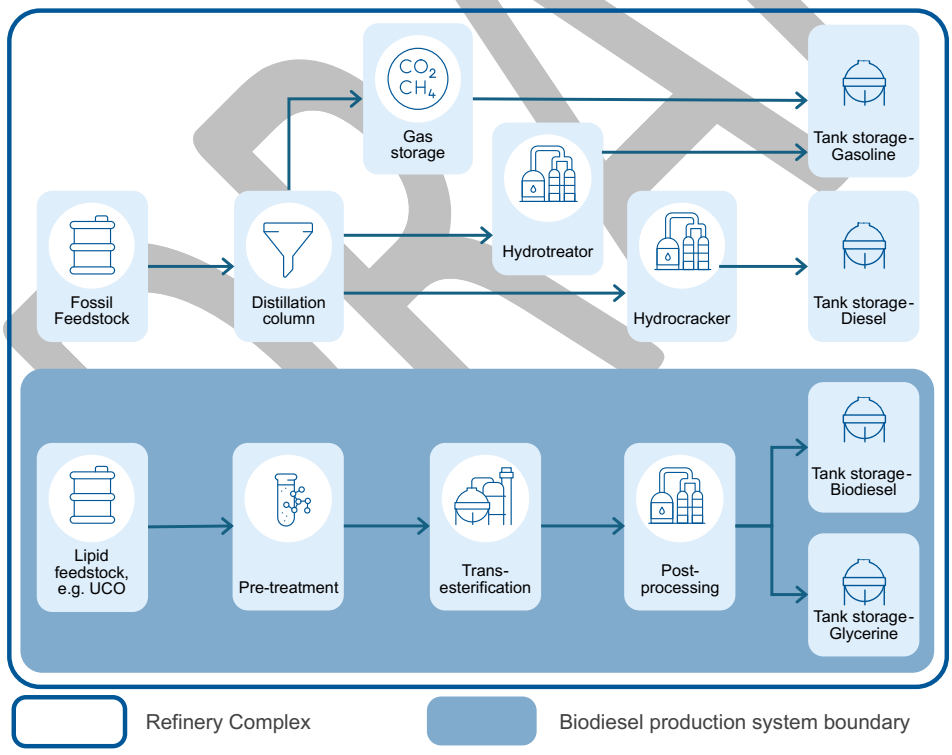

Figure 5 Illustration depicting a system boundary of a biodiesel plant located inside a refinery complex

System boundaries are specific to the System User

Since biodiesel plants differ in their process configuration, the system boundary shall reflect the actual infrastructure present at the site. Figure 6 provides an example of system boundaries for two different biodiesel plants configurations:

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- System boundary for biodiesel plant 1: If glycerine refining is carried out on-site, the refining process shall be included within the system boundary.

- System boundary for biodiesel plant 2: If crude glycerine is transferred for further treatment elsewhere, downstream refining processes shall be excluded from the system boundary.

