

**RSB – ROUNDTABLE ON SUSTAINABLE BIOMATERIALS**

## **RSB STANDARD FOR ICAO CORSIA**

Version 1.1

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## Introduction

This standard specifies requirements for operators along the *Sustainable Aviation Fuel (SAF)* supply chain to produce SAF eligible under *CORSIA*.

The Carbon Offsetting and Reduction Scheme for International Aviation, or *CORSIA*, is an emission mitigation approach for the global airline industry, developed by the International Civil Aviation Organization (ICAO). *CORSIA* has been adopted as complementary to a broader package of measures to help ICAO achieve its goal of carbon-neutral growth from 2020 onwards.

The approach for *CORSIA* is based on comparing the total CO<sub>2</sub> emissions from 2021 onwards against a baseline level of CO<sub>2</sub> emissions. In the following years, any international aviation CO<sub>2</sub> emissions covered by *CORSIA* that exceed the baseline level represent the sector's offsetting requirements for that year.

*CORSIA* will be implemented in three phases, starting with participation of States in *CORSIA* offsetting on a voluntary basis (pilot phase and first phase), followed by participation of all States except the States exempted from offsetting requirements, as follows:

- Pilot phase: from 2021 to 2023;
- First phase: from 2024 to 2026; and
- Second phase: from 2027 to 2035.

From 2021 onwards, operators can reduce their *CORSIA* offsetting requirements by claiming emissions reductions from *CORSIA* eligible fuels. The State will calculate the operator's final offsetting requirements at the end of each compliance period by subtracting the emissions reductions from the use of *CORSIA* eligible fuels from the operator's offsetting requirements

The five ICAO *CORSIA* Implementation Elements listed below are reflected in 14 ICAO documents approved by the ICAO Council for publication. These ICAO documents are directly referenced in Annex 16, Volume IV and are essential for the implementation of *CORSIA*.

*CORSIA* Implementation Elements <sup>1</sup> related to [CORSIA eligible fuels](#) include the

- *CORSIA* Eligibility Framework and Requirements for Sustainability Certification Schemes
- *CORSIA* Approved Sustainability Certification Schemes
- *CORSIA* Sustainability Criteria for *CORSIA* Eligible Fuels
- *CORSIA* Default Life Cycle Emissions Values for *CORSIA* Eligible Fuels
- *CORSIA* Methodology for Calculating Actual Life Cycle Emissions Values

All requirements described in the above *CORSIA* Implementation Elements have been incorporated in the RSB ICAO *CORSIA* certification scheme and in this standard.

### Main changes from the previous version 1.0 (draft)

a) Section 4 "Requirements related to Low ILUC Risk Feedstocks": exclusion of mention to the products certified against to the RSB Low Indirect Land Use Change Risk Biomass Criteria and Compliance indicators [RSB-STD-04-001].

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<sup>1</sup> <https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx>

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## A. Aim of this standard

This standard has been developed to define requirements for operators along the SAF supply chain to produce SAF considered as eligible under ICAO CORSIA.

## B. Scope of this Standard

This standard is globally applicable for operators producing, processing and trading feedstock, intermediates or SAF.

## C. Status and effective date

This version 1.0 of the standard shall be effective from 01 May 2020.

Whenever any contradiction or inconsistency exists between this version and previous versions of this standard, the latest version shall prevail.

## D. Note on the use of this standard

All aspects of this standard are considered to be normative, including the intent scope, standard effective date, references, terms and definitions, tables and annexes, unless otherwise stated.

Users implementing this standard shall ensure that the intent of this standard is met. To ensure that the intent of this standard is met users shall implement all of the requirements specified in this standard, and any and all additional measures necessary to achieve the intent of this standard.

In the event of any inconsistency between this RSB Standard and the RSB Principles and Criteria [RSB-STD-01-001] or other RSB Standards and Procedures, this RSB Standard shall prevail.

## E. References

Please see the RSB List of Documents and References [RSB-DOC-10-001] for the full list of RSB Standards and references.

## F. Terms, definitions and acronyms

For the purposes of this standard, the terms and definitions given in RSB Glossary of Terms [RSB-STD-01-002] shall apply. The following terms are particularly important for this standard:

- *Participating Operator*: Legal entity or natural person that has entered into a formal agreement with the RSB Association (“Participating Operator Agreement”) and that is responsible for the implementation of the requirements of all applicable RSB Standards and Procedures in all organisations listed in the scope of certification
- *Primary Biomass Producer*: Organisation that applies for certification for a specific activity that includes the production of crops or woody material, for example farm operators or plantation owners
- *Point of Origin*: The generator, such as companies, farms, forest areas, residences, industries and commercial facilities of end-of-life-products, production residues, by-product or other waste materials
- *First Collector*: Operator that receives end-of-life-products, production residues or by-products or from points of origin
- *Industrial Operator*: Organisation that applies for certification for a specific activity that includes feedstock processing and/or the production of intermediary products, fuels or advanced products
- *Mechanical operator*: Subgroup of industrial operators only conducting mechanical or physical processing (e.g. mixing, assembling, sorting, moulding, cutting etc.)
- *Trader*: Organisation that applies for certification for a specific activity that includes buying and selling of materials or products, including raw materials, intermediates and final products. Examples of traders are first collectors, blenders, wholesale and retail companies (also companies selling to end-consumers) as well as airlines or shipping companies selling transport services to their clients

The following terms and definitions apply in addition:

- *CORSIA eligible fuel*: A CORSIA sustainable aviation fuel or a CORSIA lower carbon aviation fuel, which an operator may use to reduce their offsetting requirements.
- *CORSIA lower carbon aviation fuel*: A fossil-based aviation fuel that meets the CORSIA Sustainability Criteria
- *CORSIA sustainable aviation fuel*: A renewable or waste-derived aviation fuel that meets the CORSIA Sustainability Criteria
- *Feedstock*: A type of unprocessed raw material used for the production of aviation fuel.
- *Pathway*: A specific combination of feedstock and conversion process used for the production of aviation fuel.

The following acronyms are used:

- *ATJ*: Alcohol-to-jet
- *AvGas*: Aviation Gasoline
- *CO<sub>2</sub>*: Carbon dioxide
- *CO<sub>2</sub>e*: Carbon dioxide equivalent
- *CORSIA*: Carbon Offsetting and Reduction Scheme for International Aviation

- *DLUC*: Direct land use change
- *DOC*: Degradable organic carbon
- *DOF<sub>F</sub>*: Fraction of degradable organic carbon dissimilated
- *FT*: Fischer-Tropsch
- *GHG*: Greenhouse gases
- *GWP*: Global warming potential
- *HEFA*: Hydroprocessed esters and fatty acids
- *ILUC*: Induced land use change  
     *Please note*: In the context of the RSB certification system *ILUC* stands for indirect land use changes
- *IPCC*: Intergovernmental Panel on Climate Change
- *ISO*: International Organization for Standardization
- *LCA*: Life cycle assessment
- *LEC*: Landfill emissions credit
- *LFG*: Landfill gas
- *LFGCE*: Landfill gas collection efficiency
- *LMP*: Land management practice
- *LUC*: Land use change
- *LS<sub>f</sub>*: Life cycle emissions factor for a CORSIA eligible fuel in g CO<sub>2</sub>/MJ
- *MCF*: Methane correction factor
- *MJ*: Megajoule
- *MSW*: Municipal Solid Waste
- *N<sub>2</sub>O*: Nitrous oxide
- *REC*: Recycling emissions credit
- *NBC*: Non-biogenic carbon
- *SAF*: Sustainable Aviation Fuel
- *SCS*: Sustainability Certification Scheme
- *SIP*: Synthetic iso-paraffin

## G. Requirements

### 1. General Requirements

The following standards and procedures shall apply in addition to this standard:

1. 1. The RSB Principles and Criteria [RSB-STD-01-001] shall apply to any primary biomass producer and industrial operator along the SAF supply chain.  
*Please note:* The RSB Principles and Criteria do not apply to traders or mechanical operators, i.e. operators only conducting mechanical or physical processing (e.g. mixing, assembling, sorting, moulding, cutting etc.).
1. 2. The RSB Chain of Custody Procedure [RSB-PRO-20-001] shall apply to any operator along the SAF supply chain with legal ownership of RSB certified material. The following chain of custody models are eligible under RSB ICAO CORSIA:
  - Identity Preserved
  - Segregated
  - Mass Balance
1. 3. The RSB Procedure for Participating Operators [RSB-PRO-30-001] shall apply to any Participating Operator (PO) along the SAF supply chain.
1. 4. The RSB Procedure for Risk Management [RSB-PRO-60-001] shall apply to any PO along the SAF supply chain.
1. 5. The RSB Standard for Advanced Fuels [RSB-STD-01-010] shall apply to any operator along a SAF supply chain using wastes, residues or by-products, except the requirements specified in section G.1 (Eligibility Requirements).

*Please note:* See [Annex III](#) of this document for a positive list of waste, residues and by-products that may be used under RSB ICAO CORSIA.

### 2. CORSIA Sustainability Criteria for SAF

2. 1. Requirement related to the Greenhouse Gas (GHG) emissions of SAF  
The SAF producer shall demonstrate that the SAF achieves, on a life cycle basis, net GHG emissions reductions of at least 10% compared to the baseline life cycle emissions values for aviation fuel. The fossil fuel baseline values are 89 g CO<sub>2</sub>e/ MJ for jet fuel and 95 g CO<sub>2</sub>e / MJ for AvGas<sup>2</sup>.  
*Please note:* In addition to this requirement, the SAF producer must comply with RSB Principle 3, criterion 3c which requires that fuels achieve an LCA GHG emission reduction of 50% relative to the above fossil baselines (60% for new installations that started operation after 5 October 2015).
2. 2. The SAF producer shall calculate the total life cycle GHG emission value (LS<sub>i</sub>) for a given SAF as the sum of the core LCA value and the ILUC value.

<sup>2</sup> ICAO Document – CORSIA Sustainability Criteria for CORSIA Eligible Fuels

*Please note:* To comply with RSB criterion 3c the LCA value includes only direct land use changes, but no ILUC changes.

2. 3. Requirements related to the conservation of carbon stocks

2. 3. 1. The operator shall demonstrate that the CORSIA eligible fuel was not made from biomass obtained from land converted after 1 January 2008 that was primary forest, wetland, or peat land and/or contributes to degradation of the carbon stock in primary forests, wetlands, or peat lands as these lands all have high carbon stocks.

*Please note:* This criterion is also covered by RSB Principle 7 of the RSB Principles & Criteria [RSB-STD-01-001].

