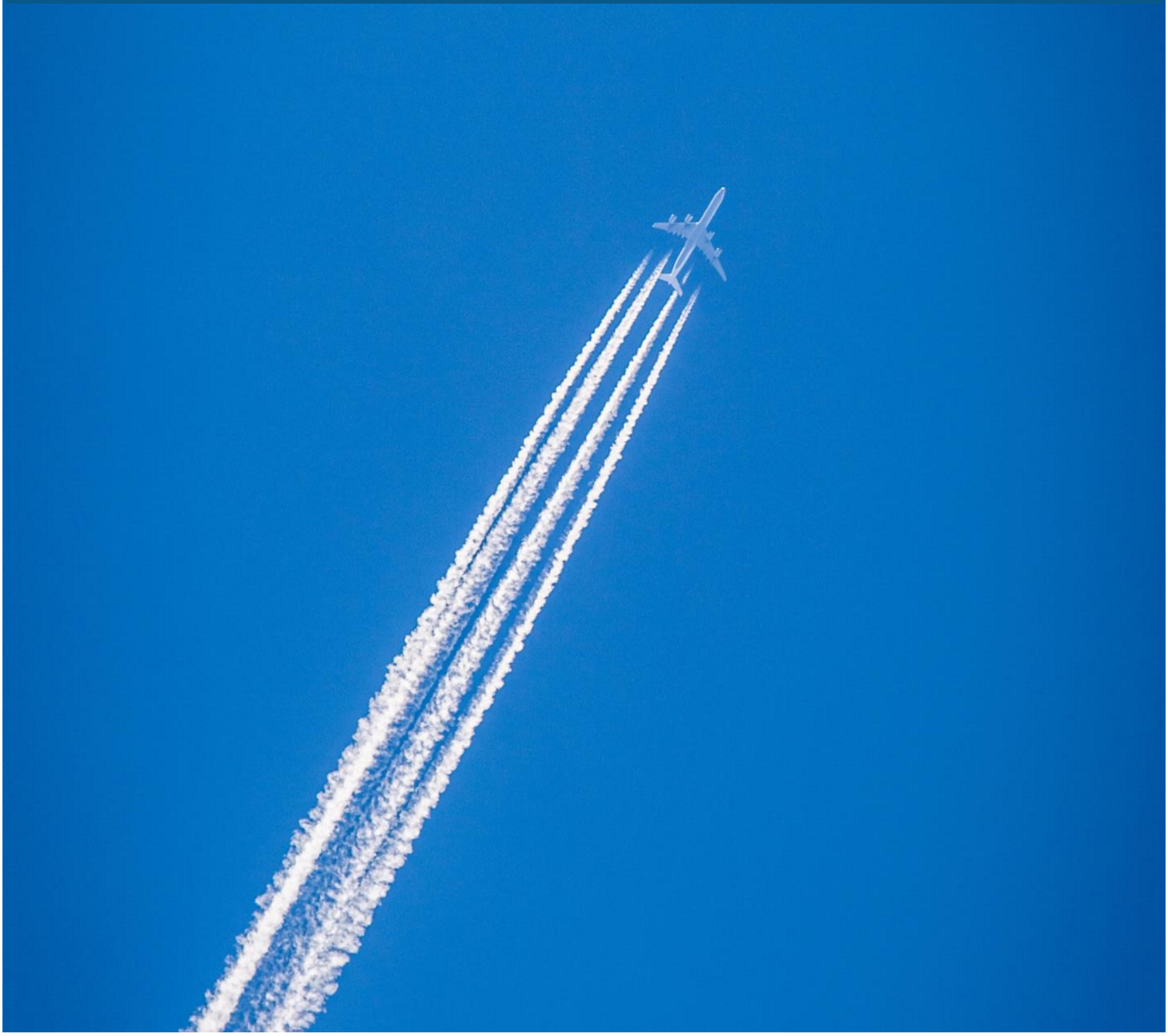
ISCC CORSIA 205

LIFE CYCLE EMISSIONS

Version 2.0



Document Title: ISCC CORSIA 205 Life Cycle Emissions

Version 2.0

Content

Glossary of Abbreviations

CH4	Methane
CEF	CORSIA Eligible Fuel(s)
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DOC	Degradable organic carbon
DOCF	Fraction of Degradable Organic Carbon Dissimilated
GHG	Greenhouse Gas
GWP	Global warming potential
ICAO	International Civil Aviation Organization
ILUC	Induced Land Use Change
LCA	Life Cycle Assessment
LEC	Landfill Emissions Credit
LFG	Landfill Gas
LFGCE	Landfill Gas Collection Efficiency
LMP	Land Management Practice
LS_f	Life cycle emissions factor for a CORSIA eligible fuel in gCO_2e/MJ
LUC	Land Use Change
MCF	Methane Correction Factor
MSW	Municipal Solid Waste
N_2O	Nitrous Oxide
REC	Recycling Emissions Credit
SAF	Sustainable Aviation Fuel

Summary of Changes

The following is a summary of all content changes to the previous version of the document (ISCC CORSIA System Document 205, v1.1). Minor amendments which do not affect the content, e.g. corrections of phrasings, marginal notes, amendments of graphics, etc. are not listed.

Summary of changes made in version 2.0	Chapter
Addition: Clarification that updates in this document are based on the recent amendment of the ICAO Document “CORSIA Methodology for Calculating Actual Life Cycle Emissions Values”.	1
Addition: Clarification that the ISCC EU Document 205 “GHG Emissions” in its latest version shall be used as basis for the ISCC CORSIA methodology.	1
Addition: Clarification that default values have to match in feedstock, conversion process (pathway), ILUC region (if applicable) and pathway specifications as specified in the Annex and ICAO document “CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels”.	3.1
Addition: Additional information for emission credits to be included in the economic operator’s Technical Report.	4
Addition: Footnote added to give definitions of double issuance and double claiming.	4
Addition: Paragraph on emissions reduction permance for CORSIA eligible SAF production.	4
Addition: Clarification that the Technical Report must be sent to ISCC by the CB as part of the standard certification documents.	5.1
Amendment: Update of chapter 6 on the certification of low land use change (LUC) risk practices to reflect updates to ICAO’s methodology.	6
Addition: Inclusion of dedicated chapter on calculating direct land use change emissions values, based on ICAO CORSIA methodology.	7
Addition: Inclusion of additional requirements for emissions credits to reflect updates to ICAO’s methodology	8
Amendment: Update of default values list to reflect changes made by ICAO	Annex
Amendment: Sentence on allowing negative ILUC values in CORSIA’s pilot phase was moved from Annex to chapter 3.3.	Annex

1 Introduction

Intention and applicability

The intention of this document “Life Cycle Emissions” is to provide the methodology, rules and guidelines for calculating, reporting and verifying emissions reductions. The methodology described here is based on the ICAO Document “CORSIA Methodology for Calculating Actual Life Cycle Emissions Values” (3rd edition, June 2022).