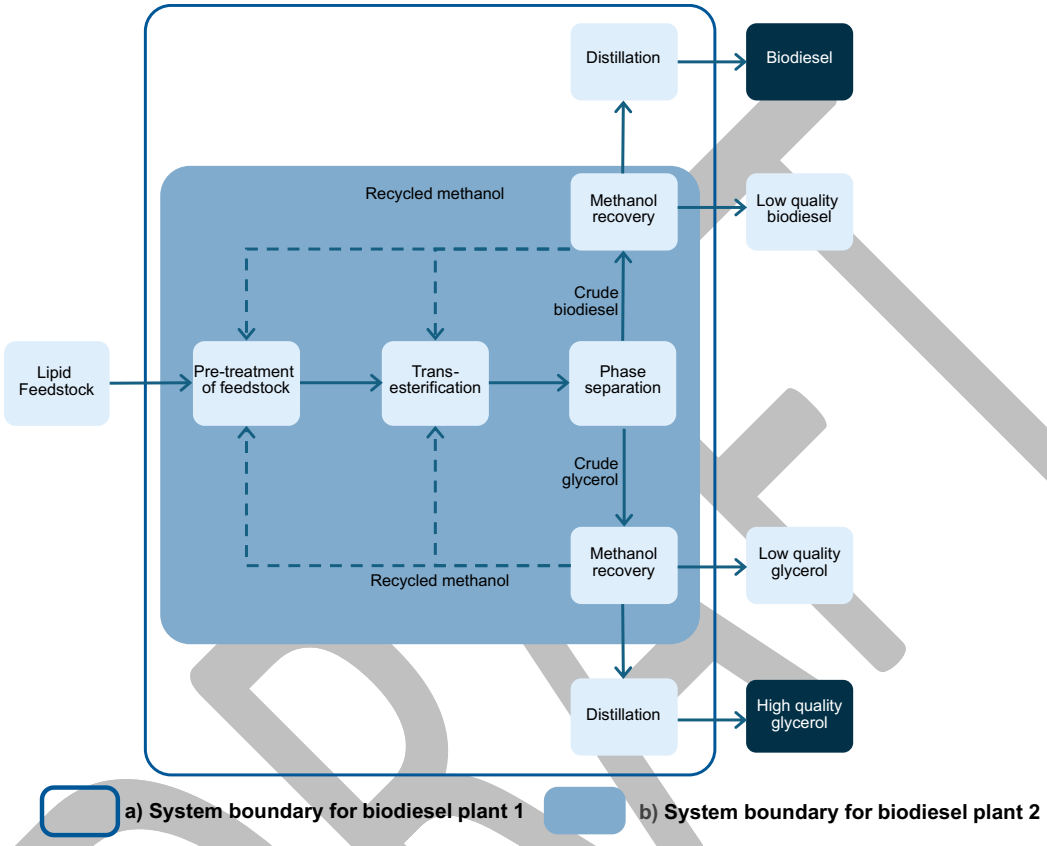

Figure 6 Illustration depicting two different system boundaries: a) System boundary 1 - biodiesel plant that produces fuel-quality biodiesel and distilled glycerine b) System boundary 2 - biodiesel plant that produces non-fuel grade biodiesel and crude glycerine.

2. Identification of material flows interacting with the system boundary:

All material flows crossing the system boundary shall be recorded

Once the system boundary has been defined, all material flows entering and leaving the system boundary shall be recorded in the Substance Inventory. All certified and non-certified material flows that interact with the system boundary shall be considered. Material inputs and outputs that are not included in ISCC sustainability declarations or ISCC mass-balance reporting, such as methanol, catalysts, wastewater, residues or emissions, shall nevertheless be included in the Substance Inventory when interacting with the system boundary. Process utilities like process water, nitrogen and steam shall be included as well. Auxiliary materials required for operating the biodiesel production process that neither undergo transformation nor become part of a material flow, such as lubricants and cooling water from closed cooling circuits, shall be

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excluded from the Substance Inventory. Overall, the following material flows shall be considered for the Substance Inventory:

- feedstocks;
- process chemicals;
- catalysts;
- products;
- by-products;
- recycling streams;
- waste and residue streams;
- wastewater streams;
- process emissions; and
- other relevant outputs.

Development of Substance Inventory from existing data

Material and energy flows are routinely monitored in industrial processing units. The System User shall use existing process records, quality control records or GHG calculation data as sources of information when compiling the material flows for the Substance Inventory. If a System User operates multiple biodiesel plants, each plant shall have a Substance Inventory of its own. The System User shall also consider the energy inputs for the Substance Inventory on a voluntary basis. Figure 7 illustrates the identification of material flows interacting with the system boundary.

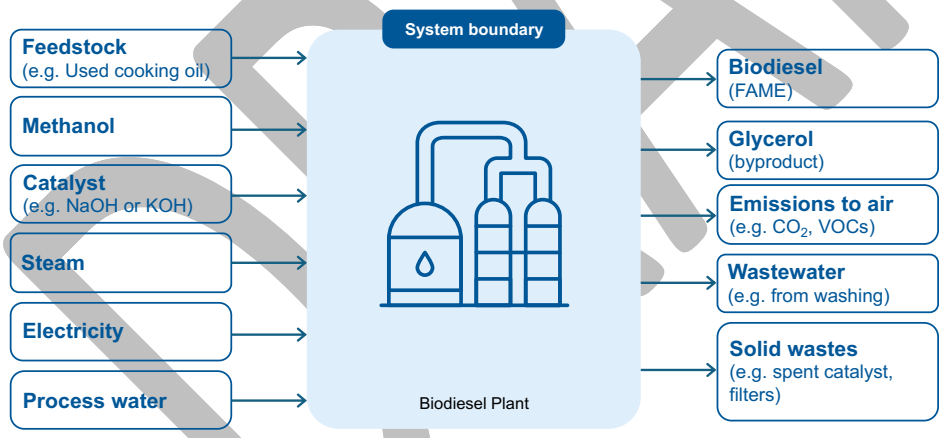

Figure 7 Illustration depicting different material flows interacting with a system boundary

3. Categorization and definition of substance entries:

Substance entries shall reflect operationally relevant material categories

Once all material flows interacting with the system boundary are identified, the System User shall then structure the substance entries into two categories: material inputs and material outputs. The material inputs shall be further categorized as feedstocks, processing inputs or utilities. The material outputs shall be further categorized as products, co-products and waste streams. It is advisable to define any recycled stream (i.e. recycled methanol from the distillation step) under material outputs.

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Once the substance entries are categorized as inputs and outputs, the System User shall then group material streams so that each substance entry represents either a distinct material or a material category that is relevant for the operation of the biodiesel plant. The System User shall use the guidance in earlier section to decide if the material entry is kept separate or combined with other entries.

Material description shall reflect actual operating conditions

For each substance entry, the System User shall define the physico-chemical characteristics and other additional information as mentioned in section 5.1. Where applicable, the System User shall use a range of values for relevant characteristics or analytical parameters that reflect the processing reality of the biodiesel plant for the corresponding period of verification. For example, if a biodiesel plant receives 50 UCO deliveries of different quality in a year, they shall record UCO as a single material entry in their Substance Inventory but indicate the range of relevant characteristics and analytical parameters (such as FFA, water content etc.). As mentioned before, the composition of UCO feedstock shall be defined via pseudo-constituents like saturated C16 and C18 fatty-acid constituents, monounsaturated C18 fatty acid derivatives, polyunsaturated fatty-acid derivatives, mono- and diglycerides, free fatty acids and oxidation or degradation products. Such representative groups provide a practical means of describing the complex and variable composition of UCO without implying a fixed chemical composition. Generic descriptions such as "typical UCO colour" or "typical UCO smell" shall not be used to define characteristics of any substance entry. Substance identification shall be based on measurable and verifiable characteristics.