2. 3. 2. In the event of land use conversion after 1 January 2008, i.e. a change from one IPCC land-use category<sup>3</sup> into another, the operator shall calculate direct land use change (DLUC) emissions. If DLUC greenhouse gas emissions exceed the default induced land use change (ILUC) value, the DLUC value shall replace the default ILUC value. The operator shall calculate DLUC emissions in accordance with the methodology laid down in [Annex VI](#).

*Please note:* The DLUC calculation shall be conducted at the stage of feedstock cultivation and transmitted through the chain of custody in addition to the LCA values described in 3.3. The value shall be calculated in the unit g CO<sub>2</sub>e / dry-t feedstock and adjusted by applying the feedstock factor and the allocation factor as it moves through the chain of custody (in line with 3.3.7).

### 3. Requirements related to the calculation of SAF GHG emissions

3. 0. Requirements related to the classification of feedstocks

3. 0. 1. Feedstocks shall be classified into three categories as follows:
- Primary and co-products are main products of a production process. These products have significant economic value and elastic supply (i.e. there is evidence that there is a causal link between feedstock prices and the quantity of feedstock being produced);
  - By-products are secondary products with inelastic supply and economic value;
  - Waste are materials with inelastic supply and no economic value. A waste is any substance or object which the holder discards or intends

<sup>3</sup> The six land-use categories defined by the IPCC are forest land, grassland, cropland, wetlands, settlements and other land: IPCC 2006: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 3 Consistent Representation of Lands



or is required to discard. Raw materials or substances that have been intentionally modified or contaminated to meet this definition are not covered by this definition.

- Residues are secondary materials with inelastic supply and little economic value. Residues include:
  - Agricultural, aquaculture, fisheries and forestry residues: Residues directly deriving from or generated by agriculture, aquaculture, fisheries or forestry.
  - Processing residues: A substance that is not the end product that a production process directly seeks to produce; the production of the residue or substance is not the primary aim of the production process and the process has not been deliberately modified to produce it.

3. 0. 2. The positive list provided in [Annex III](#) shall be used to classify feedstocks as by-product, waste and residues.

### 3. 1. General requirements for SAF producers

3. 1. 1. The SAF producer shall determine the core LCA value either on the basis of default values or on the basis of calculated actual LCA values, as transmitted through the chain of custody by operators along the supply chain.
3. 1. 2. The SAF producer shall determine the ILUC value on the basis of default values (see [Annex I](#)).
3. 1. 3. Feedstocks that are “low risk” for induced land-use change shall be assigned an ILUC value of zero (see 3.3.4 for more information).
3. 1. 4. If a fuel was produced from a feedstock that is defined as a waste, residue, or by-product (see [Annex III](#)) then the actual core LCA value shall be the total  $LS_f$ .

*Please note:* If a feedstock is not a waste, residue or by-product nor “low risk” for induced land-use change (see 3.1.3), then a default ILUC value will need to be added to the ICAO document titled “CORISIA Default Life Cycle Emissions Values for CORISIA Eligible Fuels” on the ICAO website<sup>4</sup> before the fuel is eligible under CORISIA

### 3. 2. Requirements for the use of default values

3. 2. 1. If a default life cycle emissions value is used, then the SAF producer shall use the default values published in the ICAO document entitled “CORISIA Default Life Cycle Emissions Values for CORISIA Eligible Fuels” which is available on the ICAO CORISIA website<sup>5</sup> and in [Annex I](#) of this document.

*Please note:* In the case of any inconsistencies between the values in the annex of this document and the values as published on the ICAO website, the latter shall prevail.

<sup>4</sup> <https://www.icao.int/environmental-protection/CORISIA/Pages/CORISIA-Eligible-Fuels.aspx>

<sup>5</sup> <https://www.icao.int/environmental-protection/CORISIA/Pages/CORISIA-Eligible-Fuels.aspx>

3. 2. 2. The SAF producer shall only use the default life cycle emission values if the fuel supply chain matches with the information given in the table for
- the fuel conversion process;
  - the region where the feedstock is sourced;
  - the type of feedstock;
  - further pathway specifications as given in [Annex II](#).

The RSB may issue additional guidance on the use of default values and additional pathway specifications.

3. 2. 3. If the default value is being used, operators along the supply chain shall indicate “default value” in the delivery documentation instead of an actual GHG value (see RSB Chain of Custody Procedure [RSB-PRO-20-001] for more details on the information to be submitted through the chain of custody).

### 3. 3. General requirements for the calculation of actual LCA values

The operator shall ensure that the system used to calculate GHG emissions for actual LCA values accurately follows the CORSIA LCA methodology specified in the ICAO document “CORSIA Methodology for Calculating Actual Life Cycle Emissions Values” which is implemented in this standard RSB-STD-12-001. The operator shall also ensure that the LCA value calculation is complete, accurate and transparent.

#### 3. 3. 1. System Boundary for the calculation of actual LCA values

3. 3. 1. 1. The system boundary of the core LCA value calculation shall include the full supply chain of SAF production and use. As such, emissions associated with the following life cycle stages of the SAF shall be accounted for:
- 1) Production at source (e.g. feedstock cultivation) – see section 3.4 for the calculation methodology;
  - 2) Conditioning at source (e.g. feedstock harvesting, collection and recovery) – see section 3.5. for the calculation methodology;
  - 3) Feedstock processing and extraction – see section 3.5. for the calculation methodology;
  - 4) Feedstock transportation to processing and fuel production facilities – see section 3.6. for the calculation methodology;
  - 5) Feedstock-to-fuel conversion processes – see section 3.5 for the calculation methodology;
  - 6) Fuel transportation and distribution to blend point – see section 3.6. for the calculation methodology;
  - 7) Fuel combustion in an aircraft engine.

Whenever the land use is changed from one IPCC category into another (for example forest to cropland), direct land use change emissions shall be calculated additionally (see 2.3.2 for more information).

3. 3. 1. 2. For the life cycle stages 1-6 described above carbon dioxide equivalent (CO<sub>2e</sub>) emissions of CH<sub>4</sub>, N<sub>2</sub>O and non-biogenic CO<sub>2</sub> from these activities shall be calculated on the basis of a 100-year global warming potential (GWP). CO<sub>2e</sub> values for CH<sub>4</sub> and N<sub>2</sub>O shall be based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (i.e. 28 and 265, respectively). Only non-biogenic CO<sub>2</sub> emissions from fuel combustion (step 7) in 3.3.1.1. shall be included in the calculation of CO<sub>2e</sub> emissions.

3. 3. 1. 3. The calculated LS<sub>f</sub> values shall include emissions generated during on-going operational activities (e.g. operation of a fuel production facility, feedstock cultivation), as well as emissions associated with the material and utility inputs to operational activities, such as processing chemicals, electricity and natural gas. Emissions generated during one-time construction or manufacturing activities (e.g. fuel production facility construction, equipment manufacturing) shall not be included.

### 3. 3. 2. Functional unit

The functional unit for final LS<sub>f</sub> results shall be grams of CO<sub>2e</sub> per megajoule of fuel produced and combusted in an aircraft engine, per unit of lower heating value (g CO<sub>2e</sub>/MJ).

### 3. 3. 3. Feedstock categories

SAF feedstocks shall be categorised into three groups as specified in 3.0.:

- primary or co-products
- by-product
- wastes and residues

Waste, residue and by-product feedstocks shall have zero emissions during the feedstock production step of the lifecycle. Emissions generated during the collection, recovery, extraction, and processing of these wastes, residues and by-products, however, shall be included (i.e. life cycle stages 2-7 in clause 3.3.1.1)

### 3. 3. 4. Low ILUC Risk Feedstocks

Feedstocks that are “low risk” for induced land use change shall be assigned an ILUC value of zero. Low induced land use change risk feedstocks include:

- Feedstocks that do not result in expansion of global agricultural land use for their production;
- Wastes, residues, and by-products (see 3.3.3.);
- Feedstocks that were produced by utilising land use change-risk

mitigation practices (land management practices). See section 4 for more details;

- Feedstocks that have yields per surface unit significantly higher than terrestrial crops (i.e. one order of magnitude higher), such as some algal feedstocks.

### 3. 3. 5. Documentation requirement

Operators shall either use the RSB GHG calculation tool or prepare a technical report to document the following relevant data:

- GHG emissions by life cycle step (see 3.3.1.1.) within the scope of certification, broken out by GHG emission species (i.e. N<sub>2</sub>O, CH<sub>4</sub> and CO<sub>2</sub>) and aggregated in CO<sub>2</sub>e;
- the LCA inventory data by lifecycle step within the scope of certification, including all energy and material inputs. For lifecycle steps 1-4 (see 3.3.1.1), the inventory data shall be provided per mass of feedstock, for the other steps per total fuel energy yield (in MJ of fuel);
- Emission factors used for calculating GHG emissions associated with energy and material inputs, including information about the sources of the emission factors;
- All relevant feedstock characteristics within the scope of certification, such as, for example, agricultural yield, lower heating value, moisture content, the content of sugar, starch, cellulose, hemicellulose, lignin, vegetable oil, or any other energy carrier (as applicable to the feedstock of interest).
- Quantities for all final and intermediate products, per total energy yield;
- If MSW is being used as a feedstock, then all relevant data required for the calculation of landfill emissions credits and recycling emissions credits shall be disclosed, according to the MSW crediting methodology in [Annex IV](#);
- In the case a low ILUC practice is being used, all relevant data required for the calculation and certification shall be disclosed by the operator (see Section 4).

The RSB GHG calculation tool or the technical report shall be made available to the Certification Body and to the RSB Secretariat.

### 3. 3. 6. Allocation to co-products

1. Whenever a processing step along the SAF supply chain results in the co-production of multiple commodities (for example non-SAF liquid fuels, chemicals, electricity, steam, hydrogen, and/or animal feed),

energy-based allocation shall be used to assign emission burdens to all co-products in proportion to their contribution to the total energy content (measured as lower heating value) of products and co-products.

3. 3. 6. 2. CO<sub>2e</sub> emissions shall not be allocated to waste, residues and by-products that result from the SAF supply chain of interest.

3. 3. 7. **Transmission of information along the supply chain**

3. 3. 7. 1. Operators along the supply chain shall calculate the actual LCA value for their scope of certification and transmit the information to the next operator in the supply chain. The information shall be transmitted as part of the product information which shall be attached to every batch of RSB certified material.

*Please note:* RSB-PRO-20-001 contains more information about the requirements on the product information to forward.