ISCC EU methodology as the basis

As a basic principle, the ISCC methodology for calculating greenhouse gas (GHG) emissions as specified in ISCC EU Document 205 “GHG Emissions” in its latest version is valid in the framework of ISCC CORSIA as well.[1] However, all rules and methodologies described in this document here have precedence over the ISCC EU methodology. This means, wherever the methodology described below differs from the methodology described in ISCC EU 205, the CORSIA version of the calculation methodology must be used.

CORSIA eligible fuels

An Aeroplane Operator seeking benefits from the use of CORSIA eligible fuels (CEF) in terms of reductions in CORSIA emissions offsetting requirements will have to provide documentation to their State on the life cycle emissions values (or factors; short: LS_f) and sustainability. An Aeroplane Operator will need to work with a fuel supplier to obtain this information.

Emissions reduction requirement

CORSIA eligible fuels shall achieve net GHG emissions reductions of at least 10% compared to the baseline life cycle emissions values for aviation fuel on a life cycle basis.

Options for LSf

In order to obtain the life cycle emissions value (LS_f) of a CORSIA eligible fuel, the System User can either

- use a default value as presented in the ICAO document “Default Life Cycle Emissions Values for CORSIA Eligible Fuels” or
- calculate an actual value according to the methodology described in this document.

2 Scope and Normative References

Relevant supply chain elements

For the following elements in the supply chain, information on life cycle emissions must be provided:

a) Feedstock production (extraction or cultivation)

b) Processing units (companies that process raw materials/input materials and thereby change relevant physical or chemical properties)

c) Transport and distribution

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[1] Please note that while the ISCC EU Document 205 is titled “GHG emissions”, the ISCC CORSIA 205 Document is titled “Life Cycle Emissions” to follow and ensure consistent wording with the ICAO documents on CORSIA eligible fuels. The difference in terminology (i.e. “GHG emissions” vs “life cycle emissions”) does not per se imply a difference in scope (e.g. in terms of emissions sources or life cycle stages covered).

The requirements for the life cycle emissions value calculation and verification requirements for auditors are explained in this document.

References

As the methodology, rules and guidelines for calculating, reporting and verifying emissions reductions do not differ between ISCC CORSIA and ISCC CORSIA PLUS, all references made to ISCC CORSIA in this document apply to ISCC CORSIA PLUS as well.

Scope of application

As a basic principle, all relevant ISCC CORSIA documents are valid for the scope. The normative references display the documents whose contents are linked and have to be considered.

3 Options for obtaining life cycle emissions values

Life cycle emissions value

The emissions reductions generated by the use of a CORSIA eligible fuel depends on its life cycle emissions value. There are two ways of obtaining this value:

1. Use of a default value
2. Calculating an actual value

3.1 Use of default values

Source of default values

Default values are provided in the Annex to this document, based on the tables provided in the CORSIA document “Default Life Cycle Emissions Values for CORSIA Eligible Fuels”.[2] Total default values exist for different types of fuel conversion processes, ILUC regions, feedstocks and pathway specifications. Provided are core life cycle emissions values and induced land use change (ILUC) emissions values as well as the total life cycle emissions factor (LS_f), which is the sum of the two aforementioned values.

Verification

The auditor will verify that the economic operator applies the correct default life cycle emissions values based on the associated feedstock, conversion process (pathway), ILUC region (if applicable) and pathway specifications as specified in the Annex to this document or the ICAO document “CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels”. It is the responsibility of economic operators and auditors to make sure they use the latest version of default values available.

3.2 Use of actual values

Individual calculation of emissions

An Aeroplane Operator may use an actual core life cycle emissions value as part of an accepted fuel sustainability certification process if a fuel producer can demonstrate lower core life cycle emissions compared to the CORSIA default core life cycle values provided or if a fuel producer has defined a new pathway that does not have a default core life cycle value.

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[2] Please find the latest version on the ICAO webpage for CORSIA eligible fuels under https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx

Verification

If the Aeroplane Operator chooses to use an actual core life cycle value, the auditor will ensure that the CORSIA LCA methodology specified in the ICAO document "CORSIA Methodology for Calculating Actual Life Cycle Emissions Values" and the ISCC CORSIA 205 document is accurately followed and that the LCA value calculation is complete, accurate and transparent. The auditor shall also ensure that relevant information on GHG emissions is transmitted through the chain of custody. ISCC will record detailed information about the calculation of actual values within the ISCC System and provide this information to ICAO on request.

3.3 Total life cycle emissions value

Adding of ILUC value

After the core life cycle emissions value has been calculated according to the methodology described below or been obtained via a default value, the appropriate default ILUC value must be added in order to generate the total life cycle emissions value (LS_f). The default ILUC value must be gathered from the ICAO Document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels". During the CORSIA pilot phase, negative ILUC values were provisionally allowed to obtain a negative LS_f. A decision on whether to continue allowing negative LS_f values, due to reductions from negative ILUC, will be made by the end of the CORSIA pilot phase.

The unit of the LS_f is grams of CO_2e per megajoule of fuel produced and combusted in an aircraft engine, in terms of LHV (gCO_2e/MJ).

Core LCA value + ILUC LCA value = LS_f (gCO_2e/MJ)

4 General requirements

No ILUC value for waste, residues or by-products

If a fuel was produced from a feedstock that is defined as a waste, residue, or by-product according to the ISCC CORSIA Document 201-1 "Waste, Residues, By-Products" then the actual core LCA value shall be the total LS_f. If the feedstock is not a waste, residue, or by-product, then a default core LCA value and an ILUC value will need to be added to the ICAO document entitled "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels" before the fuel can be included in CORSIA.[3]

Life cycle steps

The system boundary of the core LCA value calculation shall include the full supply chain of CEF production and use. As such, emissions associated with the following life cycle stages of the CEF supply chain must be accounted for:

(1) production at source (e.g., feedstock cultivation);

(2) conditioning at source (e.g., feedstock harvesting, collection, and recovery);

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[3] Information on how fuels can be added to the ICAO document entitled "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels" can be found in the CORSIA Supporting Document "CORSIA Eligible Fuels - Life Cycle Assessment Methodology"

(3) feedstock processing and extraction;

(4) feedstock transportation to processing and fuel production facilities;

(5) feedstock-to-fuel conversion processes;

(6) fuel transportation and distribution; and

(7) fuel combustion in an aircraft engine.

Calculating CO_2e emissions

For life cycle stages 1-6, carbon dioxide equivalent (CO_2e) emissions of CH_4, N_2O and non-biogenic CO_2 from these activities shall be calculated on the basis of a 100-year global warming potential (GWP). CO_2e values for CH_4 and N_2O shall be based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (the values being 28 and 265, respectively). For life cycle stage 7, only non-biogenic CO_2 emissions from fuel combustion shall be included in the calculation of CO_2e emissions.

Functional unit

The functional unit for final LS_f results shall be grams of CO2e per megajoule of fuel produced and combusted in an aircraft engine, in terms of lower heating value (gCO_2e/MJ).

Emissions of on-going operational activities

The calculated LS_f 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.

Emissions allocation to co-products

In many cases, the CEF supply chain of interest will result in the co-production of multiple commodities. These co-products may include non-CEF liquid fuels, chemicals, electricity, steam, hydrogen, and/or animal feed. Energy allocation shall be used to assign emissions burdens to all co-products in proportion to their contribution to the total energy content (measured as lower heating value) of the products and co-products. CO_2e emissions shall not be allocated to waste, residues and by-products that result from the CEF supply chain of interest.