Material streams can be consolidated where technically justified

Multiple streams of the same material or material category can be consolidated into a single substance entry, provided that the specified characteristics and parameter ranges accurately reflect the variability of the material quality handled during operation of the biodiesel plant. Different process chemicals and catalysts shall be reported as separate substance entries if they perform different functions. In contrast, material outputs such as biodiesel products, glycerine products and others shall be recorded as separate substance entries only if they represent materially different products, grades or process streams. An example of different FAME types is listed in Annex I. Similarly, some biodiesel plants may supply intermediate or pre-treated feedstocks to other processing facilities rather than converting all feedstocks into biodiesel on-site. Such non-processed materials shall be identified as a separate output entry (e.g. pretreated UCO).

Unless a strong justification for verification is provided, no confidential information (e.g. the name of the exact catalyst) that are business-sensitive shall not be disclosed in a Substance Inventory.

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If waste or wastewater streams generated at different processing steps are later combined into a single stream, the individual streams shall still be reported separately (e.g. wastewater from the transesterification step, wastewater from the gravity separation step etc.). The System User shall offer a justification when such distinction was not implemented. If relevant, the composition of waste streams, like solid content of wastewater, shall be defined as well. Gaseous emissions from biodiesel production shall also be recorded if they account for more than 1% of mass in relation to the mass of the main product. Any substance that is crucial for the process technology but accounts for less than 1% of final product mass shall be included in the list.

Waste streams and emissions shall be documented separately where relevant

The System Users shall use the ISCC standard Substance Inventory template. Provided that all relevant material flows are covered, the template shall be developed either for the entire biodiesel plant or for individual processing steps (i.e. unit operations). The use of a standardised template supports consistent technical verification of all ISCC EU certified biodiesel plants and enables auditors to efficiently review and compare substance inventories during certification and recertification audits.

System Users shall use the ISCC Substance Inventory template

Overall, the information provided in the Substance Inventory shall enable the assessment of whether the process technology described by the System User is suitable for processing the range of feedstock qualities received into reported product qualities.

The Substance Inventory shall support technical plausibility assessment

6. Technological Balance

The objective of a biodiesel plant operator is to convert most of the renewable feedstocks they receive into biodiesel and other products, such as glycerine. Among other factors, the quantity of biodiesel produced is mainly determined by the feedstock quality and a fraction of incoming feedstock is always lost as waste streams, residues or wastewater during biodiesel production.

Material conversion efficiency is reflected in the Technological Balance

In accordance with the principle of conservation of mass, the total mass entering the biodiesel plant or the biodiesel processing step shall be equal to the total mass leaving (considering the output flows, any accumulation and process losses) the biodiesel plant. A Technological Balance is a quantitative accounting of all material flows entering and leaving the biodiesel plant during a defined period.

Technological Balance applies the principle of conservation of mass

The term Technological Balance is synonymous with the process mass balance or process material balance that is regularly performed in the chemical industry. The term “Technological Balance” is used to avoid confusion with the ISCC mass balance. The Technological Balance is different from the ISCC sustainability mass balance. The ISCC sustainability mass balance tracks certified inputs and certified outputs in accordance with applicable certification requirements. In contrast, the

Technological Balance is distinct from the ISCC mass balance

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Technological Balance accounts for all material flows associated with the biodiesel production, regardless of their certification status. In addition, the ISCC mass balance accounts for certified materials in stock, such as UCO inventory, whereas the Technological Balance focuses only on the actual quantity of material processed during a defined period. The Technological Balance helps to validate the quantity of lipid feedstocks and other material inputs that are processed into fuel (i.e. biodiesel) and non-fuel outputs.

Technological Balance shall be based on operational plant data

The Technological Balance shall be based on actual process data recorded during biodiesel plant operation. Information from industrial data sources like flow meter readings, tank measurements, production records and other process monitoring systems shall be used to define quantities in the Technological Balance. The Technological Balance shall always be based on data covering a 12-month period. The System User shall provide valid justification if any deviation from the 12-month period is encountered.

Multiple balances can be developed for individual feedstock pathways

All substances included in the Substance Inventory shall be included in the Technological Balance with their respective masses. If relevant, the System User shall develop a feedstock-specific Technological Balance (e.g. UCO to FAME Technological Balance, POME to FAME Technological Balance) for their biodiesel plant.