3. 3. 7. 2. The LCA information shall be transmitted disaggregated for the life cycle stages 1-6 specified in 3.3.1.1. This means, that GHG LCA values have to be transmitted separately for production at source (e.g. feedstock cultivation), conditioning at source (e.g. feedstock harvesting, collection and recovery), feedstock processing and extraction, feedstock transportation to processing and fuel production facilities, feedstock-to-fuel conversion processes, fuel transportation and distribution to blend point).

3. 3. 7. 3. Each operator shall add additional GHG emissions that occur in their scope of certification for any processing and transport steps. Actual GHG LCA values shall only be transmitted to the customer if all relevant process and transport steps have been included. If the operator cannot guarantee that all relevant process and transport emissions are included in the calculation of an actual value, actual values must not be transmitted.

3. 3. 7. 4. Operators along the supply chain shall transmit the LCA values in the unit g CO<sub>2e</sub> / dry-t of product. The unit shall always refer to the raw material or the intermediary product that is forwarded by the operator.

3. 3. 7. 5. In order to transmit the correct unit to the client, operators along the supply chain shall adjust the LCA values before transmission to the next operator, by applying:
- a feedstock factor to take losses into account, and
  - an allocation factor whenever a process yields co-products.

The following formula shall be used when adjusting the LCA value.

*Please note:* the formula is shown for emissions for cultivation and shall be used equally for the other lifecycle steps.

$$e_{fc} \text{intermediate product}_a \left[ \frac{gCO_2e}{kg_{dry}} \right]$$

$$= e_{fc} \text{feedstock}_a \left[ \frac{gCO_2e}{kg_{dry}} \right] * \text{Feedstock factor}_a$$

\* Allocation factor intermediate product<sub>a</sub>

Where:

*e<sub>fc</sub>intermediate product<sub>a</sub>*: Emissions of feedstock cultivation of intermediate product a

*e<sub>fc</sub>feedstock<sub>a</sub>*: Emission of feedstock cultivation of feedstock a

Allocation factor<sub>a</sub>:  $\left[ \frac{\text{Energy in intermediate product}_a}{\text{Energy in intermediate products} + \text{co-products}} \right]$

Feedstock factor<sub>a</sub>:

[Ratio of MJ feedstock required to make 1 MJ of intermediate product]

### 3. 4. Calculation of GHG LCA values for feedstock production

Actual GHG LCA value for the lifecycle stage 1): production at source (e.g. feedstock cultivation) shall be calculated as follows:

3. 4. 1. The calculation shall take into account GHG emissions from:
  - the production of input materials (fertiliser, pesticides, seed)
  - mechanical work (e.g. tillage, weed control, application of fertilisers)
  - electricity
  - field N<sub>2</sub>O emissions
3. 4. 2. The operator shall document actual values for the operation for:
  - Annual consumption of fertilisers (per fertiliser type)
  - Annual consumption of pesticides (per pesticide type)
  - Annual consumption of seeds
  - Annual consumption of fuels for mechanical work
  - Annual consumption of electricity
  - Production of main product and co-products
3. 4. 3. The operator shall use emission factors either from the *ecoinvent database*, other recognised databases, or regionally available emission factors for
  - Fertilisers
  - Pesticides
  - Fuels
  - Electricity
  - Seeds
3. 4. 4. The following formula shall be used for the calculation of the GHG emissions from production at source:

$$e_{ec} = \frac{e_{fertiliser} + e_{pesticides} + e_{seeds} + e_{mechanical\ work} + e_{electricity} + e_{N_2O}}{y_i}$$

Where:

$$e_{ec} = \text{GHG emissions from the production of product } i \left[ \frac{\text{kg CO}_2e}{\text{kg}_i} \right]$$

$$e_{fertiliser} = \text{Annualised GHG emissions from the production of fertilisers per unit area} \left[ \frac{\text{kg CO}_2e}{\text{ha*yr}} \right]$$

$$e_{pesticides} = \text{Annualised GHG emissions from the production of pesticides per unit area} \left[ \frac{\text{kg CO}_2e}{\text{ha*yr}} \right]$$

$$e_{seeds} = \text{Annualised GHG emissions from the production of seeds per unit area} \left[ \frac{\text{kg CO}_2e}{\text{ha*yr}} \right]$$

$$e_{mechanical\ work} = \text{Annualised GHG emissions from fuels used in mechanical work per unit area} \left[ \frac{\text{kg CO}_2e}{\text{ha*yr}} \right]$$

$$e_{electricity} = \text{Annualised GHG emissions from the production of electricity per unit area} \left[ \frac{\text{kg CO}_2e}{\text{ha*yr}} \right]$$

$$e_{N2O} = \text{Annualised field N}_2\text{O emissions per unit area} \left[ \frac{\text{kg N}_2\text{O}e}{\text{ha*yr}} \right]$$

$$y_i = \text{Annual product yield of main product } i \text{ (e.g. crop } i) \text{ per unit area} \left[ \frac{\text{kg}_i}{\text{ha*yr}} \right]$$

3. 4. 5. The following formula shall be used for the calculation of the GHG emissions from the production of fertilisers:

$$e_{fertiliser} = \sum \text{fertiliser}_i * EF_{fertiliser_i}$$

where

$$\text{fertiliser}_i = \text{quantity of fertilizer } i \left[ \frac{\text{kg}}{\text{ha*yr}} \right]$$

$$EF_{fertiliser_i} = \text{emission factor of the production of fertilizer } i \left[ \frac{\text{kg CO}_2e}{\text{kg}} \right]$$

3. 4. 6. The following formula shall be used for the calculation of the GHG emissions from the production of pesticides:

$$e_{pesticides} = \sum \text{pesticide}_i * EF_{pesticide_i}$$

where

$pesticide_i$  = quantity of pesticide  $i$   $\left[\frac{kg}{ha*yr}\right]$

$EF_{pesticide\ i}$  = emission factor of the production of pesticide  $i$   $\left[\frac{kg\ CO_2e}{kg}\right]$

3. 4. 7. The following formula shall be used for the calculation of the GHG emissions from the production of seeds:

$$e_{seeds} = \sum seeds_i * EF_{seed_i}$$

where

$seeds_i$  = quantity of seeds crop  $i$   $\left[\frac{kg}{ha*yr}\right]$

$EF_{seed\ i}$  = emission factor of the production of seed  $i$   $\left[\frac{kg\ CO_2e}{kg}\right]$

3. 4. 8. The following formula shall be used for the calculation of the GHG emissions from mechanical work:

$$e_{mechanical\ work} = \sum fuel_i * EF_{fuel_i}$$

where

$fuel_i$  = quantity of fuel type  $i$  used for mechanical work  $\left[\frac{kg}{ha*yr}\right]$

$EF_{fuel\ i}$  = emission factor of the production and consumption of fuel type  $i$   $\left[\frac{kg\ CO_2e}{kg}\right]$

3. 4. 9. The following formula shall be used for the calculation of the GHG emissions from electricity:

$$e_{electricity} = electricity * EF_{electricity}$$

where

$electricity$  = quantity of electricity used  $\left[\frac{kWh}{ha*yr}\right]$



$$EF_{\text{electricity}} = \text{emission factor of the electricity} \left[ \frac{\text{kg CO}_2\text{e}}{\text{kWh}} \right]$$

3. 4. 10. The following methodology shall be used for the calculation of the GHG emissions from field N<sub>2</sub>O emissions

*Please note:* the calculation of N<sub>2</sub>O emissions follows the IPCC methodology, including direct and indirect N<sub>2</sub>O emissions.<sup>6</sup> All three IPCC tiers could be used by the operators.

Step 1: Calculate the total N<sub>2</sub>O-N emissions relating to the application of fertilisers. These shall include both synthetic and organic fertilisers and include both direct and indirect emissions (i.e. volatilisation of N as NH<sub>3</sub> and leaching to groundwater)

$$\left[ \frac{\text{N}_2\text{O-N}}{\text{kg N input}} \right]$$

Please see [Annex V](#) for the methodology.

Step 2 Convert N<sub>2</sub>O-N emissions to N<sub>2</sub>O using a conversion factor of 44/28  $\left[ \frac{\text{kg N}_2\text{O}}{\text{kg N input}} \right]$ .

Step 3 Convert N<sub>2</sub>O emissions to CO<sub>2</sub>e by multiplying by 265  $\left[ \frac{\text{kg CO}_2\text{e}}{\text{kg N input}} \right]$ .

Step 4 Calculate the N<sub>2</sub>O emissions per ha by multiplying by the fertiliser input rate  $\left[ \frac{\text{kg CO}_2\text{e}}{\text{ha}} \right]$ .

3. 4. 11. Requirements related to the calculation of group values

3. 4. 11. 1. For the emissions from lifecycle stage 1 production at source (e.g. feedstock cultivation), operators may calculate group values instead of individual operator values. Group values may be calculated either based on statistical data (i.e. **regional values**) or based on individually measured data (i.e. **group average values**). When calculating a group value, one of these approaches shall be used consistently. It is not allowed to calculate a group value based on a mixture of measured data and statistical data.

3. 4. 11. 2. **Group average values** may only be calculated if the following requirements for farm groups are fulfilled:

- Farms are geographically near each other: This means that farms produce under similar conditions, such as soil type and climate; and
- Farms produce under substantially similar conditions with regard to the specific land use requirements, i.e. the

<sup>6</sup> IPCC 2006 Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11



previous land use of the area in terms of IPCC land categories are alike. The IPCC land categories are: forest land, grassland, cropland, wetlands, settlements and other land, perennial crop land; and

- Farms produce the same crop (or biomass type); and
- Farms use similar management in terms of tillage practice (e.g. full tillage, reduced tillage or no till) and fertiliser input (low, medium or high inputs).

3. 4. 11. 3. If the requirements above are not fulfilled, the calculation of a group average value shall only be eligible under the RSB if a conservative approach is followed. This means that the most conservative input value is chosen for the entire group, for example if the farms are different in terms of their fertiliser input, the highest input value has to be assumed for the entire group instead of calculating the average.

3. 4. 11. 4. For calculating the group average value for biomass cultivation all input parameters of all group participants shall be measured and documented.

3. 4. 11. 5. The average may be calculated either:

- **at the level of the input values:** The operator shall calculate the group average for each input parameter (e.g. fertilizer, pesticides, etc.) and use the formula above to calculate the overall average; or
- **at the level of the result:** The operator shall calculate eec for each operator and calculate the weighted average (based on biomass production) as a second step.