Feedstock categorization

CEF feedstocks can be broadly categorized into three groups - primary or co-products, by-products, and wastes and residues. Further information on how feedstocks are categorized in these groups for the purposes of ISCC CORSIA can be found in ISCC CORSIA Document 201-1 “Waste, Residues, By-Products”.

Feedstocks with zero LUC emissions

Feedstocks that are “low risk” for land use change (LUC) have been identified and assigned as having zero emissions from land use change. The low land use change risk feedstock list includes:

(1) feedstocks that do not result in expansion of global agricultural land use for their production (see also chapter 6);

(2) wastes, residues, and by-products (see ISCC CORSIA Document 201-1); and

(3) feedstocks that have yields per surface unit significantly higher than terrestrial crops (~ one order of magnitude higher) such as some algal feedstocks.

The feedstocks in these three categories shall all receive an ILUC value of zero in the fourth column of the table in the ICAO document “CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels”.

Emissions reductions from low LUC practices

Aeroplane Operators may choose to capture the benefits of utilizing land use change-risk mitigation practices, (e.g., land management practices) to avoid ILUC emissions as part of the ISCC CORSIA certification process. Mitigation practices that avoid ILUC emissions and the requirements that shall be met to obtain these reductions can be found in chapter 6. The ILUC value of zero shall be used in place of the default ILUC value to calculate total LS_f. If the Aeroplane Operator chooses to claim emissions reductions from the implementation of land use change-risk mitigation practices, then the Aeroplane Operator shall provide documentation that the fuel was produced using land use change-risk mitigation practices according to chapter 6.

Lower emissions for waste, residues and by-products

Waste, residue, and by-product feedstocks are assumed to incur 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 (life cycle stages 2-7).

Emission credits

The production of CEF from wastes, residues or by-products, as defined in ISCC CORSIA Document 201-1, may generate emission credits that can be subtracted from the actual LCA values to calculate total LS_f. If the Aeroplane Operator chooses to use a CEF that would generate such an emission credit, then the auditor must ensure that the calculation of emission credits is in accordance with the specific methodologies defined in this document, as follows.

> Avoided Landfill Emissions Credit (LEC) for SAF derived from Municipal Solid Waste (MSW) – chapter 8.1

> Recycling Emissions Credit (REC) for SAF derived from Municipal Solid Waste (MSW) – chapter 8.2

Emissions credits in the technical report

The analysis to calculate these emission credits values shall be documented in a technical report citing fully the data sources, such that the results are replicable and use the most recent data available. The technical report must also demonstrate that the emission credits claimed

> are permanent;

> directly attributable to the SAF production;

- exceed any emissions reductions required by law, regulation or legally binding mandate;
- exceed any GHG reductions or removals that would otherwise occur in a conservative, business-as-usual scenario that is assessed at a minimum every 7 years (including consideration of changing legal requirements, and key parameters);
- avoid double counting (including double issuance[4] or double claiming[5]) of such credits; and exceed emissions reductions that would otherwise occur in a business-as-usual scenario, including consideration of potential leakage.

Emissions credits

Until additional requirements and guidance have been developed to (a) ensure that emission credits for SAF generated under CORSIA are of an equivalent quality and quantity to emission units and (b) resolve concerns regarding double counting, after the subtraction of the LEC and/or REC applicable to a SAF, the total LS_f value cannot be smaller than 0 gCO_2e/MJ.

Permanence of emissions reductions

As part of its sustainability framework, CORSIA requires that emissions reductions attributed to CORSIA eligible SAF are permanent. Concretely, the economic operator shall implement practices to monitor, mitigate and compensate any material incidence of non-permanence from carbon capture and sequestration (CCS) activities. Once a methodology for conducting CCS in the context of CEF production is approved by ICAO and can be applied under ISCC CORSIA, ISCC will provide further rules and guidance on how emissions reduction permanence should be achieved and verified as part of ISCC CORSIA.

5 Technical report requirements

5.1 Reporting requirements

Technical Report

Economic operators must document all relevant data appropriately in a Technical Report, which is verified by an accredited certification body cooperating with ISCC. As part of the general certification documents, the economic operator's CB is required to make the technical report available to ISCC. On request, ISCC will submit the report to ICAO.

Relevant data include:

a) GHG emissions by life cycle step within the scope of certification, broken out by GHG emission species and aggregated in CO_2e (100 year GWP). With regard to the life cycle steps, see chapter 4.

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[4] In this instance, double issuance occurs when two or more credits are being issued for the same reduction

[5] In this instance, double claiming occurs when the same unit was used by multiple entities

b) The LCA inventory data by life cycle step within the scope of certification, including all energy and material inputs. For life cycle steps 1-4, the inventory data are to be provided per mass of feedstock, for the other steps per total fuel energy yield (MJ of fuel).

c) Emission factors used for calculating GHG emissions associated with energy and material inputs, including information about the source for the emission factors.

d) 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 feedstock of interest).

e) Quantities for all final and intermediate products, per total energy yield.

f) If Municipal Solid Waste (MSW) is being used as a feedstock, then all relevant data required for the calculation of landfill emissions credits and recycling emissions credit will be disclosed according to the MSW crediting methodology outlined in chapter 8.

g) In case a low LUC risk practice is being used, all relevant data required for the calculation and certification will be disclosed according to the Low LUC Risk Practices methodology outlined in chapter 6.

5.2 Flow of information along the supply chain for actual LCA values

Track of data flow in the supply chain

Each economic operator along the supply chain will implement a robust and transparent system to track the flow of data in each life cycle step as described in chapter 5, along the supply chain ("chain of custody system"). Tracking will occur each time the feedstock or fuel passes through an internal processing step or changes ownership along the supply chain. During the ISCC audit the auditor will verify that the economic operator has used an appropriate chain of custody system.

5.3 Verification, data record and reporting

Verification of LCA methodology

ISCC will report evidence that the certification body has verified that the economic operator has accurately followed the methodology specified in this document to calculate its actual LCA value using the most recent and scientifically rigorous data available, and that the LCA value calculation is complete, accurate and transparent. ISCC will report information on chain of custody system employed. Data will be recorded and reported to ICAO upon request in a format conducive to re-calculation and verification, for example as a spreadsheet in .csv or .txt file format.

6 Low Land Use Change (LUC) risk practices

Low risk for LUC allows zero ILUC emissions

Using certain types of land, land management practices (LMP), and the incorporation of innovative agricultural practices at the production step could be considered as a contribution to low risk for LUC and therefore receive a value of zero for ILUC instead of the default value (see chapter 4). The implementation of these low LUC risk practices for a project shall avoid market mediated responses that lead to changes in land use, and lead to additional SAF feedstock available relative to a baseline, without increasing land requirements.

Guidance document

ISCC has drafted a guidance document on low LUC risk certification under ISCC CORSIA. This document, publicly available on the ISCC website, builds on the requirements laid out in this chapter and goes into more detail on the application and verification of low LUC risk practices in CEF feedstock production.