System Users shall use the ISCC Technological Balance template

To facilitate a consistent and efficient verification process, System Users shall use the standard ISCC Technological Balance template available on the ISCC website. The template can be applied to the entire biodiesel plant or to individual processing steps. Multiple templates can therefore be used for a single biodiesel plant. Figure 8 illustrates the standard ISCC Technological Balance template

Process mass balance_plant1
Period: June 2024 – May 2025
Scope: Biodiesel production

Input materials

Chemicals

Technological number	Definition	Consumption	Unit
CH####1	Chemical1	10,000	MT
CH####2	Chemical2	2,000	MT
CH####3	Chemical3	500	MT
CH####4	Chemical4	200	MT
CH####5	Chemical5	1,000	MT
	Total chemicals	**13,700**	**MT**

Feedstocks

Technological number	Definition	Consumption	Unit
FS###1	Feedstock1	700	MT
FS###2	Feedstock2	72,000	MT
FS###3	Feedstock3	10,600	MT
FS###4	Feedstock4	3,000	MT
	Total feedstock	**86.300**	**MT**
	Total input	**100.000**	**MT**

Output materials

End products

Technological number	Definition	Consumption	Unit
PR###1	Product1	63,500	MT
PR###2	Product2	8,000	MT
	Total FAME	**71,500**	**MT**

By-products / processing residues

Technological number	Definition	Consumption	Unit
PR###3	Byproduct1	14,000	MT
PR###4	Byproduct2	7,500	MT
PR###5	Byproduct3	1,000	MT
W###1	Byproduct4	5,000	MT
	Total by-products/residues	**71.500**	**MT**
	Total output	**99.000**	**MT**
Deviation		**1,00%**	

Figure 8 Illustration of the standard ISCC Technological Balance template

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6.1 Guidance for developing the Technological Balance

The following section provides general guidance for developing a Technological Balance:

1. Definition of the system boundary:

The system boundary determines the Technological Balance

The System User shall first define the system boundary applicable to their biodiesel plant and determine whether the Technological Balance will be prepared for:

- the entire biodiesel plant (global Technological Balance); or
- individual process units or processing steps (local Technological Balances).

The System User shall develop a separate Technological Balance for processing steps that are either complex or multifunctional. If a comprehensive pre-processing step exists (e.g. different pre-processing technologies for different feedstocks), they shall have their separate Technological Balances as well. The same shall apply if the biodiesel plant supplies pre-processed feedstock to third parties (as shown in Figure 9). The System User shall consider such pre-processing steps as one plant and the biodiesel production (transesterification till final distillation) as a second plant and the System User shall maintain a separate Technological Balance for each of the plants.

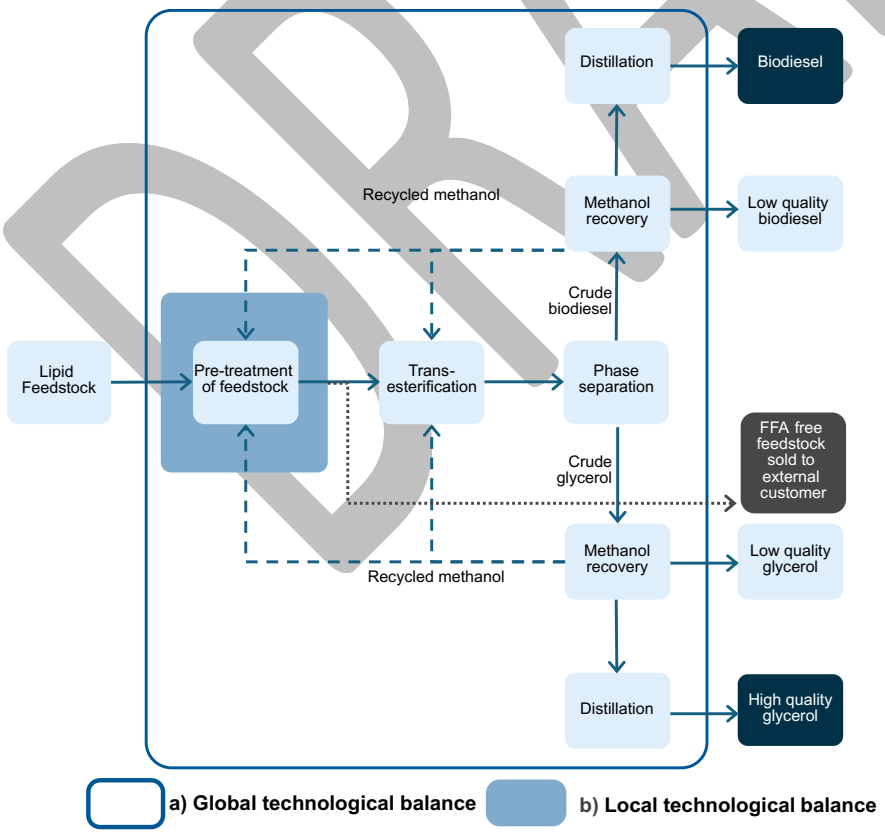

Figure 9 Illustration of system boundaries for a biodiesel plant depicting a) global Technological Balance and b) local Technological Balance.

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2. Identification and documentation of all material flows:

All identified material flows shall be included in the balance

The System User shall first identify all material flows interacting with their system boundary (or multiple system boundaries) and categorize them either as material inputs or material outputs. The material inputs shall then be grouped on one side and the material outputs on the other side in the standard Technological Balance template provided by ISCC.

The System User shall ensure that all material flows defined in the Substance Inventory are also recorded in the Technological Balance and that the material names used in the Substance Inventory and the Technological Balance are consistent.