### 3. 5. Calculation of GHG LCA values for processing and production

Actual GHG LCA value for the lifecycle stages 2), 3) and 5): Conditioning at source (e.g. feedstock harvesting, collection and recovery), Feedstock processing and extraction, feedstock-to-fuel conversion processes shall be calculated as follows:

3. 5. 1. The calculation shall take into account GHG emissions from:

- Electricity
- Heat
- Mechanical work (e.g. harvesting, collection)
- Material inputs (e.g. chemicals)
- Effluents and leakages

3. 5. 2. The operator shall measure and document actual values for the operation for:

- Consumption of electricity
- Feedstock for heat production

- Consumption of fuels for mechanical work
- Consumption of material inputs (e.g. chemicals)
- Generation of effluents and leakages
- Production of main product(s) and co-product(s)

For operations that have just started production, measured data may not be available. In this case, operators may use technical specifications of the processing facility in the first year of certification. For subsequent years, actual values shall be used.

3. 5. 3. The operator shall use emission factors either from the *ecoinvent database*, other recognised databases, or regionally available emission factors for:
- Electricity
  - Feedstock for heat production
  - Fuels
  - Material inputs (e.g. chemicals)
  - Effluents and leakages

The emission factor for electricity shall include the average GHG emissions of production and distribution of electricity in a defined region. For electricity grids that are not linked across national borders, the emission factor shall be based on a national value.

Producers may also use the average value for an individual electricity production plant for electricity directly sourced from that plant, if that plant is not connected to the electricity grid.

3. 5. 4. The following formula shall be used for the calculation of the GHG emissions from processing and production:

$$e_p = \frac{e_{electricity} + e_{heat} + e_{mechanical\ work} + e_{material\ inputs} + e_{effluent\ leakage}}{y_i}$$

Where:

$e_p$  = GHG emissions from processing and production per kg of main product  $i$   $\left[ \frac{kg\ CO_2e}{kg_i} \right]$

$e_{electricity}$  = Annualised GHG emissions from the consumption of electricity  $\left[ \frac{kg\ CO_2e}{a} \right]$

$e_{heat}$  = Annualised GHG emissions from the generation of heat  $\left[ \frac{kg\ CO_2e}{a} \right]$

$e_{mechanical\ work}$  = Annualised GHG emissions from fuels used in mechanical work per unit area  $\left[ \frac{kg\ CO_2e}{ha*yr} \right]$

$e_{material\ inputs}$  = Annualised GHG emissions from the consumption of material inputs  $\left[ \frac{kg\ CO_2e}{a} \right]$

$$e_{\text{effluents and leakages}} = \text{Annualised GHG emissions from effluents and leakages} \left[ \frac{\text{kg CO}_2\text{e}}{\text{a}} \right]$$

$$y_i = \text{Annual production of main product } i \left[ \frac{\text{kg } i}{\text{a}} \right]$$

3. 5. 5. The following formula shall be used for the calculation of the GHG emissions from electricity:

$$e_{\text{electricity}} = \text{electricity} * EF_{\text{electricity}}$$

Where

$$\text{electricity} = \text{quantity of electricity used for the operation} \left[ \frac{\text{kWh}}{\text{a}} \right]$$

$$EF_{\text{electricity}} = \text{emission factor of the electricity} \left[ \frac{\text{kg CO}_2\text{e}}{\text{kWh}} \right]$$

3. 5. 6. The following formula shall be used for the calculation of the GHG emissions from heat generation:

$$e_{\text{heat}} = \sum \text{feedstock } i_{\text{heat}} * EF_{\text{feedstock } i}$$

Where

$$\text{Feedstock } i_{\text{heat}} = \text{quantity of feedstock } i \text{ used for heat generation (e.g. natural gas, wood pellets, diesel, etc.)} \left[ \frac{\text{MJ}}{\text{a}} \right]$$

$$EF_{\text{feedstock } i} = \text{emission factor of the feedstock } i \left[ \frac{\text{kg CO}_2\text{e}}{\text{MJ}} \right]$$

The emission factor of the feedstock shall include the GHG emissions of the production of the feedstock as well as the emissions of the combustion of this feedstock.

3. 5. 7. The following formula shall be used for the calculation of the GHG emissions from mechanical work:

$$e_{\text{mechanical work}} = \sum \text{fuel}_i * EF_{\text{fuel}_i}$$

Where

$\text{fuel}_i$  = quantity of fuel type  $i$  used for mechanical work  $\left[ \frac{\text{kg}}{\text{ha*yr}} \right]$

$EF_{\text{fuel}_i}$  = emission factor of the production and consumption of fuel type  $i$   $\left[ \frac{\text{kg CO}_2\text{e}}{\text{kg}} \right]$

3. 5. 8. The following formula shall be used for the calculation of the GHG emissions from the consumption of operating materials:

$$e_{\text{material inputs}} = \sum \text{material input } i * EF_{\text{material input } i}$$

Where

$\text{material input } i$  = quantity of material input  $i$  used  $\left[ \frac{\text{kg}}{\text{a}} \right]$

$EF_{\text{material input } i}$  = emission factor of material input  $i$   $\left[ \frac{\text{kg CO}_2\text{e}}{\text{kg}} \right]$

3. 5. 9. The following formula shall be used for the calculation of the GHG emissions from effluents and leakages:

$$e_{\text{effluents and leakages}} = \sum \text{effluent or leakage } i * EF_{\text{effluent,leakage } i}$$

Where

$\text{Effluent or leakage } i$  = quantity of effluent or leakage  $i$  (e.g. methane)  $\left[ \frac{\text{kg}}{\text{a}} \right]$

$EF_{\text{effluent, leakage } i}$  = emission factor of the effluent, leakage  $i$   $\left[ \frac{\text{kg CO}_2\text{e}}{\text{MJ}} \right]$

The emission factor of the effluent is taken following clause 3.3.1.2 for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O

3. 6. Calculation of GHG LCA values for transport and distribution

Actual GHG LCA value for the lifecycle steps 4 and 6: Feedstock transportation to processing and fuel production facilities, fuel transportation and distribution to blend point shall be calculated as follows:

3. 6. 1. The calculation of the GHG LCA values for transport and distribution shall take into account GHG emissions from:
  - Energy used for transport and distribution (e.g. fuel)
  - Energy used for storage (e.g. electricity)
  - Losses
3. 6. 2. The operator shall measure and document actual values for the operation for:
  - Transport type (e.g. aircraft, lorry, vessel, pipeline)
  - Distance per transport type
  - Losses of transport and storage
  - Electricity consumption
  - Feedstock for heat generation
3. 6. 3. The operator shall use emission factors either from the *ecoinvent database*, other recognised databases, or regionally available emission factors for:
  - Transport type
  - Electricity
  - Feedstock for heat production

3. 6. 4. The following formula shall be used for the calculation of the GHG emissions from transport and distribution:

$$e_{td} = \frac{e_{transport}}{product\ i} + \frac{e_{storage}}{product\ i}$$

Where:

$$e_{td} = \text{GHG emissions from transport and distribution per kg of main product } i \left[ \frac{kg\ CO_2e}{kg_i} \right]$$

$$e_{transport} = \text{Annual GHG emissions from transport} \left[ \frac{kg\ CO_2e}{a} \right]$$

$$e_{storage} = \text{Annual GHG emissions from storage} \left[ \frac{kg\ CO_2e}{a} \right]$$

$$product\ i = \text{amount of product } i, \text{ considering transport losses} \left[ \frac{kg}{a} \right]$$

3. 6. 5. The following formula shall be used for the calculation of the GHG emissions from transport:

$$e_{transport} = \sum td_i * tq_i * EF_i$$

Where

$td_i$  = annual transport distance per means of transport  $i$   $\left[\frac{km}{a}\right]$

$tq_i$  = quantity transported per means of transport  $i$   $\left[\frac{t}{a}\right]$

$EF_i$  = emission factor for means of transport  $\left[\frac{kg\ CO_2e}{tkm}\right]$

3. 6. 6. The following formula shall be used for the calculation of the GHG emissions from storage:

$$e_{storage} = \sum energy_i * EF_i$$

where:

$energy_i$  = annual amount of energy type  $i$  consumed  $\left[\frac{MJ}{a}\right]$

$EF_i$  = emission factor for energy type  $i$   $\left[\frac{kg\ CO_2e}{MJ}\right]$

### 3. 7. Requirements related to the calculation of emission credits

3. 7. 1. The production of SAF from wastes and residues, may generate emission credits that can be subtracted from the actual LCA values to calculate the total  $LS_i$ . The calculation of emission credits shall follow the calculation specified in the annex of this document as follows:
- Avoided Landfill Emission Credit (LEC) for SAF derived from Municipal Solid Waste (MSW) shall be calculated according to [Annex IV 1](#)
  - Recycling Emissions Credit (REC) for SAF derived from Municipal Solid Waste (MSW) shall be calculated according to [Annex IV 2](#).
3. 7. 2. The analysis to calculate these emission credit values shall be documented in the technical report citing fully the data sources, such that the results are replicable and use the most recent data available.
3. 7. 3. The technical report shall also demonstrate that the emission credits claimed:
- are permanent; and
  - are directly attributable to the SAF production; and
  - exceed any emission reductions required by law, regulation or legally

- binding mandate; and
  - avoid double counting (including double issuance<sup>7</sup> or double claiming<sup>8</sup>) of such credits); and
  - and exceed emission reductions that would otherwise occur in a business-as-usual scenario.
- 3. 7. 4. The total  $LS_i$  value cannot be smaller than 0 gCO<sub>2e</sub>/MJ when applying LECs or RECs.

#### 4. Requirements related to Low ILUC Risk Feedstocks

- 4. 1. Low ILUC risk practices implemented on or after 1 January 2016 are eligible under RSB ICAO CORSIA. The feedstock producer shall provide credible and verifiable evidence of the nature of the new land management practice, timing of its implementation and level of additional feedstock production as required by RSB-STD-04-001. Exceptionally, practices implemented between 1 January 2013 and 31 December 2015 may be accepted where it can be demonstrated that the low ILUC risk practices were implemented primarily as a result of demand for biofuels, to be demonstrated on a project-specific basis.
- 4. 2. The following yield increase approaches are eligible under RSB ICAO CORSIA:
  - an improvement in agricultural practices (practices that increase yields through means such as increased organic matter content, reduced soil compaction/erosion, decreased pests, post-harvest loss reduction etc.);
  - intercropping (i.e. the combination of two or more crops that grow simultaneously, for example as hedges or through and agroforestry system);
  - sequential cropping (i.e. the combination of two or more crops that grow at different periods of the year); and/or
  - improvements in post-harvest losses (i.e. losses that occur at cultivation and transport up to but not including the first conversion unit in the supply chain)
- 4. 3. Eligible lands for the unused land approach include, amongst others, marginal lands, underused lands, unused lands, degraded pasture lands, and lands in need of remediation. The following criteria must be met for land to be eligible under the unused land approach:
  - Land was not considered to be arable land or used for crop production during the five years preceding the reference date; or
  - Land is identified as severely degraded land or undergoing a severe degradation process for at least three years

<sup>7</sup> In this instance, double issuance occurs when two or more credits or units are being issued for the same reduction.

