DRAFT VERSION

Ref. nr. NTA 8080-3:2024-0X en

Will partly replace NTA 8080-1:2015 and NTA 8080-2:2015

Netherlands Technical Agreement

NTA 8080-3

Duurzaamheidskader voor biomassa — Deel 3: Eisen aan en richtlijnen voor broeikasgasberekeningen

Sustainability framework for biomass — Part 3: Requirements and guidance for greenhouse gas calculations

ICS 03.100.50; 13.020.20; 27.190; 71.100.99; 75.160; 83.140.99

MMM 2024

Cover blz. 2

Contents

Foreword

Please Note: This is a draft version, for information purposes only!

Sustainability framework for biomass — Part 3: Requirements and guidance for greenhouse gas calculations

1 Scope

This document describes the requirements and provides guidance for greenhouse gas calculations to determine the greenhouse gas performance by using biomass compared to fossil-based raw materials for the same application considering the entire lifecycle. This document addresses both the calculations to be made at organizational level and the information to be transferred throughout the supply chain to enable calculating the net greenhouse gas emission saving across the entire supply chain.

NOTE 1 The calculation of greenhouse gas emission savings in accordance with this document conform to the greenhouse gas calculations as laid down in Directive (EU) 2018/2001. NTA 8080-2:2024, 5.1.1 defines the minimum net greenhouse gas emissions saving relative to fossil reference system for application in bioenergy to comply with legal requirements to qualify for energy from renewable sources as laid down in this Directive.

This document is applicable to following types of organizations that wish or are required to calculate the greenhouse gas performance when use biomass for energy:

— ‘producer’: organization that produces agricultural biomass or collects biobased residues and waste to be used for energy, for which four sub-types are distinguished:

1) ‘primary producer’;

2) ‘smallholder’;

3) ‘collector of primary residues and waste’;

4) ‘collector of non-primary residues and waste’;

— ‘processor’: organization that processes biomass and or intermediates / semi-finished products for further use in the supply chain;

— ‘trader’: organization that buys and sells (processed) biomass without modifying the materials;

— ‘end user’: organization that valorises (processed) biomass for application in energy.

The operations of an organization can include more than one type.

NOTE 2 An organization that only transports produced and or processed biomass, but does not own this material, is not included in the scope of this document.

NOTE 3 NTA 8080-1:2024 provides more information about the different types of organizations.

This document can also be applied for greenhouse gas calculations when biomass is used in products, acknowledging that supply chains might be more complex to determine the system boundaries.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NTA 8080-1:2024, *Sustainability framework for biomass — Part 1: Terminology, overview and general requirements*

NTA 8080-2:2024, *Sustainability framework for biomass — Part 2: Sustainability requirements*

NTA 8080-4:2024, *Sustainability framework for biomass — Part 4: Chain-of-custody requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions in NTA 8080-1:2024 apply.

4 Principles

4.1 One of the sustainability aspects with respect to the use of biomass concerns the greenhouse gas emissions as described in NTA 8080-2:2024. The use of biomass as substitute for fossil-based raw materials intends to reduce the emission of greenhouse gases across the entire supply chain. Shifting from fossil-based to biomass implies changes in the supply chain with respect to sourcing, processing and logistics and subsequently to the greenhouse gas emissions for which each organization in the supply can be accounted. The greenhouse gas emission performance can either improve or worsen at organizational level, but intends to result in a net greenhouse gas emissions saving across the entire supply chain under consideration.

4.2 When biomass is used for energy (e.g. biofuel, biogas, bioliquid and biomass fuel), the net greenhouse gas emissions saving relative to the fossil-based reference system is required to meet a minimum percentage in order to be qualified as energy from renewable sources, provided that also other sustainability requirements are met. The minimum net greenhouse gas emissions saving depending on application is described in NTA 8080-2:2024, 5.1.1 reproduces these minimum net greenhouse gas emissions saving relative to fossil reference system for application in bioenergy.

The minimum net greenhouse gas emissions saving relative to fossil reference system for application in transport, electricity, heating or cooling are:

— at least 50% for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations in operation on or before 5 October 2015

— at least 60% for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 6 October 2015 until 31 December 2020

— at least 65% for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 1 January 2021

— at least 70% for electricity, heating and cooling production from biomass fuels used in installations starting operation from 1 January 2021 until 31 December 2025, and 80% for installations starting operation from 1 January 2026

— An installation is considered to be in operation once the physical production of fuel, heat or cooling, or electricity has started (i.e. once the production of fuels including biofuels, biogas or bioliquids, or production of heat, cooling or electricity from biomass fuels has started).

5 Greenhouse gas calculations for biofuels and bioliquids

5.1 Greenhouse gas emissions from the production and use of biofuels shall be calculated in accordance with Formula (1):

$$E = e_{ec} + e_{l} + e_{p} + e_{td} + e_{u} - e_{sca} - e_{ccs} - e_{ccr} \quad (1)$$

where

- E is the total emission from the use of the fuel;
- e_{ec} is the emission from the extraction or cultivation of raw materials;
- e_{l} is the annualised emission from carbon stock changes caused by land-use change;
- e_{p} is the emission from processing;
- e_{td} is the emissions from transport and distribution;
- e_{u} is the emissions from the fuel in use;
- e_{sca} is the emission saving from soil carbon accumulation via improved agricultural management;
- e_{ccs} is the emission saving from CO_2 capture and geological storage;
- e_{cru} is the emission saving from CO_2 capture and replacement.

Emissions from the manufacture of machinery and equipment shall not be taken into account.

Greenhouse gas emissions from biofuels, E, shall be expressed in terms of grams of CO_2 equivalent per MJ of fuel, gCO_{2eq}/MJ.

5.2 Greenhouse gas emissions from the production and use of bioliquids shall be calculated as for biofuels (see 5.1) with the extension necessary for including the energy conversion to electricity and/or heat and cooling produced, as follows:

a) For energy installations delivering only heat, the extension shall be calculated in accordance with Formula (2):

$$EC_{h} = \frac{E}{\eta_{h}} \quad (2)$$

b) For energy installations delivering only electricity, the extension shall be calculated in accordance with Formula (3):

$$EC_{el} = \frac{E}{\eta_{el}} \quad (3)$$

c) For the electricity or mechanical energy coming from energy installations delivering useful heat together with electricity and/or mechanical energy, the extension shall be calculated in accordance with Formula (4):

$$EC_{el} = \frac{E}{\eta_{el}} \left(\frac{C_{el} \cdot \eta_{el}}{C_{el} \cdot \eta_{el} + C_{h} \cdot \eta_{h}} \right) \quad (4)$$

d) For the useful heat coming from energy installations delivering heat together with electricity and/or mechanical energy, the extension shall be calculated in accordance with Formula (5):

$$EC_{el} = \frac{E}{\eta_h}\left(\frac{C_h \cdot \eta_h}{C_{el} \cdot \eta_{el} + C_h \cdot \eta_h}\right) \quad (5)$$

where

EC_h is total greenhouse gas emissions from the heat output;

EC_{el} is the total greenhouse gas emissions from the electricity produced;

E is the total greenhouse gas emissions of the bioliquid before end-conversion;

η_{el} is the electrical efficiency, defined as the annual electricity produced divided by the annual bioliquid input based on its energy content;

η_h is the heat efficiency, defined as the annual useful heat output divided by the annual bioliquid input based on its energy content;

C_{el} is the fraction of exergy in the electricity and/or mechanical energy, set to 100 % (C_{el} = 1);

C_h is the Carnot efficiency, i.e. fraction of exergy in the useful heat.

Greenhouse gas emissions from bioliquids, EC, shall be expressed in terms of grams of CO_2 equivalent per MJ of final energy commodity (heat or electricity), gCO_{2eq}/MJ.

5.3 The Carnot efficiency as used in Formulas (4) and (5) shall be calculated in accordance with Formula (6):

$$C_h = \frac{T_h - T_0}{T_h} \quad (6)$$

where

T_h is the temperature, measured in absolute temperature (kelvin) of the useful heat at point of delivery;

T_0 is the temperature of surroundings, set at 273,15 kelvin (equal to 0 °C).

If the excess heat is exported for heating of buildings, at a temperature below 150 °C (423,15 kelvin), C_h can alternatively be defined as Carnot efficiency, C_h, in heat at 150 °C (423,15 kelvin), which is 0,354 6.