DLUC emissions

It is assumed that under the low LUC risk practices increased emissions from direct LUC are negligible. If this is not the case, DLUC emissions must be calculated according to the DLUC methodology laid out in chapter 7 and compliance with CORSIA sustainability criterion 2.2 (calculating DLUC and substituting the ILUC with the DLUC value if DLUC value exceeds ILUC value) must be demonstrated.

Verification and transparencyThe practices will be verified by the certification body as a net enhancement in sustainable aviation feedstock available per unit of land. The feedstock producer needs to provide credible and verifiable evidence of the nature of the new land management practice, timing of its implementation and level of additional feedstock production. For transparency purposes, a brief description of both the low LUC risk practice used and the main features of the applied practice will be made available in ISCC's certificate database.

Report for low LUC risk practices

Any economic operator who would like to claim low LUC risk practices as described in this chapter, is required to document them in a written report. The report must, in sufficient detail, describe the low LUC risk measure implemented. ISCC will provide a template for the report that will include fields for every required information, such as crop type, the approach used, the practice used or a description of the area, where the measures were carried out.

Verification of report for low LUC risk practices

The truthfulness of the report and its compliance with the ISCC CORSIA low LUC risk requirements will be verified by the auditor. In addition, the auditor will forward the report to ISCC along with the audit report and all other relevant certification documents. The certificates of any System User in the downstream supply chain who owns and/or handles the certified low LUC risk feedstock/material will include information about the low LUC risk practice applied.

Limitations for low LUC risk practices

To ensure that low LUC risk claims are correctly tracked through the chain of custody and that no double-claiming of low LUC risk certified feedstocks for CEF occurs, System Users handling low LUC risk certified feedstock need to comply with the traceability and chain of custody requirements laid down in ISCC CORSIA System Document 203.[6]

Low LUC risk practices implemented on or after January 1, 2016 could be eligible. Exceptionally, practices implemented between January 1, 2013 to December 31, 2015 may be accepted where it can be demonstrated that low LUC risk practices were implemented primarily as a result of demand for biofuels. This would have to be demonstrated on a project-specific basis.

Low LUC risk practices during

Feedstocks designated under the low LUC risk practices approach are designated as such only until 2030 and they will be subject to periodic audits to ensure ongoing compliance with the original requirements when the feedstocks were certified.

The certification as "low LUC risk" under ISCC CORSIA is only possible if the System User complies with the applicable sustainability requirements provided under ISCC CORSIA. This is to account for, amongst other examples, situations where the low LUC risk practices may otherwise have a negative impact on environmental and social services of the land and resources used, or negatively affect the uses or productivity of resources in other places.

Two approaches

There are two approaches for low LUC risk SAF feedstock production, which are presented in more detail in the following subchapters:

a) Yield Increase Approach

b) Unused Land Approach

6.1 Yield increase approach

Example measures

Eligible land management practices for the yield increase approach could include, among others, sequential cropping where more than one crop is planted per year, cover crops, the use of fallow land in a prescribed crop rotation, significant post-harvest loss reduction, and significant project level productivity increases due to the introduction of good practices and technology.

The yield increase approach applies to any situation where feedstock producers are able to increase the amount of available feedstock out of a fixed area of land (i.e. without expanding the surface of the land). An increase in the harvested feedstock may be the result of:

a) 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.);

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[6] ISCC CORSIA 203 "Traceability and Chain of Custody"

b) Intercropping, (i.e. the combination of two or more crops that grow simultaneously, for example as hedges or through an agroforestry system);

c) Sequential cropping, (i.e. the combination of two or more crops that grow at different periods of the year); and/or

d) 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).

Accounting for reduced production of food/feed

If there is a decrease of the available feedstock for the food or feed market at the project level resulting from the land management practices (e.g., reduced yield from the main crop) this will be accounted for in calculating the volume of low LUC risk CEF feedstock (i.e., the volume of low LUC risk CEF feedstock represents the net increase in feedstock after accounting for any reduction in production of the primary food/feed crop that had been grown historically). The calculation of the reduction shall be done in an appropriate unit of measurement (e.g. based on the energetic value).

Annual crops

For annual crops, measurements of yield increases and post-harvest loss reduction relative to a baseline are calculated based on historical practices using the annual yield per unit of land based on data from the preceding five years before the LMP measure takes effect from similar producers within the same region for the duration of the LMP measure. The low LUC risk feedstock thus represents additional feedstock obtained as a consequence of the improvement relative to the baseline.

Perennial crops

For perennial crops, yield increase is calculated based on a standard growth curve of the same perennial crop from similar producers within the same region, as found in FAO and/or peer-reviewed data sources. Using a standard growth curve, the producer calculates its individual growth curve as a baseline and accounts for the additional yield achieved beyond this baseline after the implementation of the yield increase measure.

Conditions for low LUC risk feedstock

The amount of additional feedstock available and considered eligible for low LUC risk feedstock is calculated as follows:

1. For annual crops, the average amount of feedstock available historically, from the same or similar producers within the same region, is calculated based on actual net feedstock production (i.e., amount harvested less post-harvest losses) in the five years before the LMP measure takes effect. For perennial crops, the average amount of feedstock available historically is calculated based on a standard growth curve of the crop from the same or similar producers within the same region. Similar producers can be defined as producers growing the same (or equivalent) crops and using a similar management model (e.g., smallholder, small or large scale plantation). For producers to be considered in the same region, it shall be determined that the relevant

location and site factors (e.g. soil, water and climate factors) are comparable and sufficiently representative.

2. The amount of feedstock available as a consequence of the land management practice is calculated based on the current/new net feedstock production (amount harvested less post-harvest losses) that is attributable to the adoption of the new LMP measure.
3. The additional low LUC risk feedstock represents the difference between the values calculated via the two previous steps.

6.2 Unused land approach

Eligible land

Eligible lands for the unused land approach could include, among others, marginal lands, underused lands, unused lands, degraded pasture lands, and lands in need of remediation.

Verifying unused land status

Remote sensing data (when available) and other detective measures combined with auditing techniques such as interviews with local stakeholders may be needed to provide reliable results in the determination of land history and land status to verify “unused land” status.

For a land to be eligible for the unused land approach, it needs to meet one of the following criteria, while simultaneously complying with the ISCC CORSIA sustainability requirements (see ISCC CORSIA Document 202):

a) The land was not considered to be arable land or used for crop production during the five years preceding the reference date.

b) The land is identified as severely degraded land or undergoing a severe degradation process for at least three years.

Definition of degraded land

Land degradation in the context of ISCC CORSIA and based on the definition of the United Nations Convention to Combat Desertification (UNCCD) is a reduction or loss “of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as: (i) soil erosion caused by wind and/or water; (ii) deterioration of the physical, chemical and biological or economic properties of soil; and (iii) long-term loss of natural vegetation”.[7]

Displacement of provisioning services

For a land to be eligible for the unused land approach, it also needs to have little risk for displacement of provisioning services from that land onto different and equivalent amounts of land elsewhere. Provisioning services refer to products obtained from ecosystems such as food, animal feed, or bioenergy feedstocks. It can be assumed that the risk for displacement of provisioning services is little if the land was not used for provisioning of services in the three preceding years prior to the start of the measure.