3. Material flow quantification:

Material quantities shall be supported by operational records

For each material entry identified in step 2, the System User shall enter the quantity (in mass) of that material processed in the last 12 months. Plant process data like mass flow meter records and readings from sensors shall be used to determine the quantity of material flows. The auditor shall ask for supplementary evidence (e.g. inspection of raw flow meter readings, SCADA data, weighbridge documents etc.) to cross verify the numbers defined in the substance Technological Balance. If required, a Technological Balance corresponding to a shorter period, such as 1 month or 3 months, shall be developed by the System User and verified by the auditor.

4. Use of estimated values and design values:

Estimated values can only be used where justified

If a required material quantity cannot be directly measured or reliably determined from available operational records, an estimated value can be used. Such acceptance of estimated values shall be allowed only if the impracticality of obtaining the actual value is reasonably justified. The assumptions, data sources, methodology and calculations used to determine the estimated values shall be sufficiently documented for the auditor. For example, estimated values shall be derived from:

- stoichiometric calculations;
- engineering estimates;
- comparison with or derivation from measured process streams; or
- design data supported by technical justification.

The auditor shall verify whether the use of an estimated value is justified and appropriately documented. Estimates shall not be used where actual data are available or could reasonably be obtained by the System User.

Use of design data is permitted for a limited period

If a biodiesel plant has not yet accumulated sufficient operational data, design values can be used to develop the Technological Balance as an exception. Design values shall be replaced by actual operational data as

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soon as sufficient production data become available. As a general principle, System Users shall transition to actual production data after six months, informing the CB that the values based on design data are appropriate or have deviations.

5. Evaluation of deviations between input and output quantities:

Mass balance deviations shall be investigated and documented

Once the quantity of all material flows is entered in the Technological Balance, the System User shall compare the total mass of all inputs with the total mass of all outputs. While Technological Balances are ideally expected to be conserved (i.e. the sum of input masses equals the sum of output masses), minor deviations may occur due to measurement errors and estimation methods. The System User can evaluate whether the deviations in their Technological Balance are acceptable using the following guidance:

- **Deviation < 2%:** Deviations below 2% shall generally be considered acceptable and can be attributed to measurement uncertainties and instrumentation errors.
- **Deviation ≥ 2% and < 5%:** The System User shall investigate the cause of the deviation and provide an explanation within the Technological Balance, even if no conclusive explanation can be identified.
- **Deviation ≥ 5%:** Significant deviations often indicate omitted material streams, double counting of material flows or incorrect treatment of internal recirculation streams. Such deviations shall be investigated and corrected wherever possible.

6.2 Additional information on energy consumption of the biodiesel plant

Energy consumption supports production plausibility assessment

In addition to the Technological Balance, the System User shall provide information on the energy consumption of the entire biodiesel plant. The energy consumption data shall enable an assessment of the plausibility of production activities and facilitate comparison with the associated GHG calculation. Overall, the information shall help to determine the energy consumed per unit of final product produced from annual energy consumption from different energy sources (e.g. methane, steam etc.). The following offers guidance for preparing energy consumption data:

1. Identification of energy sources:

All significant energy sources shall be documented

The System User shall first identify and list all energy sources used for the operation of the biodiesel plant. Typical energy sources include:

- electricity;
- natural gas;
- heating oil;
- steam; and
- process by-products used for energy generation.

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2. Quantification of energy consumption:

Energy consumption shall be reported using measured quantities

For each energy source, the quantity consumed during the preceding 12-month period shall be reported. Energy consumption shall be reported in appropriate energy units, such as kWh, MJ or GJ. If relevant, energy consumption for a shorter period (e.g. 1 month or 3 months) or feedstock-specific energy consumption shall be provided and verified.

For fuels and utilities such as natural gas, heating oil, steam or internally generated fuels, the corresponding physical quantities shall also be reported. Examples include:

- Nm^3 of natural gas;
- tonnes of heating oil;
- operating pressure and inlet temperature for steam and
- tonnes of by-products used for combustion.

3. Avoidance of multiple accounting:

Internally generated energy shall not be counted twice

The reported energy consumption shall not include multiple accounting of internally generated energy. For example, where natural gas is used to generate steam, both the natural gas consumption and the steam generated shall not be reported as separate primary energy inputs. Energy data reported in the Energy Consumption Annex shall be consistent with the energy data used in the GHG calculation.

4. Use of design data and data from GHG calculator:

New plants shall use design data for limited period

For newly commissioned biodiesel plants, energy consumption data can initially be based on design values. Design values shall be replaced by actual operational data after six months of stable operation, without requiring notice from ISCC, a CB or a competent authority. As plants continuously optimise their process performance, new biodiesel plants are expected to establish a solid Technological Balance (with minimum deviation) and energy consumption profile after two years of operation. Biodiesel plants that have been operational for many years, are expected to establish a solid Technological Balance and energy consumption data either already or with minimum effort.

Energy reporting shall be consistent with GHG calculations

If the requirements of the document are met, annual mass flow and energy consumption data that are already used for the GHG emission calculation of biodiesel shall be used to develop the Technological Balance and energy consumption data. The information in the Technological Balance, energy consumption data and GHG calculation shall be mutually consistent and shall not contain any discrepancies or contradictions. Auditors and System Users shall pay particular attention to:

- differing process conversion factors;
- missing products or co-products;

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- multiple accounting of energy inputs;
- inconsistencies between production volumes and energy consumption; and
- inconsistencies between the Technological Balance and the GHG calculation.