5.4 When heating and cooling are co-generated with electricity, emissions shall be allocated between heat and electricity (see 5.2), irrespective if the heat is used for actual heating purposes or for cooling.

NOTE Heat or waste heat is used to generate cooling (chilled air or water) through absorption chillers. Therefore, it is appropriate to calculate only the emissions associated to the heat produced per MJ of heat, irrespectively if the end-use of the heat is actual heating or cooling via absorption chillers.

5.5 Where the greenhouse gas emissions from the extraction or cultivation of raw materials, e_{ec}, are expressed in unit gCO_{2eq}/dry-ton of raw material, the conversion to grams of CO_2 equivalent per MJ of fuel, gCO_{2eq}/MJ, shall be in accordance with Formula (7):

$$e_{ec}fuel_a = \frac{e_{ec}raw\ material_a}{LHV_a} \times fuel\ feedstock\ factor_a \times allocation\ factor\ fuel_a \qquad (7)$$

where

$e_{ec}raw\ material_a = \frac{e_{ec}raw\ material_a}{(1-moisture\ content)}$ expressed in gCO_{2eq} per dry-ton raw material;

LHV_a is the lower heating value;

$fuel\ feedstock\ factor_a$ is the ratio of MJ raw material required to make 1 MJ fuel;

$allocation\ factor\ fuel_a = \frac{energy\ in\ fuel}{(energy\ in\ fuel+energy\ in\ coproducts)}$.

NOTE Formula (7) describes cases where raw material is converted into biofuels in one step. For more complex supply chains, adjustments are needed for calculating greenhouse gas emissions from the extraction or cultivation of raw materials, e_{ec}, for intermediate products.

5.6 Greenhouse gas emissions savings from biofuels shall be calculated in accordance with Formula (8):

$$SAVING = \frac{E_{F(t)} - E_B}{E_{F(t)}} \qquad (8)$$

where

$E_{F(t)}$ is the total emission from the fossil fuel comparator for transport, being 94 gCO_{2eq}/MJ;

E_B is the total emission form the biofuel.

5.7 Greenhouse gas emissions savings from heat and cooling, and electricity being generated from bioliquids shall be calculated in accordance with Formula (9):

$$SAVING = \frac{EC_{F(h\&c,el)} - EC_{B(h\&c,el)}}{EC_{F(h\&c,el)}} \qquad (9)$$

where

$EC_{F(h\&c,el)}$ is the total emission from the fossil fuel comparator for useful heat or electricity, being 80 gCO_{2eq}/MJ and 183 g CO_{2eq}/MJ respectively;

$EC_{B(h\&c,el)}$ is the total emission form the heat or electricity.

5.8 The following greenhouse gases shall be taken into account for the purposes of 5.1 and 5.2 including the values for calculating CO_2 equivalences:

— CO_2;

— N_2O, in which 1 g N_2O equals 298 g CO_2;

— CH_4, in which 1 g CH_4 equals 25 g CO_2.

NOTE The values used for calculating CO_2 equivalences are also known as the global warming potentials (GWP).

5.9 Concerning e_{ec}, emissions shall include emissions from the extraction or cultivation process itself; from the collection, drying and storage of raw materials; from waste and leakages; and from the production of chemicals or products used in extraction or cultivation. Capture of CO_2 in the cultivation of raw materials shall be excluded.

In accordance with Article 31(4) of Directive (EU) 2018/2001 (REDII), the Commission may by means of implementing acts decide that respective reports from EU Member States or third countries, submitted in accordance with Article 31 paragraphs 2 and 3 contain accurate data for the purposes of measuring the greenhouse gas emissions associated with the cultivation of agriculture biomass feedstock produced in the areas included in such reports for the purposes of Article 29(10). Therefore, only respective values that have been subject to such implementing acts can be used by economic operator and respectively by certifications schemes. In case no such values exist, economic operators in the respective areas can always use either the existing disaggregated default values in Annex V of REDII (and listed in Annex A of this document) or actual values, calculated in line with the methodology in part C of the same annex.

NOTE: The NUTS2 table is no longer available at the EC website since the values that can be used under REDII need to follow the assessment process as defined in REDII and be legally validated by a decision of the Commission. Currently only one such decision is available, for Argentina. Several EU Member States have submitted reports under RED II and they are under assessment. Once more decisions are available, the EC intends to create a respective section on typical GHG emissions values from NUTS2 and equivalent regions that can be used under REDII.

5.10 Concerning e_{sca}, greenhouse gas emission savings from improved agriculture management shall not be taken into account under the Better Biomass certification scheme.

Where applicable, the e_{sca} bonus for improved agricultural and manure management shall be attributed in the case animal manure is used as a substrate for the production of biogas and biomethane, as specified in 6.2 and 6.3.

5.11 Concerning e_l, annual emissions from carbon stock changes caused by land-use change shall be calculated by dividing total emissions equally over 20 years in accordance with Formula (10):

$$e_l = (CS_R - CS_A) \times 3{,}664 \times {}^{1}/_{20} \times {}^{1}/_{P} - e_B \qquad (10)$$

where

CS_R is the carbon stock per unit area associated with the reference land-use (measured as mass (tonnes) of carbon per unit area, including both soil and vegetation), in which the reference land-use is the land-use in January 2008 or 20 years before the raw material was obtained, whichever was the later;

CS_A is the carbon stock per unit area associated with the actual land-use (measured as mass (tonnes) of carbon per unit area, including both soil and vegetation), in which in cases where the carbon stock accumulates over more than one year, the value attributed to CS_A is the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever the earlier;

P is the productivity of the crop (measured as biofuel or bioliquid energy per unit area per year);

e_B is the bonus of 29 gCO_{2eq}/MJ biofuel or bioliquid if biomass is obtained from restored degraded land if evidence is provided that the land: (a) was not in use for agriculture or any other activity in January 2008; and (b) is severely degraded land, including such land that was formerly in agricultural use; this bonus applies for a period of up to 20 years from the date of conversion of the land to agricultural use, provided that a steady increase in carbon stocks as well as a sizable reduction in erosion phenomena for land falling under (b) are ensured.

NOTE 1 The quotient obtained by dividing the molecular weight of CO_2 (44,010 g/mol) by the molecular weight of carbon (12,011 g/mol) is equal to 3,664.

When calculating e_l, cropland and perennial cropland shall be regarded as one land use.

NOTE 2 Cropland is defined by the Intergovernmental Panel on Climate Change (IPCC). Perennial crops are defined as multi-annual crops, the stem of which is usually not annually harvested, such as short rotation coppice and oil palm.

NOTE 3 Commission Decision 2010/335/EU, which provides guidelines for the calculation of land carbon stocks in relation to RED recast, shall serve as the basis for the calculation of land carbon stocks.

5.12 Concerning e_p, emissions from processing shall include emissions from the processing itself; from waste and leakages; and from the production of chemicals or products used in processing including the CO_2 emissions corresponding to the carbon contents of fossil inputs, whether or not actually combusted in the process.

In accounting for the consumption of electricity not produced within the fuel production plant, the greenhouse gas emissions intensity of the production and distribution of that electricity shall be assumed to be equal to the average emission intensity of the production and distribution of electricity in a defined region, which can be at a NUTS2 region (if available and recognized by the European Commission) or a national level. By way of derogation from this requirement, an organization may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid.

Emissions from processing shall include emissions from drying of interim products and materials where relevant.

5.13 Concerning e_{td}, emissions from transport and distribution shall include emissions from the transport of raw materials and semi-finished materials and from the storage and distribution of finished materials (including emissions from filling stations and depots). Emissions from transport and distribution to be taken into account for in e_{ec} shall not be included in e_{td}.

Note: The emissions of depots and filling stations may be calculated using the data provided by the JRC. The provided values (depot: 0.00084 MJ/MJ fuel, filling station: 0.0034 MJ/MJ fuel) must be multiplied by the appropriate national electricity emission factors from the Commission implementing regulation (EC) 2022/996. [1]

5.14 Concerning e_u, emissions of the fuel in use shall be taken to be zero for biofuels and bioliquids.

Emissions of non-CO_2 greenhouse gases (i.e. N_2O and CH_4) of the fuel in use shall be included in the e_u factor for bioliquids.