<sup>8</sup> In this instance, double claiming occurs when the same unit was used by multiple entities.



## 5. Requirements related to the submission of information

5. 1. RSB certified operators shall provide the information as specified in the RSB Chain of Custody Procedure [RSB-PRO-20-001] Annex I whenever they forward a batch for RSB certified material.
5. 2. From the SAF production onwards, the following template shall be filled and forwarded together with every batch of SAF in addition to the information required in RSB-PRO-20-001:

Field #	Data Field	Details
1	Purchase date of neat CORSIA eligible fuel	
2	Identification of the producer of the neat CORSIA eligible fuel	2.a Name of the producer of the neat CORSIA eligible fuel 2.b Contact information of the producer of neat CORSIA eligible fuel
3	Fuel Production	3.a Production date of the neat CORSIA eligible fuel 3.b Production location of the neat CORSIA eligible fuel 3.c Batch number of each batch of neat CORSIA eligible fuel 3.d Mass of each batch of neat CORSIA eligible fuel produced
4	Fuel type	4.a Type of fuel (i.e., Jet-A, Jet-A1, Jet-B, AvGas) 4.b Feedstock used to create the neat CORSIA eligible fuel 4.c Conversion process used to create the neat CORSIA eligible fuel
5	Fuel purchased	5.a Proportion of neat CORSIA eligible fuel batch purchased (rounded to the nearest %)  <i>Note. - If less than an entire batch of CORSIA eligible fuel is purchased.</i>  5.b Total mass of each batch of neat CORSIA eligible fuel purchased (in tonnes) 5.c Mass of neat CORSIA eligible fuel purchased (in tonnes)  <i>Note. - Field 5.c is equal to the total for all batches of CORSIA eligible fuels reported in Field 5.b.</i>
6	Evidence that fuel satisfies the CORSIA Sustainability Criteria	Valid sustainability certification document
7	Life cycle emissions values of the CORSIA eligible fuel	7.a Default or Actual Life Cycle Emissions Value (LSf) for given CORSIA eligible fuel f, which is equal to the sum of 7.b and 7.c (in gCO <sub>2</sub> e/MJ rounded to the nearest whole number)  7.b Default or Actual Core Life Cycle Assessment (LCA) value for given CORSIA eligible fuel f (in gCO <sub>2</sub> e/MJ rounded to the nearest whole number)

		7.c Default Induced Land Use Change (ILUC) value for given CORSIA eligible fuel f (in gCO <sub>2</sub> e/MJ rounded to the nearest whole number)
8	Intermediate purchaser	8.a Name of the intermediate purchaser  8.b Contact information of the intermediate purchaser  <i>Note. - This information would be included in the event that the aeroplane operator claiming emissions reductions from the use of CORSIA eligible fuels was not the original purchaser of the fuel from the producer (e.g., the aeroplane operator purchased fuel from a broker or a distributor). In those cases, this information is needed to demonstrate the complete chain of custody from production to blend point.</i>
9	Party responsible for shipping of the neat CORSIA eligible fuel to the fuel blender	9.a Name of party responsible for shipping of the neat CORSIA eligible fuel to the fuel blender  9.b Contact information of party responsible for shipping of the neat CORSIA eligible fuel to the fuel blender
10	Fuel Blender	10.a Name of the party responsible for blending neat CORSIA eligible fuel with aviation fuel  10.b Contact information of the party responsible for blending neat CORSIA eligible fuel with aviation fuel
11	Location where neat CORSIA eligible fuel is blended with aviation fuel	
12	Date the neat CORSIA eligible fuel was received by blender	
13	Mass of neat CORSIA eligible fuel received (in tonnes)	Note: This number may differ from the number in Field 5.c in cases where only a portion of a batch or batches are claimed by the aeroplane operator.
14	Blend ratio of neat CORSIA eligible fuel and aviation fuel (rounded to the nearest %)	
15	Documentation demonstrating that the batch or batches of neat CORSIA eligible fuel were blended into aviation fuel (e.g., the subsequent Certificate of Analysis of the blended fuel)	
16	Mass of neat CORSIA eligible fuel claimed (in tonnes)	

*Please note:* This table corresponds to table A5-2 Supplementary information to aeroplane operator's Emission Report if emission reductions from the use of CORSIA eligible fuel being claimed in ICAO International Standards and recommended Practices Environmental Protection, Annex 16, Volume IV

5. 3. The Participating Operator shall document and report the following information (if applicable for the POs scope of certification) per product type to the RSB at regular intervals as specified by the RSB Secretariat:
  - Amount sold by batch number; and
  - Country of SAF production; and
  - Country of SAF uplifting, i.e. country in which SAF was blended and entered the airport jet system for aviation purposes; and
  - Actual GHG value per life cycle step; and
  - Actual or default  $LS_f$  value for SAF.
5. 4. The Participating Operator shall provide the RSB Secretariat with any further relevant information as requested by the RSB Secretariat through additional guidance documents to prevent double counting of GHG emission reductions related to the use of SAF.

*Please note:* Double counting could occur in the following ways as defined by ICAO<sup>9</sup>: (1) if more than one unit is issued for the same emissions reduction, referred to as double issuance; (2) if the same unit is used twice, for example in two separate registries, referred to as double use; (3) if the same unit is used by both a buyer and seller, for example the international airline and country of origin of SAF, referred to as double claiming.

*Please Note:* In order to avoid double claiming of CORSIA eligible fuels, information on the following fields can be found in the ICAO document entitled "CORSIA Central Registry (CCR): Information and Data for Transparency" that is available from the ICAO CORSIA website:

- Production year of the CORSIA eligible fuel claimed; and
- Producer of the CORSIA eligible fuel claimed; and
- Type of fuel, feedstock and conversion process for each CORSIA eligible fuel claimed; and
- Batch number(s) of each CORSIA eligible fuel claimed; and
- Total mass of each batch of CORSIA eligible fuel claimed.

## 6. Requirements related to the acceptance of material certified by other SCS

6. 1. RSB certified operators may accept incoming material certified against other SCS as "ICAO CORSIA compliant" material if the SCS has been recognised by ICAO and published on the ICAO website<sup>10</sup>.

<sup>9</sup> ICAO document "CORSIA Emissions Unit Eligibility Criteria", March 2019, available at: <https://www.icao.int/environmental-protection/CORSIA/Documents/ICAO%20document%2009.pdf>

<sup>10</sup> <https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx>

6. 2. The operator shall select a chain of custody model and comply with all requirements specified in the RSB Chain of Custody Procedure [RSB-PRO-20-001]. The following chain of custody models are eligible under RSB ICAO CORSIA:
  - Identity Preserved
  - Segregated
  - Mass Balance
6. 3. When forwarding material that originates from material that has been certified by other SCS, operators may use the claim “ICAO CORSIA compliant”. The operator shall not use any RSB trademarks on the product information.

## ANNEX I: Core LCA values, ILUC LCA values and LS<sub>f</sub>

The following default values for different SAF pathways can be used by operators if the specifications for fuel conversion process, region, fuel feedstock as well as additional specifications as outlined in Annex II of this standard are met. The source of these values is *CORSIA supporting document – Life cycle assessment methodology*. Additional or updated default values may be used upon approval by ICAO and publication on the ICAO website<sup>11</sup>

Fuel Conversion Process	Region	Fuel Feedstock	Core LCA Value	ILUC LCA Value	LS <sub>f</sub> (gCO <sub>2</sub> e/MJ)
Fischer-Tropsch (FT)	Global	Agricultural residues	7.7	0.0	7.7
	Global	Forestry residues	8.3		8.3
	Global	Municipal solid waste (MSW), 0% non-biogenic carbon (NBC)	5.2		5.2
	Global	Municipal solid waste (MSW) (NBC given as a percentage of the non-biogenic carbon content)	NBC*170.5 + 5.2		NBC*170.5 + 5.2
	USA	Poplar (short-rotation woody crops)	12.2	-5.2	7.0
	USA	Miscanthus (herbaceous energy crops)	10.4	-32.9	-22.5
	EU	Miscanthus (herbaceous energy crops)	10.4	-22.0	-11.6
	USA	Switchgrass (herbaceous energy crops)	10.4	-3.8	6.6
Hydroprocessed esters and fatty acids (HEFA)	Global	Tallow	22.5	0.0	22.5
	Global	Used cooking oil	13.9		13.9
	Global	Palm fatty acid distillate	20.7		20.7
	Global	Corn oil (from dry mill ethanol plant)	17.2		17.2
	USA	Soybean oil	40.4	24.5	64.9
	Brazil	Soybean oil	40.4	27.0	67.4
	EU	Rapeseed oil	47.4	24.1	71.5
	Malaysia & Indonesia	Palm oil – closed pond	37.4	39.1	76.5
Malaysia & Indonesia	Palm oil – open pond	60.0	39.1	99.1	
Alcohol (isobutanol) to jet (ATJ)	Global	Agricultural residues	29.3	0.0	29.3
	Global	Forestry residues	23.8		23.8
	Brazil	Sugarcane	24.0	7.3	31.3
	USA	Corn grain	55.8	22.1	77.9
	USA	Miscanthus (herbaceous energy crops)	43.4	-54.1	-10.7
	EU	Miscanthus (herbaceous energy crops)	43.4	-31.0	12.4
	USA	Switchgrass (herbaceous energy crops)	43.4	-14.5	28.9
Alcohol (ethanol) to jet (ATJ)	Brazil	Sugarcane	24.1	8.7	32.8
	USA	Corn grain	65.7	25.1	90.8
Synthesized iso-paraffins (SIP)	Brazil	Sugarcane	32.8	11.3	44.1
	EU	Sugar beet	32.4	20.2	52.6

<sup>11</sup> <https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx>

## ANNEX II: Additional pathway specifications

The following additional specifications apply for operators using default values. RSB may issue additional guidance to add specifications for default values:

- Specification for the production of agricultural residues: No nutrient replacement was included in the calculation.
- Definition of Corn oil: Corn oil is defined as the oil extracted from the distillers' dry grains and solubles (DDGS), in a dry mill ethanol plant.
- Specification of the sugarcane-ATJ pathway: Sugar milling, molasses fermentation and jet fuel production carried out in the same facility. Bagasse is used for co-generation of heat and electricity which satisfies all energy requirements.