7. Process Description

The Process Description demonstrates how feedstocks are converted into products

Process Description, in this context, refers to a well-documented explanation of how renewable feedstocks are converted into biodiesel, co-products and waste streams within a specific biodiesel plant. The Process Description shall demonstrate that the process technology and infrastructure in place are suitable for converting the declared feedstocks into the products, co-products and wastes specified in the Substance Inventory, Technological Balance and ISCC certificate.

The Process Description shall cover all activities within the system boundary

The Process Description shall provide a comprehensive description of the biodiesel production process implemented by the System User. The Process Description shall cover all relevant activities within the defined system boundary, starting from the receipt of feedstocks up until the dispatch of products, co-products and other outputs to the next element in the supply chain.

Technical explanations shall support plausibility assessment

The Process Description shall include a combination of written descriptions, process flow diagrams and supporting information to explain the plant configuration, process and material flows, control procedures and operational practices implemented by the System User that are specific to the biodiesel plant of interest. The Process Description shall include the routine operational procedures relevant to biodiesel production, including feedstock acceptance, process operations, quality control activities and product testing. The level of detail provided shall be sufficient to enable an assessment of the technical plausibility of the production process and the consistency of the information contained in the Substance Inventory and Technological Balance.

Process description shall contain four key elements

The Process Description shall be developed in a manner that is sufficiently detailed to enable technical assessment while remaining clear and understandable for auditors and other users of the document. The Process Description shall comprise of the following elements:

1. Site layout and infrastructure:

Site infrastructure shall support the declared production activities

The Process Description shall be accompanied by a site map showing the locations of all major process areas and infrastructure relevant to biodiesel production. At a minimum, the site map shall identify:

- loading and unloading areas;

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- storage units (e.g. tank farms) for feedstocks, auxiliary materials, products and co-products;
- processing units and major unit operations;
- laboratory facilities; and
- administrative buildings, where relevant.

The site map shall enable the auditor to verify the physical existence of the process infrastructure during the on-site audit.

2. Explanation of the biodiesel production process:

The production pathway shall be explained step by step

The Process Description shall contain a written explanation of the processing steps involved in the production of biodiesel from the renewable feedstock. The explanation shall enable the auditor to follow the physical flow of material from feedstock receipt to product dispatch. Process steps shall be described using commonly accepted technical terminology that accurately reflect the underlying process technology. For example, a clear distinction shall be made between:

- esterification and transesterification;
- methanol recovery and biodiesel purification;
- biodiesel distillation and glycerine processing; and
- other distinct unit operations where applicable.

Alternative processing pathways shall be documented

Where different feedstocks follow different processing routes, or where certain process steps may be bypassed under specific conditions, the Process Description shall explain the circumstances under which such alternative routes are applied. For example, if a biodiesel plant decides to process a UCO batch with 1% FFA directly via transesterification and bypass the esterification step, this shall be mentioned in the Process Description. The outcome of such a process decision shall also be reflected in the amount of soap generated during the transesterification step which shall be reported in the Substance Inventory and Technological Balance.

3. Process flow diagrams:

Process flow diagrams shall reflect actual material flows

The process explanation shall also contain process flow diagrams that include:

- all relevant process steps and unit operations;
- all major input substances;
- all products, co-products and waste streams;
- significant internal recycling streams; and
- the principal material flows through the process.

A generic process flow diagram for a biodiesel production process is provided in Annex III.

4. Feedstock acceptance and incoming goods inspection:

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Feedstock quality control procedures shall be documented

Any procedures used for incoming goods inspection and/or feedstock acceptance shall also be included in the Process Description. For feedstocks, the following information shall be provided:

- Internal guidelines (e.g. SOPs) used for the inspection of incoming goods
- Analytical tests/parameters that are regularly checked to identify and accept feedstocks (examples of such tests are listed in Annex IV)
- Limits or ranges for analytical parameters used for acceptance
- Information on retain samples of the feedstocks
- Information on regional regulations on feedstock retention and company retention periods
- Procedure on sampling method and frequency (e.g. sampling of each batch, random sampling of selected batches, composite samples from all delivered batches)
- Follow-up measures when an analytical parameter of a feedstock was identified to be outside the acceptable limit

Product quality verification procedures shall be documented

Similarly, the following information shall be provided for intermediates and products:

- Internal guidelines (e.g. SOPs) used for the inspection of final products
- Analytical tests/parameters performed for final products and other outputs
- Frequency of analytical testing
- Information on compliance with fuel quality standards (e.g. EN 14214) that are relevant for the final product
- Information on retain samples of the final products
- Information on regional regulations on product retention and company retention periods
- Follow-up measures when an analytical parameter of a final product was identified to be outside the accepted fuel quality standard

All technical documents shall use consistent terminology

If a documented company procedure exists, the System User can either describe the procedure within the Process Description or reference the relevant internal document. The names of all input and output substances used in the Process Description and associated process flow diagrams shall be identical to those used in the Substance Inventory and the Technological Balance. The material flows represented in the process diagrams shall be consistent with those reported in the Technological Balance.