5.15 Concerning e_{ccs}, emission savings from CO_2 capture and geological storage that have not already been accounted for in e_p, shall be limited to emissions avoided through the capture and storage

[1] European Commission, Joint Research Centre, Padella, M., O'Connell, A., Giuntoli, J. et al., Definition of input data to assess GHG default emissions from biofuels in EU legislation – Version 1d – 2019, Publications Office, 2019, https://data.europa.eu/doi/10.2760/69179

of emitted CO_2 directly related to the extraction, transport, processing and distribution of fuel if stored in compliance with Directive 2009/31/EC.

5.16 Concerning e_{ccr}, emission savings from CO_2 capture and replacement shall be related directly to the production of biofuel or bioliquid they are attributed to, and shall be limited to emissions avoided through the capture of CO_2 of which the carbon originates from biomass and which is used to replace fossil-derived CO_2 in production of commercial products and services.

5.17 Where a cogeneration unit – providing heat and/or electricity to a fuel production process for which emissions are being calculated – produces excess electricity and/or excess useful heat, the greenhouse gas emissions shall be divided between the electricity and the useful heat according to the temperature of the heat, which reflects the usefulness (utility) of the heat.

The useful part of the heat is found by multiplying its energy content with the Carnot efficiency, C_h, in accordance with 5.3. For the purposes of this calculation, the actual efficiencies shall be used, defined as the annual mechanical energy, electricity and heat produced respectively divided by the annual energy input.

NOTE: For ‘cogeneration’ and ‘economically justifiable demand’ the definitions specified in NTA 8080-1 shall apply.

5.18 Where a fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (co-products), greenhouse gas emissions shall be divided between the fuel or its intermediate product and the co-products in proportion to their energy content (determined by lower heating value in the case of co-products other than electricity and heat). The greenhouse gas intensity of excess useful heat or excess electricity is the same as the greenhouse gas intensity of heat or electricity delivered to the fuel production process and is determined from calculating the greenhouse intensity of all inputs and emissions, including the raw material and CH_4 and N_2O emissions, to and from the cogeneration unit, boiler or other apparatus delivering heat or electricity to the fuel production process. In the case of cogeneration of electricity and heat, Formula (6) shall be applied.

NOTE: For ‘useful heat’, the definition specified in NTA 8080-1 shall apply.

5.19 For the purposes of the aforementioned calculation, the emissions to be divided shall be e_{ec} + e_l + e_{sca} plus those fractions of e_p, e_{td}, e_{ccs}, and e_{ccr} that take place up to and including the process step at which a co-product is produced. If any allocation to co-products has taken place at an earlier process step in the lifecycle, the fraction of those emissions assigned in the last such process step to the intermediate fuel product shall be used for those purposes instead of the total of those emissions.

In the case of biofuels and bioliquids, all co-products shall be taken into account for the purposes of that calculation. No emissions shall be allocated to wastes and residues. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purposes of the calculation.

Wastes and residues, including tree tops and branches, straw, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined) and bagasse, shall be considered to have zero lifecycle greenhouse gas emissions up to the process of collection of those materials irrespectively of whether they are processed to interim products before being transformed into the final product.

In the case of fuels produced in refineries, other than the combination of processing plants with boilers or cogeneration units providing heat and/or electricity to the processing plant, the unit of analysis for the purposes of the aforementioned calculation shall be the refinery.

5.20 Transmission of greenhouse gas information through the chain of custody

All information which is relevant for establishing compliance with the sustainability criteria shall be transmitted through the chain of custody. This includes information on greenhouse gas emissions. The following describes what kind of information shall be submitted and which units shall be used.

In order to establish whether the minimum greenhouse gas emissions savings have been achieved, greenhouse gas emissions from bioenergy production are compared to the relevant fossil fuel comparator. Greenhouse gas emissions are measured in this context in the unit gCO_{2eq}/MJ of bioenergy. Final bioenergy greenhouse gas emissions shall always be reported in this unit.

The situation is different for raw materials and intermediate products. In case actual values are calculated for raw materials and intermediate products, primary biomass producers (e.g. farmers) cannot report cultivation greenhouse gas emissions in the unit gCO_{2eq}/MJ of bioenergy, because this would require knowing how efficiently these are converted into final bioenergy. Instead, for raw materials and intermediate products, information on greenhouse gas emissions shall be provided in the unit gCO_{2eq}/dry-ton raw material or gCO_{2eq}/dry-ton intermediate product, respectively.

To receive information on emissions per dry-ton raw material, Formula (B.1) shall be applied:

$$e_{ec}\text{raw material}_a \left[\frac{\text{g CO}_{2eq}}{\text{kg}_{dry}}\right] = \frac{e_{ec}\text{raw material}_a \left[\frac{\text{g CO}_{2eq}}{\text{kg}_{moist}}\right]}{\text{(1-moisture content)}} \quad \text{(B.1)}$$

The moisture content should be the value measured after delivery, or, if this is not known, the maximum value allowed by the delivery contract.

Information on greenhouse gas emissions shall include accurate data on all relevant elements of the emission calculation formula. When default values are used, information on greenhouse gas emissions should be only reported for final bioenergy and can be reported as an aggregate value. When actual values are calculated, it is necessary to split the total amount of emissions into all elements of the greenhouse gas emission calculation formula that are relevant. This applies also to the elements of the formula, which are not included in the default values such as e_l, e_{sca}, e_{ccr}, and e_{ccs}.

NOTE 1 This measure is required to ensure transparency and robustness of the calculation of actual greenhouse gas emissions. If only aggregated values were used, it would not be sufficiently transparent which elements of the greenhouse gas emission calculation formula are comprised in the transmitted value. This would be in particular problematic at later stages of the chain of custody when it still could be decided to use disaggregated default values of individual elements of greenhouse gas emissions calculation formula.

Application of the feedstock factor when using actual values

A feedstock factor shall be applied to all emissions to take the mass losses occurred into account. A feedstock factor shall be applied at every processing step but may also be relevant at other steps where mass losses occur (e.g. storage). This means that all GHG emissions that are linked with the incoming feedstock (upstream emissions from e_{sca}, e_l, e_p and e_{td}) shall be adjusted to the respective intermediate product using the feedstock factor.

The feedstock factor shall be calculated in accordance with Formula (11):

Feedstock factor = feedstock (kg_{dry}) / intermediate product (kg_{dry}) (11)

Where 'feedstock' is the input material of the processing step considered, and 'intermediate product' is the output material of the processing step considered. The calculation of the feedstock factor shall be based on actual plant data.

After application of the feedstock factor to the upstream emissions, the additional emissions occurring at the recipient (i.e. the supply chain operator where the feedstock factor is calculated) shall be included.

N.B. For the application of the feedstock factor the LHV values per dry tonne need to be applied while for the calculation of the allocation factor LHV values for wet biomass need to be used as this approach was also applied for the calculation of the default values.

In case actual values are not used, information on the amount of greenhouse gas emissions should not be transmitted through the chain of custody (before the last processing step), as it would be difficult to know at later stages of the chain of custody whether these emissions represent actual values or are derived from (disaggregated) default values. Furthermore, it would unnecessarily increase the administrative burden. Therefore, it is the responsibility of downstream organizations to include information concerning the (disaggregated) default greenhouse gas emission values for the final bioenergy when reporting to the Member States.

NOTE 2 In principle, only organizations operating within the framework of Directive (EU) 2018/2001 have this reporting requirement to the Member States.

6 Greenhouse gas calculations for biomass fuels

6.1 Greenhouse gas emissions from the production and use of biomass fuels before conversion into electricity, heating and cooling shall be calculated in accordance with Formula (11):

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} \quad (11)$$

where

E is the total emission from the production of the fuel before energy conversion;

e_{ec} is the emission from the extraction or cultivation of raw materials;

e_l is the annualised emission from carbon stock changes caused by land-use change;

e_p is the emission from processing;

e_{td} is the emissions from transport and distribution;

e_u is the emissions from the fuel in use;

e_{sca} is the emission saving from soil carbon accumulation via improved agricultural management;

e_{ccs} is the emission saving from CO_2 capture and geological storage;

e_{cru} is the emission saving from CO_2 capture and replacement.

Emissions from the manufacture of machinery and equipment shall not be taken into account.

Greenhouse gas emissions from biomass fuels, *E*, shall be expressed in terms of grams of CO_2 equivalent per MJ of biomass fuel, gCO_{2eq}/MJ.