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[7] UNCCD Article 1(f).

Eligible low LUC risk feedstock

The amount of feedstock considered eligible for low LUC risk feedstock is equal to the amount of feedstock harvested for sustainable aviation fuel production from the eligible land.

7 Calculating direct land use change emissions values

Background

This section describes the methodology for calculating Direct Land Use Change (DLUC) emissions for an economic operator aiming at producing a feedstock for CORSIA eligible SAF. It applies in the event where feedstocks were sourced from land obtained through land use conversion after 1 January 2008.

7.1 Collecting required data

Required data

To conduct a DLUC calculation, the following data needs to be available:

a) The type and locations of the feedstock production

b) The types of lands converted to feedstock production will be determined using the IPCC definitions[8]. The reference date for initial land cover is 1 January 2008, even if land conversion occurred after this date. Any land use change to a feedstock plantation for bioenergy production will be considered as land conversion. Within cropland, cultivation of unused land[9] and conversion of annual to perennial crops, from perennial to annual, and between perennial crops will also be considered as land conversion.[10]

   The area of each reference type of land $\boldsymbol{j}$ converted to feedstock cultivation measured in hectares is expressed below as $\boldsymbol{L_j}$. Total area of land used for CEF feedstock production per year is noted $\mathrm{L} = \Sigma_j \mathrm{L}_j$.

c) The yield of feedstock for each type of converted land, $\boldsymbol{y_j}$, will be determined in metric tons per hectare (mt per ha) per year

d) The energy outputs of the main sustainable aviation fuels (E_{SAF}) and production of other types of co-products such as marketable road biofuels, electricity, or feed meals ($E_{coproducts}$), all expressed in energy terms measured in Megajoules (MJ) per year. The lower heating value

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[8] Please refer to Chapter 3, Volume 4 of the 2019 Refinement to the 2006 IPCC Guidelines for Naitonal Greenhouse Gas Inventories. At minimum, the six main IPCC land categories must be clearly distinguished, and idle land and perennial crops considered separately. Depening on the individual scenario, a higher level of refinement may be needed to properly capture the landscape heterogeneity.

[9] Please see chapter 6.2 for what is considered unused land under CORSIA.

[10] Within cropland, crop rotations will not be considered as land conversion, except for pathways using lignocellulosic energy crops.

will be used to calculate the energy output, including for non-energy co-products.[11]

7.2 DLUC calculation

Step 1

Land use emission factors

Determine land use emission factors, $\boldsymbol{F_j}$, for each reference type of land converted to bioenergy feedstock production after 1 January 2008. This variable will be measured in grams of CO2 equivalent per hectare (gCO2e/ha). Emission factors shall reflect terrestrial carbon fluxes due to land conversion including changes in soil organic carbon, in living vegetation carbon stock, and in dead organic matter and litter carbon pools in accordance with the IPCC guidelines[12].

Non-CO2 emissions

In addition to CO_2 emissions, the land use emission factors will include the relevant non-CO_2 emissions associated with the Land Use Land Use Change and Forestry (LULUCF) sources of the IPCC, including emissions from biomass burning through land clearing and N_2O emissions from mineralisation associated with the loss of soil organic carbon. Subchapter 7.3 provides the formulas and default parameters for the calculations of non-CO2 emissions.

Calculation of emission factor

For emissions from the conversion of land type *j* to feedstock production, the emission factor will be calculated using the following equation:

$$F_j = \frac{44}{12} * [CS_j^R - CS_j^A] + F_j^{nCO2}$$

Where:

CS_j^R = carbon stock of land type *j* measured in gC/ha for the reference *(R)* (1 January 2008)

CS_j^A = carbon stock of land type *j* measured in gC/ha for actual *(A)* land uses

F_j^{nCO2} = emission factor for non-CO_2 emissions measured in gCO_2e/ha

Calculation of carbon stocks

The carbon stocks for the reference and actual land uses are defined as:

$$CS_j^K = \left[SOC_j^K + CVEG_j^K\right], for\ K = R\ or\ A$$

Where:

SOC = soil organic carbon measured in gC/ha

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[11] If more than one crop are produced in each crop year and only one of these is used as feedstock for SAF, then the additional crops in the annual rotation will be considered as co-product and their energy output will be included in the calculation of $E_{coproduct}$, using their lower heating value.

[12] Please refer to Volume 4 of the 2019 Refinement to the 2006 IPCC Guidelines for Naitonal Greenhouse Gas Inventories.

CVEG = above and below ground vegetation carbon stock measured in gC/ha, including dead wood and litter

Follow IPCC principles

Calculations must always respect the IPCC guidelines principles. Economic operators should follow the decision trees provided by IPCC to help determine the relevant methodology to be applied. Depending on data availability and quality, operators will either follow the Tier 1, Tier 2 or Tier 3 method (with the latter being the most comprehensive). In the case where there is ambiguity in the magnitude of a DLUC value, compared to ILUC, due to uncertainty in the choice of Tier 1 coefficients, economic operators will use Tier 2 or Tier 3 approaches.

More detailed guidance

More detailed guidance compatible with the IPCC methodology should be used for those regions for which it is available, facilitating the calculation of land carbon stocks and emission factors[13].

Negative DLUC values

If calculation of DLUC leads to a negative value, due to enhancement in carbon stocks associated with the land use conversion (e.g., soil organic carbon sequestration, sequestration in agricultural plantation biomass), the contribution of negative sources shall be verified against the same criteria as for CORSIA Emissions Units. Before they can be used to account for negative emissions or carbon stock variations leading to negative DLUC values, methodologies must have been submitted to ICAO by the Sustainability Certification Schemes and approved by the CORSIA SCS Evaluation Group.

Update of methodologies

Any methodologies for calculating negative DLUC values valid under ISCC CORSIA (following approval by the CORSIA SCS Evaluation Group) will be included by ISCC in updated versions of this System Document, or, alternatively, be communicated in a dedicated System Update to all stakeholders.

Calculation in any case

Calculation based on approved methodologies will be performed even if the negative DLUC is ultimately lower than ILUC and the negative ILUC applies.

Change in average crop biomass

If the feedstock production affects the average crop biomass of the feedstock production area, it shall be calculated as part of $CVEG_j^K$. For example, converting a piece of land which has been used for soybean cultivation to oil palm plantation could increase the average crop biomass of the feedstock production area.

Biomass burning

Non-CO_2 emissions from biomass burning are to be accounted only if the necessary information on area burnt is available.

Step 2

Calculating DLUC for land types

The formula to calculate $DLUC_j$, for land type j, in gCO_2e/MJ, is as follows:

$$DLUC_j = \frac{L_j * F_j}{T * E * l_j}$$

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[13] For example, the European Commission guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC.