## ANNEX III: Positive list of feedstocks that are classified as by-product, waste or residues

This positive list is not exhaustive. The ICAO Council can add materials to it, according to the feedstock definitions and the process shown in *CORSIA supporting document – Life cycle assessment methodology*. The classification of specific feedstocks as by-products is subject to later revisions as part of the regular CORSIA review process. Additional feedstocks classified as by-product, waste or residues may be used upon approval by ICAO and publication on the ICAO website<sup>12</sup>

Category	Sub-category	Feedstock
Residues	Agricultural residues	Bagasse
		Cobs
		Stover
		Husks
		Manure
		Nut shells
		Stalks
		Straw
	Forestry residues	Bark
		Branches
		Cutter shavings
		Leaves
		Needles
		Pre-commercial thinnings
		Slash
Tree tops		
Residues	Processing residues	Crude glycerine
		Forestry processing residues
		Empty palm fruit bunches
		Palm oil mill effluent
		Sewage sludge
		Crude Tall Oil
		Tall oil pitch
Wastes		Municipal Solid Waste
		Used Cooking Oil
By-Products		Palm Fatty Acid Distillate
		Tallow
		Technical Corn Oil

<sup>12</sup> <https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx>

## ANNEX IV: Emission credits

### 1. Methodology for calculation of landfill emissions credits

SAF produced from Municipal Solid Waste (MSW) feedstocks may generate an avoided Landfill Emissions Credit (LEC). The value of the LEC shall be calculated as follows:

**Step 1** – Estimate the proportional shares of each of the following four waste categories (j) that make up the MSW diverted from landfilling: paper/textiles; wood/straw; other (non-food) organic putrescible/garden and park waste; and food waste/sewage sludge. These shares should be expressed in terms of the dry mass of each waste category (j) per dry mass of MSW diverted from landfilling (before additional sorting and recycling, if applicable) (e.g.  $W_{\text{paper/textiles}} = 0.4$  dry tonne per dry tonne of MSW).

**Step 2** – Select the degradable organic carbon content (DOC) and the fraction of carbon dissimilated ( $\text{DOC}_F$ ) values from Table 1 that best represent each waste category (j) in the MSW. Use weighted averages to generate DOC and  $\text{DOC}_F$  values that accurately represent each of the four waste categories of the MSW feedstock of interest.

Table 1: DOC and  $\text{DOC}_F$

Material	DOC <sup>13</sup> (% of dry matter)	DOC <sub>F</sub> (%)
Corrugated containers	47%	45%
Newspaper	49%	16%
Office paper	32%	88%
Coated paper	34%	26%
Food waste	50%	84%
Grass	45%	46%
Leaves	46%	15%
Branches	49%	23%
Gypsum board	5%	45%
Dimensional lumber	49%	12%
Medium-density fiberboard	44%	16%
Wood flooring	46%	5%

**Step 3** - Select the methane correction factor (MCF) from Table 2 that most accurately represents the conditions of the landfill in question.

<sup>13</sup> EPA, "Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM). Management Practices Chapters." 2016. EPA Office of Resource Conservation and Recovery (ORCR). [https://www.epa.gov/sites/production/files/2016-03/documents/warm\\_v14\\_management\\_practices.pdf](https://www.epa.gov/sites/production/files/2016-03/documents/warm_v14_management_practices.pdf)



Table 2: Methane correction factor (MCF)<sup>14</sup>

Landfill conditions	MCF
Anaerobic managed solid waste disposal site	1.0
Unmanaged solid waste disposal site – deep	0.8
Semi-aerobic managed solid waste disposal site	0.5
Unmanaged solid waste disposal site - shallow	0.4

**Step 4 -** Use Equation 1 to calculate total CH<sub>4</sub> generation, Q, from each waste category, j, per dry tonne of diverted MSW.

**Equation 1:** Total CH<sub>4</sub> generation from waste category j, per dry tonne of diverted MSW [g CH<sub>4</sub> / t dry diverted MSW]

$$Q_j = W_j \times DOC_j \times DOC_{F,j} \times F \times MCF \times (16/12) \times 10^6$$

where:

$Q_j$  = total CH<sub>4</sub> generation over a 100-year period from waste category j

$W_j$  = dry mass of waste category j per dry mass of MSW diverted from landfilling [%]

$DOC_j$  = degradable organic carbon content from Table 1 [%]

$DOC_{F,j}$  = fraction of degradable organic carbon dissimilated from Table 1 [%]

$F$  = CH<sub>4</sub> concentration in LFG, 50%

$MCF$  = Methane correction factor from Table 2

$16/12$  = CH<sub>4</sub> to carbon ratio

$10^6$  = grams per tonne conversion [g / t]

**Step 5 -** Select the lifetime landfill gas collection efficiency (LFGCE) that most accurately represents the landfill-specific conditions in Table 3, for each waste category of the organic MSW diverted from the landfill. If the landfill in question is not managed, and landfill gas (LFG) is not collected, use a value of 0%. Note that in this case, it would be inappropriate to also select a MCF value of 1.0, which corresponds to an anaerobic managed solid waste disposal site.

<sup>14</sup> Intergovernmental Panel on Climate Change (IPCC). 2006 IPCC guidelines for national greenhouse gas inventories. <https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html>

Table 3 Landfill gas collection efficiency (LFGCE)<sup>15</sup>

Climate zone		Boreal and temperate (MAT ≤ 20°C)						Tropical (MAT > 20°C)					
		Dry (MAP/PET < 1)			Wet (MAP/PET > 1)			Dry (MAP < 1000mm)			Moist and wet (MAP > 1000mm)		
Waste category, j		LFG collection											
		Active <sup>a</sup>	Moderate <sup>b</sup>	Minimal <sup>c</sup>	Active <sup>a</sup>	Moderate <sup>b</sup>	Minimal <sup>c</sup>	Active <sup>a</sup>	Moderate <sup>b</sup>	Minimal <sup>c</sup>	Active <sup>a</sup>	Moderate <sup>b</sup>	Minimal <sup>c</sup>
Slowly degrading waste	Paper / textiles waste	78%	70%	56%	82%	71%	56%	79%	70%	56%	83%	71%	56%
	Wood/straw waste	68%	63%	51%	74%	67%	54%	71%	65%	53%	76%	68%	55%
Moderately degrading waste	Other (non-food) organic putrescible/garden and park waste	80%	71%	56%	83%	69%	54%	83%	71%	56%	80%	61%	55%
Rapidly degrading waste	Food waste / sewage sludge	82%	71%	56%	79%	59%	49%	84%	70%	55%	72%	46%	43%

MAT – Mean annual temperature; MAP – Mean annual precipitation; PET – Potential evapotranspiration.

<sup>a</sup>Active: Typically, the landfill operator is using horizontal LFG collectors from the early stage of cell development while still accepting MSW (less than a year after cells' first waste disposal), and vertical collectors once cells are capped.

<sup>b</sup>Moderate: Horizontal collectors are installed to capture LFG 1-3 years after cells' first waste disposal, and vertical collectors are used once cells are capped.

<sup>c</sup>Minimal: LFG is not collected during waste acceptance, but vertical collectors are used once cells are capped.

**Step 6** - Select the oxidation rate that best represents the landfill conditions: 10% should be used for modern, sanitary, and well-managed landfills; 0% should be used in all other cases.

**Step 7** – Calculate non-captured CH<sub>4</sub> emissions, CH<sub>4</sub><sup>n</sup>, per dry tonne of diverted MSW using Equation 2. Note that Q<sub>j</sub> and LFGCE<sub>j</sub> are defined for each waste category, j.

**Equation 2:** Non-captured CH<sub>4</sub> emissions (CH<sub>4</sub><sup>n</sup>) [g CH<sub>4</sub> / t dry MSW]

$$CH_4^n = \sum_j [Q_j \times (1 - LFGCE_j) \times (1 - \text{oxidation rate})]$$

**Step 8** – Calculate biogenic CO<sub>2</sub> in non-captured CH<sub>4</sub> emissions, CO<sub>2</sub><sup>n</sup>, and biogenic CO<sub>2</sub> that remains as carbon in the landfill, CO<sub>2</sub><sup>S</sup>, using Equation 3.

<sup>15</sup> Nine landfills were interviewed, and three landfills that represent active, moderate, and minimal LFG collection were selected and simulated based on the method provided in Lee et al. (2018) with phased collection efficiency specified in Barlaz et al. (2009). Lee, U., Han, J. and Wang, M., 2017. Evaluation of landfill gas emissions from municipal solid waste landfills for the life-cycle analysis of waste-to-energy pathways. Journal of Cleaner Production, 166, pp.335-342. Barlaz, M.A., Chanton, J.P., Green, R.B., 2009. Controls on landfill gas collection efficiency: instantaneous and lifetime performance. J. Air Waste Manag. Assoc. 59, 1399–1404.

**Equation 3:**  $CO_2^n$  and  $CO_2^S$ , [g CO<sub>2</sub>e / t dry MSW]

$$CO_2^n = CH_4^n \times 44/16$$

$$CO_2^S = \sum_j [W_j \times DOC \times (1 - DOC_F) \times (44/12) \times 10^6]$$

where:

- $CO_2^n$  = biogenic CO<sub>2</sub> in non-captured CH<sub>4</sub> emissions
- $CO_2^S$  = biogenic CO<sub>2</sub> that remains as carbon in the landfill
- $CH_4^n$  = non-captured CH<sub>4</sub> emissions
- $W_j$  = dry mass of waste category j per dry mass of MSW diverted from landfilling [%]
- $DOC$  = degradable organic carbon content from Table 1 [%]
- $DOC_F$  = fraction of degradable organic carbon dissimilated from Table 1 [%]
- $44/16$  = CH<sub>4</sub> to CO<sub>2</sub> conversion
- $44/12$  = CO<sub>2</sub> to carbon ratio
- $10^6$  = grams per tonne conversion [g / t]

**Step 9** – In the case that the project of interest diverts MSW from a landfill where collected CH<sub>4</sub> is used for electricity generation instead of flaring, calculate the avoided electricity credit using Equation 4.