6.2 In the case of co-digestion of different substrates in a biogas plant for the production of biogas or biomethane, the typical and default values of greenhouse gas emissions shall be calculated in accordance with Formula (12):

$$E = \sum_1^n S_n \cdot E_n \qquad (12)$$

where

E is the greenhouse gas emissions per MJ biogas or biomethane produced from co-digestion of the defined mixture of substrates;

S_n is the share of raw material n in energy content;

E_n is the emission in g CO_2/MJ for pathway n as provided in Part D of Directive (EU) 2018/2001, Annex VI.

NOTE 1 For 'wet manure' with a minimum moisture content of 90 % used as substrate, a bonus of 45 g CO_{2eq}/MJ manure (– 54 kg CO_{2eq}/t fresh matter) is added for improved agricultural and manure management.

NOTE 2 The greenhouse gas emissions of the defined mixture of substrates shall be calculated as a sum (i.e. a single value) for the whole amount of the biogas or biomethane, resulting from co-digestion, taking into account the relative shares of the respective inputs and their emission factors.

The aforementioned share of raw material n in energy content, S_n, shall be calculated in accordance with Formula (13):

$$S_n = \frac{P_n \cdot W_n}{\sum_1^n P_n \cdot W_n} \qquad (13)$$

where

P_n is the energy yield [MJ] per kilogram of wet input of raw material n;

NOTE 2 The following values of P_n apply for calculating typical and default values:

P(maize): 4,16 $[MJ_{biogas}$/kg wet maize @ 65 % moisture];

P(manure): 0,50 $[MJ_{biogas}$/kg wet manure @ 90 % moisture];

P(biowaste) 3,41 $[MJ_{biogas}$/kg wet biowaste @ 76 % moisture].

W_n is the weighting factor of substrate n.

The aforementioned weighting factor of substrate n, W_n, shall be calculated in accordance with Formula (14):

$$W_n = \frac{I_n}{\sum_1^n I_n} \cdot \left(\frac{1-AM_n}{1-SM_n}\right) \tag{14}$$

where

I_n is the annual input to digester of substrate n [tonne of fresh matter];

AM_n is the average annual moisture of substrate n [kg water/kg fresh matter];

SM_n is the standard moisture for substrate n.

NOTE 3 The following values of the standard moisture for substrate SM_n apply:

SM(maize): 0,65 [kg water/kg fresh matter];

SM(manure): 0,90 [kg water/kg fresh matter];

SM(biowaste): 0,76 [kg water/kg fresh matter].

6.3 The total emission factor of the biomass fuels resulting from a co-digestion of different substrates shall be calculated as a sum and taking into account on the share of the respective inputs and their emission factors. Therefore, the GHG value needs to be calculated as a single value for the whole amount of the biogas/ biomethane, resulting from the co-digestion (following REDII Annex VI. Part B. point 1 (b) and (c)). In the case of co-digestion of n substrates in a biogas plant for the production of electricity or biomethane, actual greenhouse gas emissions of biogas and biomethane shall be calculated in accordance with Formula (15):

$$E = \sum_1^n S_n \cdot \left(e_{ec,n} + e_{td,rm,n} + e_{l,n} - e_{sca,n}\right) + e_p + e_{td,p} + e_u - e_{ccs} - e_{ccr} \tag{15}$$

where

E is the total emission from the production of the biogas or biomethane before energy conversion;

S_n is the share of raw material n, in fraction of input to the digester;

$e_{ec,n}$ is the emission from the extraction or cultivation of raw material n;

$e_{td,rm,n}$ is the emissions from transport of raw material n to the digester;

$e_{l,n}$ is the annualised emission from carbon stock changes caused by land-use change for raw material n;

e_{sca} is the emission saving from improved agricultural management of raw material n;

NOTE For e_{sca} a bonus of 45 g CO_{2eq}/MJ manure shall be attributed for improved agricultural and manure management in the case animal manure is used as a substrate for the production of biogas and biomethane.

e_p is the emission from processing;

$e_{td,p}$ is the emission from transport and distribution of biogas and/or biomethane;

e_u is the emission from the fuel in use, that is greenhouse gases emitted during combustion;

e_{ccs} is the emission saving from CO_2 capture and geological storage;

e_{ccr} is the emission saving from CO_2 capture and replacement.

6.4 Greenhouse gas emissions from biomass fuels in producing electricity, heating and cooling, including the energy conversion to electricity and/or heat or cooling produced shall be calculated as follows:

a) For energy installations delivering only heat, Formula (16) shall be applied:

$$EC_h = \frac{E}{\eta_h} \tag{16}$$

b) For energy installations delivering only electricity, Formula (17) shall be applied:

$$EC_{el} = \frac{E}{\eta_{el}} \tag{17}$$

c) For the electricity or mechanical energy coming from energy installations delivering useful heat together with electricity and/or mechanical energy, Formula (18) shall be applied:

$$EC_{el} = \frac{E}{\eta_{el}} \left(\frac{C_{el} \cdot \eta_{el}}{C_{el} \cdot \eta_{el} + C_h \cdot \eta_h} \right) \tag{18}$$

d) For the useful heat coming from energy installations delivering heat together with electricity and/or mechanical energy, Formula (19) shall be applied:

$$EC_{el} = \frac{E}{\eta_h} \left(\frac{C_h \cdot \eta_h}{C_{el} \cdot \eta_{el} + C_h \cdot \eta_h} \right) \tag{19}$$

where

EC_h is total greenhouse gas emissions from the heat output;

EC_{el} is the total greenhouse gas emissions from the electricity produced;

E is the total greenhouse gas emissions of the fuel before end-conversion;

η_{el} is the electrical efficiency, defined as the annual electricity produced divided by the annual fuel input based on its energy content;

η_h is the heat efficiency, defined as the annual useful heat output divided by the annual fuel input based on its energy content;

C_{el} is the fraction of exergy in the electricity and/or mechanical energy, set to 100 % (C_{el} = 1);

C_h is the Carnot efficiency, i.e. fraction of exergy in the useful heat.

Greenhouse gas emissions from heating or electricity, produced from biomass fuels, *EC*, shall be expressed in terms of grams of CO_2 equivalent per MJ of final energy commodity (heat or electricity), gCO_{2eq}/MJ.

6.5 The Carnot efficiency as used in Formulas (18) and (19) shall be calculated in accordance with Formula (20):

$$C_h = \frac{T_h - T_0}{T_h} \quad (20)$$

where

T_h is the temperature, measured in absolute temperature (kelvin) of the useful heat at point of delivery;

T_0 is the temperature of surroundings, set at 273,15 kelvin (equal to 0 °C).

If the excess heat is exported for heating of buildings, at a temperature below 150 °C (423,15 kelvin), C_h can alternatively be defined as Carnot efficiency, C_h, in heat at 150 °C (423,15 kelvin), which is 0,354 6.

6.6 When heating and cooling are co-generated with electricity, emissions shall be allocated between heat and electricity (see 6.4), irrespective if the heat is used for actual heating purposes or for cooling.

NOTE Heat or waste heat is used to generate cooling (chilled air or water) through absorption chillers. Therefore, it is appropriate to calculate only the emissions associated to the heat produced per MJ of heat, irrespectively if the end-use of the heat is actual heating or cooling via absorption chillers.

6.7 Where the greenhouse gas emissions from the extraction or cultivation of raw materials, e_{ec}, are expressed in unit gCO_{2eq}/dry-ton of raw material, the conversion to grams of CO_2 equivalent per MJ of fuel, gCO_{2eq}/MJ, shall be in accordance with Formula (21):

$$e_{ec}fuel_a = \frac{e_{ec}raw\ material_a}{LHV_a} \times fuel\ feedstock\ factor_a \times allocation\ factor\ fuel_a \quad (21)$$

where

$e_{ec}raw\ material_a = \frac{e_{ec}raw\ material_a}{(1 - moisture\ content)}$ expressed in gCO_{2eq} per dry-ton raw material;

LHV_a is the lower heating value;

$fuel\ feedstock\ factor_a$ is the ratio of MJ raw material required to make 1 MJ fuel;

$allocation\ factor\ fuel_a = \frac{energy\ in\ fuel}{(energy\ in\ fuel + energy\ in\ coproducts)}$.

6.8 Greenhouse gas emissions savings from biomass fuels used as transport fuels shall be calculated in accordance with Formula (22):

$$SAVING = \frac{E_{F(t)} - E_B}{E_{F(t)}} \quad (22)$$

where

$E_{F(t)}$ is the total emission from the fossil fuel comparator for transport, being 94 gCO_{2eq}/MJ;

E_B is the total emission form biomass fuels used as transport fuels.