Where:

L_j = land area in ha, as identified via data collected

F_j = associated emission factor measured in gCO_2e/ha, as defined in Step 1

E = $E_{SAF} + E_{coproducts}$ are the energy outputs measured in MJ, as identified via data collected

T = 25; the number of years for amortization of the emissions in CORSIA

l_j = land use share of type *j* defined as $l_j = \frac{L_j * y_j}{\Sigma_j L_j * y_j}$

Compliance with minimum saving

If the combined values for *DLUC_j* and core LCA do not at least achieve a 10% minimum saving compared to the respective fossil reference value as per CORSIA rules, then the land type *j* shall be classified as ineligible. Economic operators must discriminate land types at the level of detail needed so that this exclusion criteria is respected.

Step 3

Calculating DLUC in gCO2e/MJ

To calculate *DLUC* in gCO_2e/MJ, the following formula shall be applied for all types of eligible land identified during Step 2:

$$DLUC = \sum_j DLUC_j * l_j$$

Simplified expression

In case only one type of land is converted to cropland for feedstock production, then the following, simplified, expression can be used:

$$DLUC = \frac{L * F}{T * E}$$

7.3 Accounting for non-CO2 emissions

Calculation of emission factor

The emission factor for non-CO_2 emissions, F_j^{nCO2}, shall be calculated using the following equation:

$$F_j^{nCO2} = FF_j + FM_j$$

Where:

FF_j = non-CO_2 emissions due to biomass burning associated with clearing land type *j* measured in gCO_2e/ha

FM_j = non-CO_2 emissions due to soil mineralization associated with conversion of land type *j* measured in gCO_2e/ha

Emission factor for biomass burning

The emission factor for biomass burning (FF_j) shall be calculated via the following formula:

$$FF_j = \alpha_j * \beta_j * \frac{CVEGABOV_j * [G_j^{CH4} * GWP_{CH4} + G_j^{N2O} * GWP_{N2O} + G_j^{NOX} * GWP_{NOX}]}{1000} / \theta$$

Where:

α_j = fraction of area of land type *j* cleared due to biomass burning, varying between 0 and 1

β_j = combustion factor for land type *j*, selected from Table 1

$CVEGABOV_j$ = above ground biomass carbon stock plus litter and deadwood for land type *j* measured in gC/ha, as determined by the System User

G_j^{CH4} = CH_4 biomass burning emission factor for land type *j* before land conversion, measured in kg per metric ton of dry matter

G_j^{N2O} = N_2O biomass burning emission factor for land type *j* before land conversion, measured in kg per metric ton of dry matter

G_j^{NOX} = NO_X biomass burning emission factor for land type *j* before land conversion, measured in kg per metric ton of dry matter

GWP_{CH4} = IPCC global warming potential associated with CH_4 emissions, equal to 25

GWP_{N2O} = IPCC global warming potential associated with N_2O emissions, equal to 298

GWP_{NOX} = IPCC global warming potential associated with NO_X emissions, equal to $298 * \left(\frac{44}{28}\right) * 0.01$

θ = woody biomass carbon fraction, equal to 0.47 based on IPCC

Table 1: Biomass burning default emission and combustion factors by land type and latitude

	Emission factor *Gj* (kg per metric ton dry matter)			Combustion factor β_j
Land type	CH_4	N_2O	NO_X	
Tropical forest	6.8	0.2	1.6	0.55
Temperate forest	4.7	0.26	3	0.45
Boreal forest	4.7	0.26	3	0.34

Grassland / Savanna	2.3	0.21	3.9	0.755

Soil mineralization

The non-CO2 emissions due to soil mineralization due to land conversion (*FM$_j$*) are composed of two components: direct emissions FM_j^{Direct} and indirect emissions $FM_j^{Indirect}$ from volatilization and leaching/run-off. They are calculated as follows:

$$FM_j = FM_j^{Direct} + FM_j^{Indirect}$$

Direct emissions

Following IPCC guidelines, direct emissions from soil mineralization for land type *j* can be expressed as:

$$FM_j^{Direct} = \frac{44}{28} EF_1 * FSOM_j, where\ FSOM_j = 1000 * \Delta SOC_j / R$$

Where:

EF_1 = emission factor for direct emissions, in kg N_2O-N. $(kg\ N)^{-1}$, equal to 0.005 in dry climate and 0.006 in wet climate

$FSOM_j$ = net amount of N mineralized in mineral soils and land type *j*, in kg N

ΔSOC_j = average loss of soil organic carbon in the land type *j*, in metric tonnes C

R = C:N ratio of the soil organic matter (15 for forest or grassland, 10 for cropland)

Indirect emissions

Following IPCC guidelines, indirect emissions from soil mineralization are exclusively associated to leaching and run-off and calculated as follows:

$$FM_j^{Indirect} = \frac{44}{28} EF_5 * Frac_{LEACH-(H)} * FSOM_j$$

Where:

EF_5 = indirect emission factor from N leaching and run-off, in kg N_2O-N. $(kg\ N)^{-1}$, equal to 0.011

$Frac_{LEACH-(H)}$ = fraction of N mineralized lost through leaching and run-off, in $kg.kg^{-1}$, equal to 0.24

$FSOM_j$ = net amount of N mineralized in mineral soils, in kg N

8 Emissions credits

Two different emissions credits for SAF from MSW

The production of sustainable aviation fuels from Municipal Solid Waste (MSW) may generate emission credits that can be subtracted from the actual LCA values to calculate total LS_f. The calculation of emission credits will be audited by the CB in order to assess whether it is in accordance with the specific methodologies of:

> Avoided Landfill Emissions Credit (LEC) for sustainable aviation fuels derived from Municipal Solid Waste (MSW) – Chapter 8.1 or

> Recycling Emissions Credit (REC) for sustainable aviation fuels derived from Municipal Solid Waste (MSW) – Chapter 8.2

Calculating credit volume

For both types of emissions credits, economic operators shall calculate credit volume as the portion in excess of what would be achieved if best management practices according to the regulations applicable to the landfill, particularly for management and collection of landfill gas, were implemented.

Does not lead to reduction in recycling

Economic operators shall demonstrate that the economic activity does not lead to a reduction in recycling in the area of interest relative to that which would be recycled in the absence of the economic activity. Options for how this can be demonstrated include:

> Evidence that the materials recycled under the economic activity are recovered only from end-of-life wastes and the economic operator is not claiming reductions from waste diverted through any existing recycling activity

> Directly measured final output of the recycling facility (e.g. weight of materials leaving the recycling facility (on a dry basis), segregated by type)

> If the recycling facility is an existing activity, the average data on the amount of recycled materials from the previous three years of operation (a minimum of one-year data would be required if the facility is less than three years old) to be used for the estimation of the baseline recycling actdivity, with the activity of the economic operator consisting of the increase of the recycling capacity above this level

LS_f not smaller than 0 g CO_2e/MJ

Until additional requirements and guidance have been developed to resolve concerns regarding double counting for CEF, after the subtraction of credits, the total LS_f value cannot be smaller than 0 g CO_2e/MJ.

8.1 Methodology for the calculation of landfill emissions credits

LEC

Sustainable aviation fuels produced from MSW feedstocks may generate an avoided 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;
- 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. $W_{paper/textiles}$ = 0.4 dry ton per dry ton of MSW).