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If the System User chooses to establish separate system boundaries for individual process sections or processing units, this approach shall be explained and consistently reflected in the Process Description, Substance Inventory and Technological Balance.

Boundary definitions shall be applied consistently across documents

The System User shall ensure that the Process Description remains up to date. If significant changes are made to:

Technical documentation shall be kept up to date

- feedstocks;
- process technology;
- process configuration;
- products;
- co-products; or
- system boundaries,

the Process Description, Substance Inventory and Technological Balance shall be updated without undue delay.

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Annex I: An example table for a Substance Inventory

An example of a Substance Inventory containing mono-constituent (Order number: 0815), multi-constituent (Order number: 2267) and UVCB substances (Order number: 9324 and 6687) is shown below:

Order number, or your internal unique technological number	Brand name, trade name or internal name used in the company	Scientific name of the substance or constituent (CAS name or IUPAC name)[1]	CAS number (if applicable)	Composition[2] or other data used to identify the substance
Material inputs:				
0815	Technical methanol	Origin/process: not relevant		
		Methanol	67-56-1	99.6 %
2267	Crude glycerine	Origin/process: not relevant		
		Glycerine	56-81-5	47 % - 52 %
		Fatty acids, unknown composition (mainly C16-18 and C18 unsaturated)	67701-05-7	10 % - 15%
		Unknown impurities (e.g. water, inorganics)	-	35 % - 40 %
9324	UCO (type A)	Origin/process: Collected oil from restaurants, using only vegetable oils for frying, solids < 5 mm and free water phase removed		
		Triglycerides, unknown composition (mainly C16-18 and C18 unsaturated)	-	85 % - 90 %
		Free fatty acids, unknown composition (mainly C16-18 and C18 unsaturated)	67701-05-7	5 % - 8 %
		Water	7732-18-5	0.2 % - 0.5 %
		Solid impurities	-	1 % - 3 %
		Iodine number	-	70 g/100 g - 95 g/100 g
		Saponification value	-	≥ 185 mg KOH/g
		Acid number	-	10 - 16 mg KOH/g
		Processability test („yield“)	-	≥ 83 %
		Sulphur content	-	≤ 50 mg/kg

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Order number, or your internal unique technological number	Brand name, trade name or internal name used in the company	Scientific name of the substance or constituent (CAS name or IUPAC name)[1]	CAS number (if applicable)	Composition[2] or other data used to identify the substance
Material outputs:				
6687	FAME of vegetable origin	Origin/process: Used vegetable oils, collected, purified and converted via esterification and transesterification with methanol		
		Fatty acids, vegetable-oil, Me esters	68990-52-3	100 %
		Properties according EN 14214, except following endpoints:	-	Refer to EN 14214
		Ester content	-	≥ 95 %
		Sulphur content	-	≤ 23 mg/kg
		CFPP	-	≤ +8 °C

Note:

1. **Use of scientific material names:** Substances shall be identified using a defined scientific name (i.e. IUPAC name) and CAS number where applicable. Such identifiers normally exist for mono-constituent substances and some UVCB substances. Well-defined constituents of multi-constituent substances shall also be identified by their scientific names and CAS numbers where available.

2. **Definition of material composition:** For mono-constituent substances (e.g. methanol), the concentration or concentration range of the main constituent shall be specified in % (w/w). For multi-constituent substances, the typical concentration or concentration range of each constituent shall be provided in % (w/w), based on the best available knowledge.

For UVCB substances (e.g. UCO), the typical concentration or concentration range of each known pseudo-constituent shall be provided in % (w/w). As these pseudo-constituents may themselves be complex substances, the relevant level of characterisation shall be selected accordingly. In addition, the key analytical test methods used for substance identification and incoming-goods inspection shall be specified, together with the expected ranges of the corresponding test results.

For FAME, which is also considered a UVCB substance, the table entry can be simplified by using the applicable CAS name and CAS number for the substance as a whole. Instead of listing individual analytical methods, the substance can be characterised by reference to a relevant standard, e.g. “according to EN 14214” or ASTM D 6751. Such a reference is considered an implicit definition of the applicable analytical

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methods and acceptance limits. Any deviations from the referenced standard for individual parameters or endpoints shall be explicitly stated.

Annex II: List of FAME types registered under REACH

FAME category	CAS number	Definition
Fatty acids, vegetable-oil, Me Esters	CAS# 68990-52-3 EC# 273-606-8	FAME, exclusively produced from vegetable oils/fats
Fatty acids, C16-18 and C18-unsatd., Me esters	CAS# 67762-38-3 EC# 267-015-4	Like CAS# 68990-52-3, but open also for animal oil/fat based products
Fatty acids, C14-18 and C16-18-unsatd., Me esters	CAS# 67762-26-9 EC#267-007-0	
Fatty acids, C10-18 and C12-22-unsatd., C14-18 and C16-18-unsatd. Alkyl esters	CAS# 85049-31-6 EC# 285-200-8	The competent authority recommended to change the name to “Fatty acids, C12-18 (even numbered) and C18-unsatd. Me esters”, however the name has been not accepted by the registrants.