6.9 Greenhouse gas emissions savings from heat and cooling, and electricity being generated from biomass fuels shall be calculated in accordance with Formula (23):

$$SAVING = \frac{EC_{F(h\&c,el)} - EC_{B(h\&c,el)}}{EC_{F(h\&c,el)}} \quad (23)$$

where

$EC_{F(h\&c,el)}$ is the total emission from the fossil fuel comparator for useful heat or electricity, being 80 gCO_{2eq}/MJ or if direct physical substitution of coal can be demonstrated 124 gCO_{2eq}/MJ for heat, and 183 g CO_{2eq}/MJ or in case of outermost regions 212 gCO_{2eq}/MJ for electricity;

$EC_{B(h\&c,el)}$ is the total emission form the heat or electricity.

6.10 The following greenhouse gases shall be taken into account for the purposes of 5.1 and 5.2 including the values for calculating CO_2 equivalences:

— CO_2;

— N_2O, in which 1 g N_2O equals 298 g CO_2;

— CH_4, in which 1 g CH_4 equals 25 g CO_2.

NOTE The values used for calculating CO_2 equivalences are also known as the global warming potentials (GWP).

6.11 Concerning e_{ec}, emissions shall include emissions from the extraction or cultivation process itself; from the collection, drying and storage of raw materials; from waste and leakages; and from the production of chemicals or products used in extraction or cultivation. Capture of CO_2 in the cultivation of raw materials shall be excluded.

In accordance with Article 31(4) of Directive (EU) 2018/2001 (REDII), the Commission may by means of implementing acts decide that respective reports from EU Member States or third countries, submitted in accordance with Article 31 paragraphs 2 and 3 contain accurate data for the purposes of measuring the greenhouse gas emissions associated with the cultivation of agriculture biomass feedstock produced in the areas included in such reports for the purposes of Article 29(10). Therefore, only respective values that have been subject to such implementing acts can be used by economic operator and respectively by certifications schemes. In case no such values exist, economic operators in the respective areas can always use either the existing disaggregated default values in Annex V of REDII (and listed in Annex A of this document) or actual values, calculated in line with the methodology in part C of the same annex.

Estimates of emissions from cultivation and harvesting of forestry biomass may be derived from the use of averages for cultivation and harvesting emissions calculated for geographical areas at national level, as an alternative to using actual values.

NOTE 1: The NUTS2 table is no longer available at the EC website since the values that can be used under REDII need to follow the assessment process as defined in REDII and be legally validated by a decision of the Commission. Currently only one such decision is available, for Argentina. Several EU Member States have submitted reports under RED II and they are under assessment. Once more decisions are available, the EC intends to create a respective section on typical GHG emissions values from NUTS2 and equivalent regions that can be used under REDII.

6.12 Concerning e_{sca}, greenhouse gas emission savings from improved agriculture management shall not be taken into account under the Better Biomass certification scheme.

Where applicable, the e_{sca} bonus for improved agricultural and manure management shall be attributed in the case animal manure is used as a substrate for the production of biogas and biomethane, as specified in 6.2 and 6.3.

6.13 Concerning e_l, annual emissions from carbon stock changes caused by land-use change shall be calculated by dividing total emissions equally over 20 years in accordance with Formula (24):

$$e_l = (CS_R - CS_A) \times 3{,}664 \times {}^{1}/_{20} \times {}^{1}/_{P} - e_B \qquad (24)$$

where

CS_R is the carbon stock per unit area associated with the reference land-use (measured as mass (tonnes) of carbon per unit area, including both soil and vegetation), in which the reference land-use is the land-use in January 2008 or 20 years before the raw material was obtained, whichever was the later;

CS_A is the carbon stock per unit area associated with the actual land-use (measured as mass (tonnes) of carbon per unit area, including both soil and vegetation), in which in cases where the carbon stock accumulates over more than one year, the value attributed to CS_A is the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever the earlier;

P is the productivity of the crop (measured as biofuel or bioliquid energy per unit area per year);

e_B is the bonus of 29 gCO_{2eq}/MJ biofuel or bioliquid if biomass is obtained from restored degraded land if evidence is provided that the land: (a) was not in use for agriculture or any other activity in January 2008; and (b) is severely degraded land, including such land that was formerly in agricultural use; this bonus applies for a period of up to 20 years from the date of conversion of the land to agricultural use, provided that a steady increase in carbon stocks as well as a sizable reduction in erosion phenomena for land falling under (b) are ensured.

NOTE 1 The quotient obtained by dividing the molecular weight of CO_2 (44,010 g/mol) by the molecular weight of carbon (12,011 g/mol) is equal to 3,664.

When calculating e_l, cropland and perennial cropland shall be regarded as one land use.

NOTE 2 Cropland is defined by the Intergovernmental Panel on Climate Change (IPCC). Perennial crops are defined as multi-annual crops, the stem of which is usually not annually harvested, such as short rotation coppice and oil palm.

NOTE 3 Commission Decision 2010/335/EU, which provides guidelines for the calculation of land carbon stocks in relation to RED recast, shall serve as the basis for the calculation of land carbon stocks.

6.14 Concerning e_p, emissions from processing shall include emissions from the processing itself; from waste and leakages; and from the production of chemicals or products used in processing including the CO_2 emissions corresponding to the carbon contents of fossil inputs, whether or not actually combusted in the process.

In accounting for the consumption of electricity not produced within the solid or gaseous biomass fuel production plant, the greenhouse gas emissions intensity of the production and distribution of that electricity shall be assumed to be equal to the average emission intensity of the production and distribution of electricity in a defined region, which can be at a NUTS2 region (if available and recognized by the European Commission) or a national level. By way of derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid.

Emissions from processing shall include emissions from drying of interim products and materials where relevant.

Note 1: For liquefied NG or biomethane, in JEC Well-to-Tank report v5, there are available calculations for both the options of liquefaction for sea transport and at the refueling station. Please note that these figures may be reviewed upwards as a result of the upcoming update of Annexes V and VI of RED II in order to take fully into account the real fugitive emissions. The assumed process for methane liquefaction is described for example in the “CBM” Excel sheet, in any xxLGx pathway (for example OWLG1 in cell B83). If no actual data is available, the electricity and LPG consumption (OWLG1, cell E69 and E70) can be used and multiplied by their emission factors. For the electricity emission factors, the values from Annex IX the IR on sustainability certification can be used. See: https://publications.jrc.ec.europa.eu/repository/handle/JRC119036

6.15 Concerning e_{td}, emissions from transport and distribution shall include emissions from the transport of raw materials and semi-finished materials and from the storage and distribution of finished materials (including emissions from depots and filling stations). Emissions from transport and distribution to be taken into account for in e_{ec} shall not be included in e_{td}.

Note 1: The emissions of depots and filling stations may be calculated using the data provided by the JRC. The provided values (depot: 0.00084 MJ/MJ fuel, filling station: 0.0034 MJ/MJ fuel) must be multiplied by the appropriate national electricity emission factors from the Implementing Regulation. [2]

Note 2: For gas grid losses, the 2019 report[3] which contains the calculations to obtain the default values in RED II contains an emission factor of 0.17 g CH4/MJ NG supplied.

6.16 Concerning e_u, emissions of the fuel in use shall be taken to be zero for biomass fuels.

Emissions of non-CO_2 greenhouse gases (i.e. N_2O and CH_4) of the fuel in use shall be included in the e_u factor.

6.17 Concerning e_{ccs}, emission savings from CO_2 capture and geological storage that have not already been accounted for in e_p, shall be limited to emissions avoided through the capture and storage of emitted CO_2 directly related to the extraction, transport, processing and distribution of fuel if stored in compliance with Directive 2009/31/EC.

6.18 Concerning e_{ccr}, emission savings from CO_2 capture and replacement shall be related directly to the production of biomass fuel they are attributed to, and shall be limited to emissions avoided through the capture of CO_2 of which the carbon originates from biomass and which is used to replace fossil-derived CO_2 in production of commercial products and services.