DOC

Step 2 – Select the degradable organic carbon content (DOC) and the fraction of carbon dissimilated (DOC_F) values from table 1 that best represent each waste category (j) in the MSW. Use weighted averages to generate DOC and DOC_F values that accurately represent each of the four waste categories of the MSW feedstock of interest.

Table 1: DOC and DOC_F

Material	DOC (% of dry matter)	DOC_F (%)
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%

Methane correction factor

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

Table 2: Methane correction factor (MCF)

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

Total CH_4 generation

Step 4 – Use Equation 1 below to calculate total CH_4 generation, Q, from each waste category, j, per dry ton of diverted MSW.

Equation 1: Total CH_4 generation from waste category j, per dry ton of diverted MSW [g CH_4 / t dry diverted MSW]

$$Q_j = W_j * DOC_j * DOC_{F\_j} * F * MCF * (16/12) * 10^6$$

Where:

Q_j = total CH_4 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 = degradable organic carbon content from table 1 [%]

DOC_F = fraction of degradable organic carbon dissimilated from table 1 [%]

F = CH_4 concentration in LFG, 50%

MCF = Methane correction factor from table 2

16/12 = CH_4 to carbon ratio

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

Lifetime LFG collection efficiency

Step 5 – Select the lifetime LFG 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 LFG is not collected, use a value of 0%. Note that in this case, it would be inappropriate to also select an MCF value of 1.0 which corresponds to an anaerobic managed solid waste disposal site.

Table 3: Landfill gas collection efficiency (LFGCE)

Climate zone		Boreal and temperate (MAT ≤ 20°C)						Tropical (MAT > 20°C)					
		Dry (MAP/PET < 1)			Wet (MAP/PET > 1)			Dry (MAP < 1000 mm)			Moist and wet (MAP > 1000 mm)		
LFG collection Waste category, j		Active[a]	Moderate[b]	Minimal[c]	Active[a]	Moderate[b]	Minimal[c]	Active[a]	Moderate[b]	Minimal[c]	Active[a]	Moderate[b]	Minimal[c]
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.

[a] *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.*

[b] *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.*

[c] *Minimal: LFG is not collected during waste acceptance, but vertical collectors are used once cells are capped.*

Oxidation rate

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.

Non-captured CH_4

Step 7 – Calculate non-captured CH_4 emissions, CH_4^n, per dry ton of diverted MSW using Equation2. Note that Q_j and $LFGCE_j$ are defined for each waste category, j.

Equation 2: Non-captured CH_4 emissions (CH_4^n) [g CH_4 / t dry MSW]

$$CH_4^n = \sum_j \left[Q_j * \left(1 - LFGCE_j\right) * (1 - oxidation\ rate)\right]$$

Biogenic CO_2

Step 8 – Calculate biogenic CO_2 in non-captured CH_4 emissions, CO_2^n, and biogenic CO_2 that remains as carbon in the landfill, CO_2^s, using Equation 3.

Equation 3: CO_2^n and CO_2^s [g CO_2e / t dry MSW]

$$CO_2^n = CH_4^n * \frac{44}{16}$$

$$CO_2^s = \sum_j \left[W_j * DOC * (1 - DOC_F) * (\frac{44}{12}) * 10^6\right]$$

Avoided electricity credit

Step 9 – In the case that the project of interest diverts MSW from a landfill where collected CH_4 is used for electricity generation instead of flaring, calculate the avoided electricity credit using Equation 4.

Equation 4: Avoided electricity credit [g CO_2e / t dry MSW]

$$\begin{aligned} &Avoided\ electricity\ credit \\ &\quad = LHV_{CH4} * \eta * CF * \left[\Sigma_j \left(Q_j * LFGCE_j\right)\right] * Cl_{elec} * 10^{-3} \end{aligned}$$

where:

LHV_{CH4}	= LHV of CH_4, 0.0139 MWh / kg
η	= 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_4 generation from waste category j from Equation 1 [g CO_2e / 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_2e/MWh]

10^{-3} = kilogram per gram conversion [kg / g]

Final LEC

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_2e/MJ) of MSW-derived SAF.

Equation 5: Final LEC calculation [g CO_2e/MJ]

$$LEC = \frac{CH_4^n * (GWP_{CH4}) - CO_2^n - CO_2^s - [avoided\ electricity\ credit]}{Y}$$

Where:

CH_4^n = non-captured CH_4 emissions [g CH_4 / t dry MSW]

GWP_{CH4} = 100-year global warming potential of CH_4, 28 g CO_2e / g CH_4

CO_2^n = Biogenic CO_2 in non-captured CH_4 emissions [g CO_2e / t dry MSW]

CO_2^s = Biogenic CO_2 that remains as carbon in the landfill [g CO2e / t dry MSW]

[avoided electricity credit]

= Emissions offset by replacing grid electricity with electricity from captured CH_4 [g CO_2e / 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 the landfill, before any additional sorting or recycling takes place.

8.2 Methodology for the calculation of recycling emissions credits

REC

Sustainable aviation fuels produced from MSW feedstocks may generate a 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 a total REC value. REC shall be calculated as follows:

8.2.1 Plastics

Energy factors

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

	Specific electricity consumption for virgin plastic production (SEC_{bl}) [MWh / t]	Specific fossil fuel consumption for the production of virgin plastic (SFC) [GJ / t]	Specific electricity consumption for plastic recycling (SEC_{rec}) [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

Emission factors

Step 1b – Select appropriate emission factors for electricity, and direct fossil fuels use, for virgin plastic 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) [gCO_2e / MWh].

CI_{ff} = carbon intensity of fossil fuel used in the virgin plastic production process [g CO_2e / 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_2e/MJ, respectively. Note that more regionally or context appropriate data should be substituted for the values given here, if available.

Avoided emissions

Step 1c – Estimate the emissions avoided by using recycled plastics to reduce virgin plastic production, per ton 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_2e / t dry MSW]

$$REC_{plastic} = \sum_{i} q_i * \left[L_i * \left(SEC_{bl,i} * CI_{elec} + SFC_i * Cl_{ff}\right) - \left(SEC_{rec,i} * CI_{elec}\right)\right]$$

Where:

q_i = quantity of plastic i recycled [t / dry t MSW]. This is on the basis of per ton 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]

$SEC_{rec,i}$ = specific electricity consumption for recycling of plastic i [MWh / t plastic]

SFC_i = specific fossil fuel consumption for virgin material production of plastic i [GJ / t plastic]

8.2.2 Metals

Energy factors

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

	Emissions factor for virgin metal production (CI) [gCO_2e / t]	Specific electricity consumption for metal recycling (SEC_{rec}) [GJ / t]
Aluminium	8.40×10^6	0.66
Steel	1.27×10^6	0.9

Emission factors

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) [gCO_2e / MWh].

Avoided emissions

Step 2c – Estimate the emissions avoided by using recycled metals to reduce virgin metal production, per ton 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 recycling metal [gCO_2e / t dry MSW]

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

Where:

q_i = quantity of metal i recycled [t/dry t MSW]. This is on the basis of per ton 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 [gCO_2e/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]

Sum of credits

Step 3 – Sum up emissions 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 [gCO₂e / MJ]

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

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.