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Annex III: A generic process flow diagram of FAME production

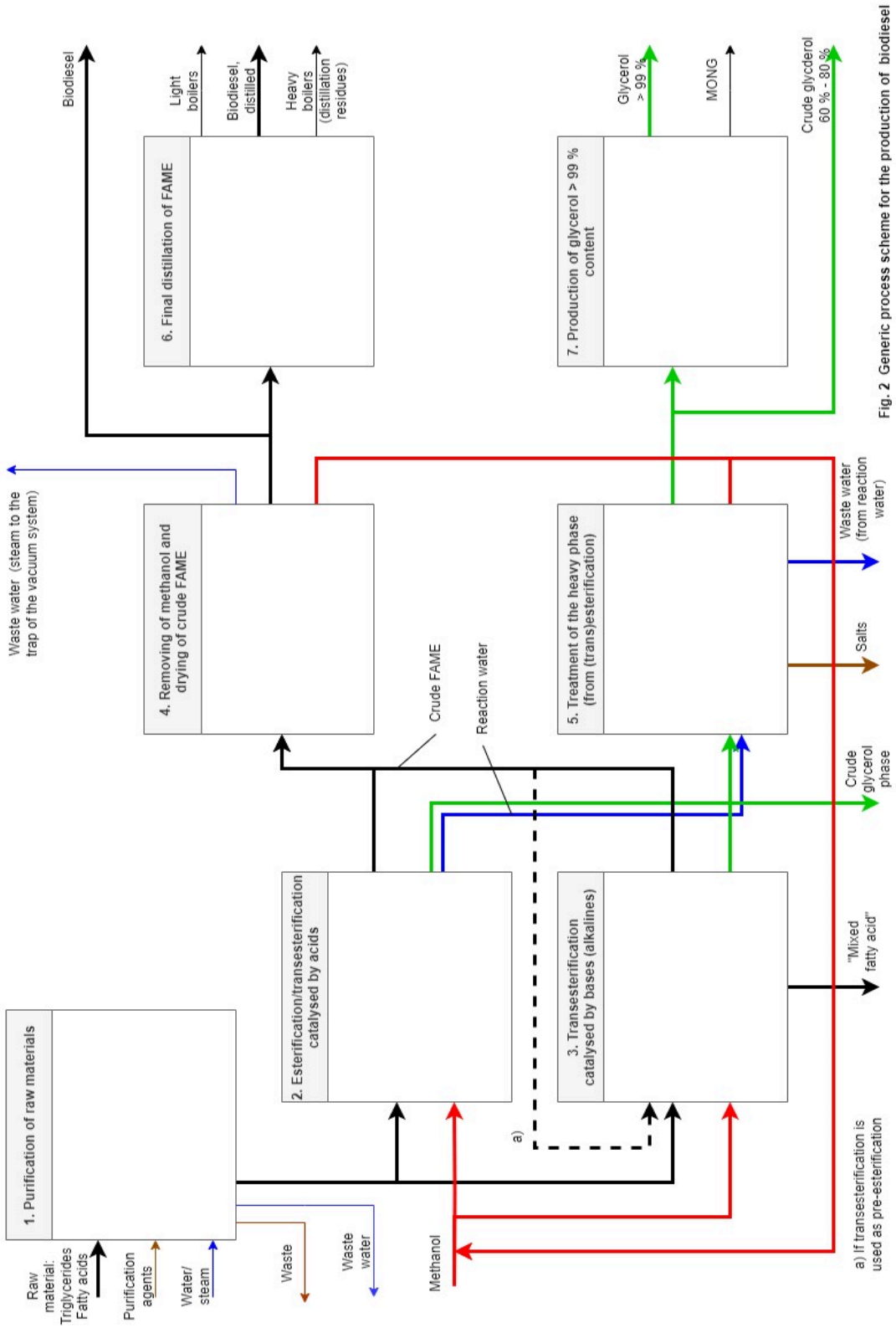

Fig. 2 Generic process scheme for the production of biodiesel

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Annex IV: Recommended tests for the incoming goods inspection of recycled biogenic fats and oils

The following table is based on practical experience from the industry and can be adapted to the real source of the material and the linked risks. It contains both endpoints that are an indication of processability and those that are an indication of the origin of the material.

Item	Endpoint	P	O	Remark
1	Appearance		X	Description in words and/or photo
2	Odour		X	It is recommended to limit the description to specific basic types of odours so that the persons involved in the incoming goods inspection can be trained accordingly. Statements such as “typical odour” are not helpful to identify a material.
2	(Mechanical) impurities	X	X	There exist various methods, e.g., filterability through a sieve or determination of the insoluble portion of the sample in solvents.
3	Water content (moisture)	X	X	
4	Acid number/Free fatty acid content	X	X	
5	Iodine number		X	
6	Fatty acid profile			
7	Free fatty acid content		X	
8	Saponification number	X	X	
9	Theoretically achievable yield	X		Such a method is a simplified representation of the company's own process technology and provides an indication of the material‘s processability in the implemented process. The result of such a test is usually more realistic than a consideration based on the saponification number.
10	Sulphur content	X	X	
11	Chlorine content	X	X	High chlorine levels indicate that not only biogenic oils were collected. Raw material with a high chlorine content poses a risk both to the own plant and to product quality.

P Indication for processability of the raw material
O Indication for origin of the raw material

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