[2] European Commission, Joint Research Centre, Padella, M., O'Connell, A., Giuntoli, J. et al., Definition of input data to assess GHG default emissions from biofuels in EU legislation – Version 1d – 2019, Publications Office, 2019, https://data.europa.eu/doi/10.2760/69179

[3] Definition of input data to assess GHG default emissions from biofuels in EU legislation - Publications Office of the EU (europa.eu)

6.19 Where a cogeneration unit – providing heat and/or electricity to a biomass fuel production process for which emissions are being calculated – produces excess electricity and/or excess useful heat, the greenhouse gas emissions shall be divided between the electricity and the useful heat according to the temperature of the heat, which reflects the usefulness (utility) of the heat.

The useful part of the heat is found by multiplying its energy content with the Carnot efficiency, C_h, in accordance with 6.5. For the purposes of this calculation, the actual efficiencies shall be used, defined as the annual mechanical energy, electricity and heat produced respectively divided by the annual energy input.

6.20 Where a biomass fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (co-products), greenhouse gas emissions shall be divided between the fuel or its intermediate product and the co-products in proportion to their energy content (determined by lower heating value in the case of co-products other than electricity and heat). The greenhouse gas intensity of excess useful heat or excess electricity is the same as the greenhouse gas intensity of heat or electricity delivered to the biomass fuel production process and is determined from calculating the greenhouse intensity of all inputs and emissions, including the raw material and CH_4 and N_2O emissions, to and from the cogeneration unit, boiler or other apparatus delivering heat or electricity to the biomass fuel production process. In the case of cogeneration of electricity and heat, Formula (20) shall be applied.

6.21 For the purposes of the aforementioned calculation, the emissions to be divided shall be e_{ec} + e_l + e_{sca} plus those fractions of e_p, e_{td}, e_{ccs}, and e_{ccr} that take place up to and including the process step at which a co-product is produced. If any allocation to co-products has taken place at an earlier process step in the lifecycle, the fraction of those emissions assigned in the last such process step to the intermediate fuel product shall be used for those purposes instead of the total of those emissions.

In the case of biogas and biomethane, all co-products that are not covered in the calculation of e_l shall be taken into account for the purposes of that calculation. No emissions shall be allocated to wastes and residues. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purposes of the calculation.

Wastes and residues, including tree tops and branches, straw, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined) and bagasse, shall be considered to have zero lifecycle greenhouse gas emissions up to the process of collection of those materials irrespectively of whether they are processed to interim products before being transformed into the final product.

In the case of biomass fuels produced in refineries, other than the combination of processing plants with boilers or cogeneration units providing heat and/or electricity to the processing plant, the unit of analysis for the purposes of the aforementioned calculation shall be the refinery.

6.22 Transmission of greenhouse gas information through the chain of custody

All information which is relevant for establishing compliance with the sustainability criteria shall be transmitted through the chain of custody. This includes information on greenhouse gas emissions. The following describes what kind of information shall be submitted and which units shall be used.

In order to establish whether the minimum greenhouse gas emissions savings have been achieved, greenhouse gas emissions from bioenergy production are compared to the relevant fossil fuel comparator. Greenhouse gas emissions are measured in this context in the unit gCO_{2eq}/MJ of bioenergy. Final bioenergy greenhouse gas emissions shall always be reported in this unit.

The situation is different for raw materials and intermediate products. In case actual values are calculated for raw materials and intermediate products, primary biomass producers (e.g. farmers) cannot report cultivation greenhouse gas emissions in the unit gCO_{2eq}/MJ of bioenergy, because this would require knowing how efficiently these are converted into final bioenergy. Instead, for raw materials and intermediate products, information on greenhouse gas emissions shall be provided in the unit gCO_{2eq}/dry-ton raw material or gCO_{2eq}/dry-ton intermediate product, respectively.

To receive information on emissions per dry-ton raw material, Formula (B.1) shall be applied:

$$e_{ec}\text{raw material}_a\left[\frac{\text{g CO}_{2eq}}{\text{kg}_{dry}}\right]=\frac{e_{ec}\text{raw material}_a\left[\frac{\text{g CO}_{2eq}}{\text{kg}_{moist}}\right]}{(1\text{-moisture content})} \tag{B.1}$$

The moisture content should be the value measured after delivery, or, if this is not known, the maximum value allowed by the delivery contract.

Information on greenhouse gas emissions shall include accurate data on all relevant elements of the emission calculation formula. When default values are used, information on greenhouse gas emissions should be only reported for final bioenergy and can be reported as an aggregate value. When actual values are calculated, it is necessary to split the total amount of emissions into all elements of the greenhouse gas emission calculation formula that are relevant. This applies also to the elements of the formula, which are not included in the default values such as e_l, e_{sca}, e_{ccr}, and e_{ccs}.

NOTE 1 This measure is required to ensure transparency and robustness of the calculation of actual greenhouse gas emissions. If only aggregated values were used, it would not be sufficiently transparent which elements of the greenhouse gas emission calculation formula are comprised in the transmitted value. This would be in particular problematic at later stages of the chain of custody when it still could be decided to use disaggregated default values of individual elements of greenhouse gas emissions calculation formula.

Application of the feedstock factor when using actual values

A feedstock factor shall be applied to all emissions to take the mass losses occurred into account. A feedstock factor shall be applied at every processing step but may also be relevant at other steps where mass losses occur (e.g. storage). This means that all GHG emissions that are linked with the incoming feedstock (upstream emissions from e_{sca}, e_l, e_p and e_{td}) shall be adjusted to the respective intermediate product using the feedstock factor.

The feedstock factor shall be calculated in accordance with Formula (11):

Feedstock factor = feedstock (kg$_{dry}$) / intermediate product (kg$_{dry}$) (11)

Where 'feedstock' is the input material of the processing step considered, and 'intermediate product' is the output material of the processing step considered. The calculation of the feedstock factor shall be based on actual plant data.

After application of the feedstock factor to the upstream emissions, the additional emissions occurring at the recipient (i.e. the supply chain operator where the feedstock factor is calculated) shall be included.

N.B. For the application of the feedstock factor the LHV values per dry tonne need to be applied while for the calculation of the allocation factor LHV values for wet biomass need to be used as this approach was also applied for the calculation of the default values.

In case actual values are not used, information on the amount of greenhouse gas emissions should not be transmitted through the chain of custody (before the last processing step), as it would be difficult to know at later stages of the chain of custody whether these emissions represent actual values or are derived from (disaggregated) default values. Furthermore, it would unnecessarily increase the administrative burden. Therefore, it is the responsibility of downstream organizations to include information concerning the (disaggregated) default greenhouse gas emission values for the final bioenergy when reporting to the Member States.

NOTE 2 In principle, only organizations operating within the framework of Directive (EU) 2018/2001 have this reporting requirement to the Member States.

7 Use of default values, actual values and disaggregated default values

7.1 Default values

7.1.1 If the activities of the organization are related to biofuels or bioliquids, the default values as included in Directive (EU) 2018/2001, Annex V (parts A and B) may be used, if the process technology and raw material used for the production of the biofuel or bioliquid match their description and scope.

7.1.2 If the activities of the organization are related to biomass fuels, the default values as included in Directive (EU) 2018/2001, Annex VI (part A) may be used, if the process technology and raw material used for the production of the biomass fuel match their description, scope and transportation distance.

7.1.3 In the case biomethane is used as compressed biomethane as a transport fuel, a value of 4,6 g CO_{2eq}/MJ biomethane shall be added to the default values included in Directive (EU) 2018/2001, Annex VI (part A).

7.1.4 Any change in the default values as included in Annexes V and VI of Directive (EU) 2018/2001 will become effective on the date as communicated by the European Commission and shall be applied from that moment.

NOTE Annex V of Directive (EU) 2018/2001 contains the rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators. Annex VI of Directive (EU) 2018/2001 contains the rules for calculating the greenhouse gas impact of biomass fuels and their fossil fuel comparators. The European Commission published on 25 September 2020 a Corrigendum to Directive (EU) 2018/2001 including changes in the default values as included in Annexes V and VI of Directive (EU) 2018/2001.

7.1.5 In case specific technologies are set out, the default values may only be used if those technologies were actually applied. The organization shall demonstrate the effectiveness of each technology applied to justify the use of default values (e.g. data, technical specifications, efficiency measurements).

7.1.6 With respect to calculating e_l in accordance with Clause 5 or Clause 6, default values may only be used if the value is equal to or less than zero.