**Equation 4:** Avoided electricity credit [g CO<sub>2</sub>e / t dry MSW]

$$\text{Avoided electricity credit} = LHV_{CH_4} \times \eta \times CF \times \left[ \sum_j (Q_j \times LFGCE_j) \right] \times CI_{elec} \times 10^{-3}$$

where:

- $LHV_{CH_4}$  = lower heating value of CH<sub>4</sub>, 0.0139 MWh/kg
- $\eta$  = net electricity generation efficiency (e.g. 30%, dependent on landfill of interest)
- $CF$  = capacity factor including downtime (e.g. 85% dependent on landfill of interest)
- $Q_j$  = total CH<sub>4</sub> generation from waste category j from Equation 1 [g CO<sub>2</sub>e / t dry MSW]
- $LFGCE_n$  = landfill gas collection efficiency selected from Table 3 [%]
- $CI_{elec}$  = average carbon intensity of grid electricity in the region where the landfill generating electricity is located (use the highest spatial resolution regional-level CI published by a relevant national entity [gCO<sub>2</sub>e / MWh])
- $10^{-3}$  = kilogram per gram conversion [kg/g]

**Step 10** – Calculate the final LEC of the SAF production process, as shown in Equation 5. This landfill- and waste-specific LEC value is to be subtracted from the core LCA value [g CO<sub>2</sub>e/MJ] of MSW-derived SAF.

**Equation 5:** Final LEC calculation [g CO<sub>2</sub>e/MJ]

$$LEC = \frac{CH_4^n \times (GWP_{CH_4}) - CO_2^n - CO_2^S - [avoided\ electricity\ credit]}{Y}$$

where:

$CH_4^n$  = non-captured CH<sub>4</sub> emissions [g CH<sub>4</sub> / t dry MSW]

$GWP_{CH_4}$  = 100-year global warming potential of CH<sub>4</sub>, 28 g CO<sub>2</sub>e / g CH<sub>4</sub>

$CO_2^n$  = Biogenic CO<sub>2</sub> in non-captured CH<sub>4</sub> emissions [g CO<sub>2</sub>e / t dry MSW]

$CO_2^S$  = Biogenic CO<sub>2</sub> that remains as carbon in the landfill [g CO<sub>2</sub>e / t dry MSW]

[avoided electricity credit] = Emissions offsets by replacing grid electricity with electricity from captured CH<sub>4</sub> [g CO<sub>2</sub>e / t dry MSW]

$Y$  = Total energy yield (liquid fuels, other fuel and energy co-products and non-energy co-products from MSW [MJ / t dry MSW]. Note that this is calculated on the basis of MSW diverted from landfill, before any additional sorting or recycling takes place.

## 2. Methodology for calculation of recycling emission credits

SAF produced from Municipal Solid Waste (MSW) feedstocks may generate a Recycling Emissions Credit (REC), due to additional recyclable material being recovered and sorted during feedstock preparation. The emissions avoided for additional recycling of plastics and metals, calculated separately, are summed to generate the total REC value. REC shall be calculated as follows:

### 2.1. Plastics

**Step 1a** – Select the energy consumption factors for virgin plastic production and recycling from Table 4, for the plastic types recovered from the MSW feedstock in question.

Table 4: Energy factors for virgin plastic production and recycling<sup>16</sup>

Material	Specific electricity consumption for virgin plastic production (SEC <sub>bl</sub> )	Specific fossil fuel consumption for the production of virgin plastic (SFC)	Specific electricity consumption for plastic recycling (SEC <sub>rec</sub> )
	[MWh/t]	[GJ/t]	[MWh/t]
PET	1.11	15.0	0.83
HDPE	0.83	15.0	0.83
LDPE	1.67	15.0	0.83
PP	0.56	11.6	0.83

**Step 1b** – Select appropriate emission factors for electricity, and direct fossil fuels use, for virgin plastics production, that accurately represent the specific project in question.

$CI_{elec}$  = average carbon intensity of grid electricity in the region where the virgin plastic production is being offset (use the highest spatial resolution regional-level CI published by a relevant national entity) [g CO<sub>2e</sub>/MWh]

$CI_{ff}$  = carbon intensity of fossil fuel used in the virgin plastic production process [g CO<sub>2e</sub> / GJ]. The life cycle CIs of coal, natural gas, fuel oil, and diesel, used as stationary fuels in US industrial processes are 100.7, 69.4, 95.6 and 93.4 g CO<sub>2e</sub>/MJ, respectively. Note that more regionally or context appropriate data should be substituted for the values given here, if available.

<sup>16</sup> United Nations Framework Convention on Climate Change (UNFCCC). 2018. AMS-III.AJ.: Recovery and recycling of materials from solid wastes --- Version 7.0. Clean Development Mechanism. Valid from August 2018.

**Step 1c** – Estimate the emissions avoided by using recycled plastics to reduce virgin plastic production, per tonne of diverted MSW feedstock. This calculation should be carried out for each plastic type, and summed up, as shown in Equation 6.

**Equation 6:** REC associated with additional recycled plastic [g CO<sub>2</sub>e / t dry MSW]

$$REC_{plastic} = \sum_i q_i \times [L_i \times (SEC_{bl,i} \times CI_{elec} + SFC_i \times CI_{ff}) - (SEC_{rec,i} \times CI_{elec})]$$

where:

- $q_i$  = quantity of plastic  $i$  recycled [t / dry t MSW]. This is on the basis of per tonne of dry MSW diverted from the landfill, before additional recycling takes place
- $i$  = type of plastic recycled (e.g. PET, HDPE, LDPE, or PP)
- $L_i$  = adjustment factor for degradation in material quality and loss when using the recycled material, 0.75
- $SEC_{bl,i}$  = specific electricity consumption for virgin material production for plastic  $i$  [MWh/t plastic]
- $SFC_i$  = specific fossil fuel consumption for virgin material production of plastic  $i$  [GJ / t plastic]
- $SEC_{rec,i}$  = specific electricity consumption for recycling of plastic  $i$  [MWh / t plastic]

## 2.2. Metals

**Step 2a** – Select the energy consumption factors for virgin metal production and recycling from Table 5, for the metal types recovered from the MSW feedstock in question.

Table 5: Emissions and energy factors for virgin metal production recycling<sup>17</sup>

Material	Emission factor for virgin metal production (CI)	Specific electricity consumption for metal recycling (SEC <sub>rec</sub> )
	[g CO <sub>2</sub> e / t]	[MWh / t]
Aluminium	8.40 x 10 <sup>6</sup>	0.66
Steel	1.27 x 10 <sup>6</sup>	0.9

**Step 2b**– Select an appropriate emission factor for electricity use in virgin metal production that accurately represents the specific project in question

- $CI_{elec}$  = average carbon intensity of grid electricity in the region where virgin metal production is being offset (use the highest spatial resolution regional-level CI published by a relevant national entity) [g CO<sub>2</sub>e / MWh]

<sup>17</sup> United Nations Framework Convention on Climate Change (UNFCCC). 2018. AMS-III.AJ.: Recovery and recycling of materials from solid wastes --- Version 7.0. Clean Development Mechanism. Valid from August 2018.

**Step 2c** – Estimate the emissions avoided by using recycled materials to reduce virgin metal production, per tonne of diverted MSW feedstock. This calculation should be carried out for each metal type, and summed up, as shown in Equation 7.

**Equation 7:** REC associated with additional recycled material [g CO<sub>2e</sub> / t dry MSW]

$$REC_{metal} = \sum_i q_i \times [L_i \times (CI_i) - (SEC_{rec,i} \times CI_{elec})]$$

where:

- $q_i$  = quantity of metal  $i$  recycled [t / dry t MSW]. This is on the basis of per tonne of dry MSW diverted from the landfill, before additional recycling takes place
- $i$  = type of metal recycled (e.g. steel, or aluminium)
- $CI_i$  = emission factor for virgin production of metal  $i$  [g CO<sub>2e</sub> / t metal]
- $L_i$  = adjustment factor for degradation in material quality and loss when using the recycled material, 0.75
- $SEC_{rec,i}$  = specific electricity consumption for recycling of metal  $i$  [MWh / t metal]

**Step 3** – Sum up emission credits from plastics and metals, and convert to a basis of per MJ of fuel, as shown in Equation 8

**Equation 8:** Final REC calculation [g CO<sub>2e</sub> / MJ]

$$REC = \frac{REC_{plastic} + REC_{material}}{Y}$$

where:

- $Y$  = Total energy yield (liquid fuels, other fuel and energy co-products and non-energy co-products) from MSW [MJ / t dry MSW]. Note that this is calculated on the basis of MSW diverted from the landfill, before any additional sorting or recycling takes place.

## ANNEX V Calculation of N<sub>2</sub>O emissions

The calculation is based on IPCC (2006): 2006 IPCC guidelines for national greenhouse gas inventories. Volume 4: Agriculture, forestry and other land use. L. B. Simon Eggleston, Kyoko Miwa, Todd Ngara and Kiyoto Tanabe. Kanagawa.

### 1. The operator shall calculate N<sub>2</sub>O emissions as follows:

#### Equation 1

$$N_2O = 44/28 * (EF_1 * (N_{tot} + N_{cr}) + EF_4 * NH_3 + EF_5 * NO_3)$$

Where:

$N_2O$  = emissions of N<sub>2</sub>O [kg N<sub>2</sub>O/ha]

$EF_1$  = default emission factor for N additions from mineral fertilisers, organic amendments and crop residues, and N mineralised from mineral soil as a result of loss of soil carbon: 0.01 ([kg N<sub>2</sub>O-N]/kg N) (IPCC 2006, Table 11.1)

$N_{tot}$  = total nitrogen input [kg N/ha]

$N_{cr}$  = nitrogen contained in the crop residues [kg N/ha]

$EF_4$  = default emission value for N volatilization and re-deposition: 0.01 ([kg N<sub>2</sub>O-N]/kg NH<sub>3</sub>-N + NO<sub>x</sub>-N volatilized) (IPCC 2006, table 11.3)

$NH_3$  = losses of nitrogen in the form of ammonia [kg NH<sub>3</sub>-N/ha]

$EF_5$  = default emission value for leaching and runoff: 0.0075 ([kg N<sub>2</sub>O-N] / kg N leaching/runoff) (IPCC 2006, table 11.3)

$NO_3$  = losses of nitrogen in the form of nitrate [kg NO<sub>3</sub>-N/ha]

### 2. The operator shall calculate ammonia emissions as follows:

#### Equation 2

$$NH_3-N \text{ [kg NH}_3\text{-N/ha volatilized]} = (N_{min\_fert} * FraC_{GASF} + N_{org\_fert} * FraC_{GASM})$$

With:

$N_{min\_fert}$  = kg N/ha in mineral fertilizer

$N_{org\_fert}$  = kg N/ha in organic fertilizer



$Frac_{GASF}$  = default emissions for the volatilisation from synthetic (mineral) fertiliser: 0.1  
([kg NH<sub>3</sub>-N + NO<sub>x</sub>-N] / kg of N applied) (Table 11.3, IPCC 2006)

$Frac_{GASM}$  = default emissions for the volatilisation from all organic N fertilisers applied:  
0.2 [(kg NH<sub>3</sub>-N + NO<sub>x</sub>-N)/kg of N applied) (Table 11.3, IPCC 2006)

The N-content of organic fertilisers can be taken from following table

**Table 1: N content of organic fertiliser for ammonia calculation**

Animal category	Manure type	Unit	N soluble
Cattle	liquid manure	kg/m <sup>3</sup>	2.3
	low-excrement liquid manure	kg/m <sup>3</sup>	3.2
	stackable manure	kg/t	0.8
	solid manure from loose housing	kg/t	1.3
Pigs	liquid manure	kg/m <sup>3</sup>	4.2
	solid manure	kg/t	2.3
Poultry	broiler manure	kg/t	10
	laying hen manure	kg/t	6.3
	laying hen litter	kg/t	7
	dried poultry litter	kg/t	9

### 3. The operator shall calculate nitrate emissions as follows:

#### Equation 3

$$NO_3-N \text{ [kg } NO_3\text{-N/ha leaching]} = (N_{min\_fert} + N_{org\_fert} + N_{cr}) * Frac_{LEACH-(H)}$$

With:

$N_{min\_fert}$  = kg N in mineral fertilizer

$N_{org\_fert}$  = kg N in organic fertilizer

$N_{cr}$  = kg N in crop residues

$Frac_{LEACH-(H)}$  = default emission factor for N losses by leaching / runoff for regions where  $\Sigma(\text{rain in rainy season}) - \Sigma(\text{Potential evaporation in same period}) >$  soil water holding capacity, OR where irrigation (except drip irrigation) is employed (kg N additions or deposition by grazing animals): 0.3

The N content of organic fertilizer is given in Table 1.

## Annex VI: Methodology to determine DLUC emissions

The operator shall determine the carbon stocks only for areas that have similar:

- Biophysical conditions in terms of climate and soil type.
- Management history in terms of tillage.
- Input history in terms of carbon input to soil.

### Step 1 – Estimation of DLUC emissions

DLUC emissions  $e_i$  shall be calculated by dividing the land use change total emissions equally over 25 years as shown in Equation 1

#### Equation 1

$$e_i = \frac{CS_R - CS_A}{yield_i \times 25} \times 3.664$$

where:

$e_i$  = annualised greenhouse gas emissions from carbon stock change due to land-use change  $\left[ \frac{kg\ CO_2e}{kg_i} \right]$

$CS_R$  = Carbon stock per unit area associated with the reference land use (determined as mass of carbon per unit area, including both soil and vegetation). The reference land use shall be the land use in January 2008  $\left[ \frac{kg\ C}{ha} \right]$

$CS_A$  = Carbon stock per unit area associated with the actual land use (measured as mass of carbon per unit area, including both soil and vegetation). In cases where the carbon stock accumulates over more than one year, the value attributed to  $CS_A$  shall be the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever the earlier  $\left[ \frac{kg\ C}{ha} \right]$ ;

$Yield_i$  = productivity of crop  $i$   $\left[ \frac{kg}{ha \times yr} \right]$

Land use change shall be understood as referring to changes in terms of land cover between the six land categories used by the IPCC (forest land, grassland, cropland, wetlands, settlements and other land) plus a seventh category of perennial crops, i.e. multi annual crops whose stem is usually not annually harvested such as short rotation coppice and oil palm. This means, for example, that a change from grassland to cropland is a land use change, while a change from one crop (such as maize) to another (such as rapeseed) is not. Cropland includes fallow land (i.e. land set at rest for one or several years before being cultivated again). A change of management activities, tillage practice or manure input practice is not considered land use change.

### Step 2 - Estimation of carbon stock of actual and reference land use

The carbon stock of the area associated with land use  $i$  shall be calculated as shown in Equation 2

### Equation 2

$$CS_i = (SOC + C_{VEG}) \times A$$

where:

- $CS_i$  = the carbon stock per unit area associated with the land use  $i$  (determined as mass of carbon per unit area, including both soil and vegetation)
- $SOC$  = soil organic carbon (measured as mass of carbon per hectare)
- $C_{VEG}$  = above and below ground vegetation carbon stock (determined as mass of carbon per hectare)
- $A$  = factor scaling to the area concerned (determined as hectares per unit area)

### Step 3 – Calculation of the soil organic carbon

The operator shall calculate the soil organic carbon as mass of carbon per hectare as shown in Equation 3

### Equation 3

$$SOC = SOC_{ST} \times F_{LU} \times F_{MG} \times F_I$$

where:

- $SOC$  = soil organic carbon (measured as mass of carbon per hectare);
- $SOC_{ST}$  = standard soil organic carbon in the 0-30 centimetre topsoil layer (measured as mass of carbon per hectare);
- $F_{LU}$  = land use factor reflecting the difference in soil organic carbon associated with the type of land use compared to the standard soil organic carbon;
- $F_{MG}$  = management factor reflecting the difference in soil organic carbon associated with the principle management practice compared to the standard soil organic carbon;
- $F_I$  = input factor reflecting the difference in soil organic carbon associated with different levels of carbon input to soil compared to the standard soil organic carbon.

For the determination of  $SOC_{ST}$ ,  $F_{LU}$ ,  $F_{MG}$  and  $F_I$  the appropriate values presented in C (2010) 3751 shall be selected<sup>18</sup>

<sup>18</sup> EU Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V of Directive 2009/28/EC

**Step 4** – Calculate the above and below ground vegetation carbon stock

The operator shall calculate the above and below ground vegetation carbon stock as shown in Equation 4.

**Equation 4**

$$C_{VEG} = C_{BM} + C_{DOM}$$

where:

$C_{VEG}$  = above and below ground vegetation carbon stock (measured as mass of carbon per hectare);

$C_{BM}$  = above and below ground carbon stock in living biomass (measured as mass of carbon per hectare),

$C_{DOM}$  = above and below ground carbon stock in dead organic matter (measured as mass of carbon per hectare),

For  $C_{DOM}$  the value of 0 may be used, except in the case of forest land — excluding forest plantations — having more than 30 % canopy cover.

**Step 5** – Calculate the above and below ground carbon stock in living biomass

The operator shall calculate the above and below ground carbon stock in living biomass (measured as mass of carbon per hectare) as shown in Equation 5.

**Equation 5**

$$C_{BM} = C_{AGB} + C_{BGB}$$

where:

$C_{BM}$  = above and below ground carbon stock in living biomass (measured as mass of carbon per hectare);

$C_{AGB}$  = above ground carbon stock in living biomass (measured as mass of carbon per hectare)

$C_{BGB}$  = below ground carbon stock in living biomass (measured as mass of carbon per hectare)

**Step 6** – Calculate the above ground living biomass

The operator shall calculate the above ground living biomass as shown in Equation 6.

**Equation 6**

$$C_{AGB} = B_{AGB} \times CF_B$$

where:

$C_{AGB}$  = above ground carbon stock in living biomass (measured as mass of carbon per hectare);

$B_{AGB}$  = weight of above ground living biomass (measured as mass of dry matter per hectare);

$CF_B$  = carbon fraction of dry matter in living biomass (measured as mass of carbon per mass of dry matter).

For cropland, perennial crops and forest plantations the value for  $B_{AGB}$  shall be the average weight of the above ground living biomass during the production cycle.

For  $CF_B$  the value of 0,47 may be used.

### Step 6 – Calculate the below ground living biomass

For the calculation of  $C_{BGB}$  one of the following two rules shall be used:

(1)

#### Equation 7

$$C_{BGB} = B_{BGB} \times CF_B$$

where:

$C_{BGB}$  = below ground carbon stock in living biomass (measured as mass of carbon per hectare);

$B_{BGB}$  = weight of below ground living biomass (measured as mass of dry matter per hectare);

$CF_B$  = carbon fraction of dry matter in living biomass (measured as mass of carbon per mass of dry matter).

For cropland, perennial crops and forest plantations the value for  $B_{BGB}$  shall be the average weight of the below ground living biomass during the production cycle.

For  $CF_B$  the value of 0,47 may be used.

(2)

#### Equation 8

$$C_{BGB} = C_{AGB} \times R$$

where:

$C_{BGB}$  = below ground carbon stock in living biomass (measured as mass of carbon per hectare);

$C_{AGB}$  = above ground carbon stock in living biomass (measured as mass of carbon per hectare);

*R* = ratio of below ground carbon stock in living biomass to above ground carbon stock in living biomass. Appropriate values for *R* set out in C (2010) 3751 shall be used.<sup>19</sup>

### Step 7 – Calculate the dead organic matter

For the calculation of  $C_{DOM}$  the operator shall use Equation 9

#### Equation 9

$$C_{DOM} = C_{DW} + C_{LI}$$

where:

$C_{DOM}$  = above and below ground carbon stock in dead organic matter (measured as mass of carbon per hectare);

$C_{DW}$  = carbon stock in dead wood pool (measured as mass of carbon per hectare)

$C_{LI}$  = carbon stock in litter (measured as mass of carbon per hectare)

### Step 8 – Calculate carbon stock in dead wood pool

For the calculation of  $C_{DW}$  the operator shall use Equation 10

#### Equation 10

$$C_{DW} = DOM_{DW} + CF_{DW}$$

where:

$C_{DW}$  = carbon stock in dead wood pool (measured as mass of carbon per hectare);

$DOM_{DW}$  = weight of dead wood pool (measured as mass of dry matter per hectare);

$CF_{DW}$  = c carbon fraction of dry matter in dead wood pool (measured as mass of carbon per mass of dry matter).

For  $CF_{DW}$  the value of 0,5 may be used.

### Step 9 – Calculate the carbon stock in litter

For the calculation of  $C_{LI}$  the operator shall use Equation 11

#### Equation 11

$$C_{LI} = DOM_{LI} + CF_{LI}$$

where:

$C_{LI}$  = carbon stock in litter (measured as mass of carbon per hectare);

<sup>19</sup> EU Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V of Directive 2009/28/EC

$DOM_{LI}$  = weight of litter (measured as mass of dry matter per hectare);

$CF_{LI}$  = carbon fraction of dry matter in litter (measured as mass of carbon per mass of dry matter).

For  $CF_{LI}$  the value of 0,4 may be used.