9 Calculation methodology for GHG savings

GHG saving requirements

A minimum of 10 % GHG savings is required for CORSIA eligible fuels. CEF producers shall calculate the emissions savings of the produced CEF as follows:

Formula GHG savings for CEF producers

$$Emission\ savings = \left(1 - \frac{LS_f}{LC}\right)$$

Where:

LS_f = Life cycle emissions value of the CORSIA eligible fuel

LC = Baseline life cycle emissions; fixed value; 89 gCO_2e /MJ for jet fuels and 95 gCO_2e /MJ for AvGas

Fossil comparator

The baseline values with which the LSf is compared are 89 gCO2e/MJ for jet fuel and 95 gCO2e /MJ for aviation gasoline (AvGas).

Information on the life cycle emissions reductions of CEF is forwarded to aeroplane operators. To calculate the emissions reductions (ER_y) from CORSIA eligible fuels, the aeroplane operator shall use the following formula:[14]

Formula GHG savings for aeroplane operators

$$ER_y = FCF * \left[\sum_f MS_{f,y} * \left(1 - \frac{LS_f}{LC}\right)\right]$$

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[14] See also ICAO Standards and Recommended Practices, Annex 16, Volume IV, Part II, Chapter 3.3.

Where:

ER_y = Emissions reductions of the CORSIA eligible fuel

FCF = Fuel conversion factor, fixed value, 3.16 kg CO_2/kg fuel for Jet-A/Jet-A1 or 3.10 kg CO_2/kg fuel for AvGas/Jet B

$MS_{f,y}$ = Total mass (tons) of CORSIA eligible fuel claimed in the year y, by fuel type f

LS_f = Life cycle emissions value of the CORSIA eligible fuel

LC = Baseline life cycle emissions, fixed value, 89 gCO_2e /MJ for jet fuels and 95 gCO_2e /MJ for AvGas

Annex CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels

Fuel Conversion Process	Region	Fuel Feedstock	Pathway specifications	Core LCA Value	ILUC LCA Value	LS$_f$ (gCO$_2$e/ MJ)
Fischer-Tropsch (FT)	Global	Agricultural residues	Residue removal does not necessitate additional nutrient replacement on the primary crop	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
	Global			12.2	8.6	20.8
	USA	Miscanthus (herbaceous energy crops)		10.4	-32.9	-22.5
	EU			10.4	-22.0	-11.6
	Global			10.4	-12.6	-2.2
	USA	Switchgrass (herbaceous energy crops)		10.4	-3.8	6.6
	Global			10.4	-5.3	15.7

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	Oil from dry mill ethanol plant	17.2		17.2
	Malaysia and Indonesia	Palm Oil	At the oil extraction step, at least 85% of the biogas released from the POME treated in anaerobic ponds is captured and oxidized	37.4	39.1	76.5
		Palm Oil	At the oil extraction step, less than 85% of the biogas released from the POME treated in anaerobic ponds is captured and oxidized	60.0	39.1	99.1
	Brazil	Brassica carinata oil	Feedstock is grown as a secondary crop that avoids other crops displacement	34.4	-20.4	14.0
	USA			34.4	-21.4	13.0
	Global			34.4	-12.7	21.7
	USA	Soybean oil		40.4	24.5	64.9
	Brazil			40.4	27.0	67.4
	Global			40.4	25.8	66.2
	EU	Rapeseed oil		47.4	24.1	71.5
	Global			47.4	24.1	71.5
	Global	Camelina oil	Feedstock is grown as a secondary crop that avoids other crops displacement	42.0	-13.4	28.6
	India	Jatropha oil	Meal used as fertilizer or electricity input	46.9	-24.8	22.1
		Jatropha oil	Meal used as animal feed after detoxification	46.8	-48.1	-1.3

Alcohol (isobutanol) to jet (ATJ)	Global	Agricultural residues	Residue removal does not necessitate additional nutrient replacement on the primary crop.	29.3	0.0	29.3
	Global	Forestry residues		23.8		23.8
	Brazil	Sugarcane	Standalone or integrated conversion design	24.0	7.3	31.3
	Global			24.0	9.1	33.1
	USA	Corn grain	Standalone or integrated conversion design	55.8	22.1	77.9
	Global			55.8	29.7	85.5
	USA	Miscanthus (herbaceous energy crops)		43.4	-54.1	-10.7
	EU			43.4	-31.0	12.4
	Global			43.4	-14.5	28.9
	USA	Switchgrass		43.4	-14.5	28.9
	Global			43.4	5.4	48.8
	Brazil	Molasses		27.0	7.3	34.3
	Global			27.0	9.1	36.1

Alcohol (ethanol) to jet (ETJ)	Brazil	Sugarcane	Integrated conversion design	24.1	8.7	32.8
	Global			24.1	8.5	32.6
	USA	Corn grain	Standalone or integrated conversion design	65.7	25.1	90.8
	Global			65.7	34.9	100.6
	Global	Agricultural residues	Standalone conversion design Residue removal does not necessitate additional nutrient replacement on the primary crop.	39.7	0.0	39.7
		Agricultural residues	Integrated conversion design Residue removal does not necessitate additional nutrient replacement on the primary crop.	24.6		24.6
	Global	Forestry residues	Standalone conversion design	40.0	0.0	40.0
		Forestry residues	Integrated conversion design	24.9		24.9
	USA	Miscanthus	Standalone conversion design	43.3	-42.6	0.7
	EU			43.3	-23.3	20
	Global			43.3	-19.0	24.3
	USA	Miscanthus	Integrated conversion design	28.3	-42.6	-14.3
	EU			28.3	-23.3	5.0
	Global			28.3	-19.0	9.3
	USA	Switchgrass	Standalone conversion design	43.9	-10.7	33.2
	Global			43.9	4.8	48.7
	USA	Switchgrass	Integrated conversion design	28.9	-10.7	18.2
	Global			28.9	4.8	33.7
	Global	Waste gases	Standalone conversion design	42.4	0.0	42.4
		Waste gases	Integrated conversion deisgn	29.4		29.4

Synthesized isoparaffins (SIP)	Brazil	Sugarcane		32.8	11.3	44.1
	Global			32.8	11.1	43.9
	EU	Sugar beet		32.4	20.2	52.6
	Global			32.4	11.2	43.6

Hydroprocessed esters and fatty acids (HEFA) **Co-processing**	Global	Tallow	Maximum of 5% of tallow in volume Feedstock inserted at either the hydrotreater (HDT) or hydrocracker (HYK) points	27.2	0.0	27.2
	Global	UCO	Maximum of 5% of used cooking oil in volume Feedstock inserted at either the hydrotreater (HDT) or hydrocracker (HYK) points	16.7	0.0	16.7
	USA	Soybean oil	Maximum of 5% of soybean oil in volume Feedstock inserted at either the hydrotreater (HDT) or hydrocracker (HYK) points	40.7	24.5	65.2
	Brazil			40.7	27.0	67.7
	Global			40.7	25.8	66.5

Important: Please note that the values shown in this annex are from 2023. While ISCC takes care to regularly update these values following amendments by ICAO, it is the responsibility of economic operators and auditors to make sure they use the latest version of default values available. If in doubt please check the official ICAO document on default values