7.2 Actual values

7.2.1 The organization can be required or can decide to use actual values. When actual values are used, the organization shall be able to demonstrate that it is capable to conduct the greenhouse calculation according to the methodology described in Clause 5 or Clause 6, depending on its activities. When demonstrating legal compliance, the organization may only make claims about greenhouse gas emissions based on actual values after the capability to conduct actual value calculations has been verified by the certification body as part of the audit, normally the initial audit. In the case the organization decides to use actual values after obtaining certification, the certification body shall also first verify the capability to conduct actual value calculations during the surveillance audit or additional audit.

7.2.2 Actual values can only be calculated when all relevant information is available and transmitted throughout the chain of custody. This means that the following conditions shall be met:

a) actual values of emissions from cultivation, e_{ec}, can only be determined at the origin of the chain of custody;

b) actual values of emissions from transport, e_{td}, can only be determined if emissions of all transport steps are documented and transmitted throughout the chain of custody;

c) actual values of emissions from processing, e_{p}, can only be determined if emissions of all processing steps are recorded and transmitted throughout the chain of custody.

NOTE See also NTA 8080-4:2024, 5.2.5 and Annex B about greenhouse gas emission intensity and use of actual values throughout the chain of custody.

7.2.3 Relevant information for the calculation based on actual values can consist of:

— data gathered at the production location (see 7.2.3.1);

— data obtained from databases and literature (see 7.2.3.2).

7.2.3.1 Data gathered at the production location relate to measurable values based on actual operations (e.g. consumption of fuel, electricity, heat, fertilizers, chemicals; production volumes of primary product(s) and residual flows; transport distances and mode of transportation). Data shall cover a 12-month period reflecting the annual cycle of operations. The organization shall document the data used including the source (e.g. metering, transaction notes, purchasing orders), and the reference area and the time period to which the data relate.

In the case an organization is a start-up with no access to actual data, the organization may use data which are part of the business case ('design data'). Once the organization has access to actual data, it shall make a comparison with the design data and amend the calculation if deviations are identified, subject to verification by the certification body when demonstrating legal compliance.

7.2.3.2 Data from databases and literature should be obtained from recognized sources like national or European governmental bodies (e.g. regulatory documents, list of standard emission factors and lower heating values statistical data) and peer-reviewed scientific journals. The organization shall document the data used including the source, and the reference area and the time period to which the data relate. The data used shall be representative for the operations of the organization taking into account the geographical location. The data obtained from databases and literature shall be based on the most recent publications. The organization shall periodically update the data following new publications.

7.2.4 Standard calculation values published in Annex IX of the Implementing Regulation 2022/996 shall be applied whenever available.

NOTE The list of standard calculation values can be subject to changes resulting from technological progress, new scientific evidence or changes to the legal framework.

7.2.5 Whenever actual values are calculated at each step of the chain of custody, the additional emissions from transport and/or processing shall be added to e_p and/or e_{td}, respectively. Whenever a processing step yields co-products, emissions shall be allocated as set out in Clause 5 or Clause 6.

7.2.6 Formula (25) shall be applied to e_{ec} when processing intermediate products:

$$e_{ec} intermediate\ product_a = e_{ec} raw\ material_a \times raw\ material\ factor_a \times allocation\ factor\ intermediate\ product_a \quad (25)$$

where

$e_{ec} raw\ material_a = \frac{e_{ec} raw\ material_a}{(1 - moisture\ content)}$ expressed in gCO_{2eq} per dry-ton raw material;

$raw\ material\ factor_a$ is the ratio of kg dry raw material required to make 1 kg dry intermediate product;

$allocation\ factor\ intermediate\ product_a = \frac{energy\ in\ intermediate\ product_a}{(energy\ in\ intermediate\ products + energy\ in\ coproducts)}$.

At the last processing step, the emission estimate shall be converted into the unit gCO_{2eq}/MJ of final fuel in accordance with Formula (26):

$$e_{ec} fuel_a = \frac{e_{ec} raw\ material_a}{LHV_a} \times fuel\ raw\ material\ factor_a \times allocation\ factor\ fuel_a \quad (26)$$

where

$e_{ec} raw\ material_a = \frac{e_{ec} raw\ material_a}{(1 - moisture\ content)}$ expressed in gCO_{2eq} per dry-ton raw material;

$fuel\ raw\ material\ factor_a$ is the ratio of MJ raw material required to make 1 MJ fuel;

$allocation\ factor\ fuel_a = \frac{energy\ in\ fuel}{(energy\ in\ fuel + energy\ in\ coproducts)}$.

The moisture content shall be the value measured after delivery. If this value is not known, the maximum value allowed by the delivery contract may be used.

7.2.7 Similarly, also the values for e_p, e_{td}, and e_l shall be adjusted. As mentioned in 7.2.4, in case of e_p and e_{td}, the emissions from the relevant processing step shall be added. For e_{ccr} and e_{ccs}, dedicated rules apply as described in 7.2.12. For the purpose of this calculation, raw material factors based on plant data shall be applied. LHV values per dry ton shall be applied for the calculation of the raw material factor, while LHV values for wet biomass shall be applied for the calculation of the allocation factor.

NOTE Concerning wet biomass, the 'wet definition LHV' is used for the purpose of allocation. This subtracts the energy needed to evaporate the water in the wet material from the LHV of the dry matter. Products with a negative energy content are treated at this point as having zero energy, and no allocation is made (see also Directive (EU) 2018/2001, Annex V, part C, point 18 and Annex VI, part B, point 18).

7.2.8 If actual values are used, Formula (27) shall be applied to calculate e_{ec}:

$$e_{ec} = \frac{EM_{fertilizer}+EM_{pesticides}+EM_{fuel}+EM_{electriciy}+EM_{N20}}{Y_{main\ raw\ material}} \tag{27}$$

where

EM is the emission (from fertilizer, pesticides, fuel, electricity and N_2O, respectively) expressed in $kgCO_{2eq}/(ha \times yr)$;

Y is the yield of dry matter content (of main raw material) expressed in kg/(ha × yr).

The emissions from fertilizer, pesticides, fuel and electricity shall be calculated in accordance with Formulas (28) to (31).

$$EM_{fertilizr} = V_{fertilzer} \times (Ef_{production\ fertilizer} + Ef_{field}) \tag{28}$$

$$EM_{pesticide} = V_{pesticide} \times Ef_{production\ pesticide} \tag{29}$$

$$EM_{fuel} = V_{fuel} \times Ef_{fuel} \tag{30}$$

$$EM_{electricity} = V_{electricity} \times Ef_{EU\ mix} \tag{31}$$

where

$V_{\text{fertilizer}}$ is the use of fertilizer expressed in kg/(ha × yr);

$Ef_{\text{production fertilizer}}$ is the emission factor of fertilizer production expressed in $kgCO_{2eq}$/kg fertilizer;

Ef_{field} is the emission factor of N_2O expressed in $kgCO_{2eq}$/kg N fertilizer;

$V_{\text{pesticide}}$ is the use of pesticide expressed in kg/(ha × yr);

$Ef_{\text{production pesticide}}$ is the emission factor of pesticide production expressed in $kgCO_{2eq}$/kg pesticide;

V_{fuel} is the use of fuel expressed in l/(ha × yr);

Ef_{fuel} is the emission factor of fuel expressed in $kgCO_{2eq}$/l;

$V_{\text{electricity}}$ is the use of electricity expressed in kWh/(ha × yr);

Ef_{EUmix} is the emission factor based on electricity mix in the European Union expressed in $kgCO_{2eq}$/kWh.

Concerning $EM_{\text{fertilizer}}$, N_2O field emissions shall be calculated for synthetic and organic nitrogen fertilizer and for crop residues left on the production location. The organization can make use of IPCC Guidelines for National Greenhouse Gas Inventories in which volume 4 addresses agriculture, forestry and other land use, or the Global Nitrous Oxide Calculator (GNOC) developed by the Joint Research Centre of the European Commission.

Concerning Ef_{EUmix}. it applies that in the case the processing facility is located outside the European Union, an emission factor shall be used that is representative for the region in which the processing facility is located. If electricity from renewable energies is directly consumed (i.e. not connected and supplied from the grid), an adapted emission factor for the type of renewable electricity may be used instead, under the condition that the plant is not connected to the electricity grid. In the case the electricity production plant is connected to the grid (e.g. a waste incineration plant), using the average emission value for electricity from that individual electricity production plant in the biofuel production process is permitted under the condition that it is guaranteed that there is a direct connection between the biofuel plant and the individual electricity production plant and that it is possible to validate the amount of electricity used with a suitable meter.

7.2.9 If actual values are used, Formula (32) shall be applied to calculate e_p:

$$e_p = \frac{EM_{electricity} + EM_{heat} + EM_{input\ production} + EM_{waste\ water}}{Y_{main\ product}} \quad (32)$$

where

EM is the emission (from electricity, heat, input production and wastewater, respectively) expressed in $kgCO_{2eq}$/yr;

Y is the yield of main product expressed in kg/yr.

The emissions from electricity, heat, input production and wastewater shall be calculated in accordance with to Formulas (33) to (36).

$$EM_{electricity} = V_{electricity} \times Ef_{EU\ mix} \quad (33)$$

$$EM_{heat} = V_{fuel} \times Ef_{fuel} \quad (34)$$

$$EM_{input\ production} = V_{input\ production} \times Ef_{input\ production} \quad (35)$$

$$EM_{waste\ water} = V_{waste\ water} \times Ef_{waste\ water} \quad (36)$$

where

$V_{electricity}$ is the use of electricity from externally providers expressed in kWh/yr;

Ef_{EUmix} is the emission factor based on electricity mix in the European Union expressed in $kgCO_{2eq}$/kWh;

V_{fuel} is the use of fuel for heat generation expressed in kg/yr;

Ef_{fuel} is the emission factor of fuel for heat generation expressed in $kgCO_{2eq}$/kg;

$V_{input\ production}$ is the quantity of chemicals or additional products used in processing expressed in kg/yr;

$Ef_{input\ production}$ is the emission factor of chemicals or additional products used in processing expressed in $kgCO_{2eq}$/kg;

$V_{waste\ water}$ is the quantity of wastewater expressed in l/yr;

$Ef_{waste\ water}$ is the emission factor of wastewater expressed in $kgCO_{2eq}$/l.

Formula (32) applies to a single processing step. For each processing step, the corresponding emissions shall be calculated according to Formula (32). The data used for calculating the emissions from a single processing step shall be measured or based on technical specifications of the processing facility. If the range of emissions for a group of processing facilities is known, the most conservative value for this group shall be used

Concerning Ef_{EUmix}. it applies that in the case the processing facility is located outside the European Union, an emission factor shall be used that is representative for the region in which the processing facility is located. If electricity from renewable energies is directly consumed (i.e. not connected and supplied from the grid), an adapted emission factor for the type of renewable electricity may be used instead, under the condition that the plant is not connected to the electricity grid. In the case the electricity production plant is connected to the grid (e.g. a waste incineration plant), using the average emission value for electricity from that individual electricity production plant in the biofuel production process is permitted under the condition that it is guaranteed that there is a direct connection between the biofuel plant and the individual electricity production plant and that it is possible to validate the amount of electricity used with a suitable meter.

7.2.10 If actual values are used, Formula (37) shall be applied to calculate e_{td}:

$$e_{td} = \frac{(d_{loaded} \times K_{loaded} + d_{unloaded} \times K_{unloaded}) \times Ef_{fuel}}{m} \quad (37)$$

where

d_{loaded} is the distance across the biofuel, bioliquid or biomass fuel is transported expressed in km;

K_{loaded} is the fuel efficiency of the loaded transport expressed in l/km;

$d_{unloaded}$ is the distance across the vehicle used for transporting the biofuel, bioliquid or biomass fuel was unloaded the expressed in km;

$K_{unloaded}$ is the fuel efficiency of the unloaded transport expressed in l/km;

Ef_{fuel} is the emission factor of fuel expressed in $kgCO_{2eq}/l$;

m is the measured mass of the transported biofuel, bioliquid or biomass fuel expressed in kg.

Formula (37) applies to a single transportation step. For each transportation step the corresponding emissions shall be calculated according to Formula (37).

If upstream transport is calculated, the actual greenhouse gas emissions shall be divided by the mass of dry matter content of the transported biofuel, bioliquid or biomass expressed in gCO_{2eq}/kg. The upstream transport emission shall be adapted by applying a raw material factor and an allocation factor.

The greenhouse gas emissions related to storage of biofuel, bioliquids and biomass fuels and, where applicable, the greenhouse gas emissions produced at fuelling stations shall be included as well.

7.2.11 If actual values are used, Formula (39) shall be applied to calculate e_{ccs} and Formula (40) shall be applied to calculate e_{ccr}:

$$e_{ccs} = \frac{V_{produced\ CO2} - V_{energy} \times Ef_{energy} - V_{auxiliary\ materials} \times Ef_{auxiliary\ materials}}{V_{main\ product} \times LHV} \times 1000 \quad (39)$$

$$e_{ccr} = \frac{V_{produced\ CO2} - V_{energy} \times Ef_{energy} - V_{auxiliary\ materials} \times Ef_{auxiliary\ materials}}{V_{main\ product} \times LHV} \times 1000 \quad (40)$$

where

$V_{produced\ CO2}$ is the amount of CO_2 produced (for replacement or geological storage) expressed in t;

V_{energy} is the amount of energy consumed in MWh;

Ef_{energy} is the emission factor of energy for CO_2 production expressed in tCO_{2eq}/MWh;

$V_{\text{auxiliary materials}}$ is the amount of auxiliary materials consumed in t;

$Ef_{\text{auxiliary materials}}$ is the emission factor of auxiliary materials expressed in tCO_{2eq}/t;

$V_{\text{main product}}$ is the amount of biofuel, bioliquid or biomass fuel produced expressed in t;

LHV is the lower heating value expressed in GJ/t.

For both e_{ccs} and e_{ccr}, the emission saved shall relate directly to the production of the bioenergy to which they are attributed. It would, for instance, not be justified to allocate arbitrarily different amounts of savings to bioenergy obtained from the same process, i.e. all bioenergy originating from the same process would need to be treated equally in this regard. If the CO_2 is not captured continuously, it might be appropriate to deviate from this approach and to attribute different amounts of savings to bioenergy obtained from the same process. However, in no case a higher amount of savings shall be allocated to a given batch of bioenergy than the average amount of CO_2 captured per MJ of bioenergy in a hypothetical process where the entire CO_2 stemming from the production process is captured. Capturing and processing of CO_2 has its own greenhouse gas emission footprint. Those emissions shall be taken into account in the calculation applying the appropriate emission factors for the energy consumed and the inputs used for capturing and processing of CO_2.

To verify that the capturing of CO_2 is used in commercial products and services to replace fossil-derived CO_2, the organization shall check that the CO_2 is sold to an organization from which it can be expected that this organization has an economical meaningful use for the CO_2. In order to ensure that e_{ccr} is limited to emissions avoided through the capture of CO_2 and to verify that fossil-derived CO_2 is replaced, the organization shall request the buyer to provide information how the CO_2 that is replaced was generated previously and to declare, in writing, that due to the replacement emissions are avoided.

NOTE Good examples for a replacement which can be expected to avoid CO_2 emissions are cases where the CO_2 that is replaced was previously produced in a dedicated process aiming at the production of CO_2, such as a CO_2 generator burning natural gas to produce CO_2 to stimulate the growth of vegetables in a greenhouse.

7.3 Disaggregated default values

7.3.1 If the activities of the organization are related to biofuels or bioliquids, the disaggregated default values as included in Directive (EU) 2018/2001, Annex V (parts D and E) may be used for the emission factors e_{ec}, e_p and e_{td} in Formula (1) in accordance with 5.9, 5.12 and 5.13.

7.3.2 If the activities of the organization are related to biomass fuels, the disaggregated default values as included in Directive (EU) 2018/2001, Annex VI (part C) may be used for the emission factors e_{ec}, e_p, e_{td} and e_u in Formula (11) in accordance with 6.11, 6.14, 6.15 and 6.16.

7.3.3 Any change in the disaggregated default values as included in Annexes V and VI of Directive (EU) 2018/2001 will become effective on the date as communicated by the European Commission and shall be applied from that moment.

NOTE Annex V of Directive (EU) 2018/2001 contains the rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators. Annex VI of Directive (EU) 2018/2001 contains the rules for calculating the greenhouse gas impact of biomass fuels and their fossil fuel comparators. The European Commission published on 25 September 2020 a Corrigendum to Directive (EU) 2018/2001 including changes in the disaggregated default values as included in Annexes V and VI of Directive (EU) 2018/2001.

7.3.4 For emissions from agricultural management, e_{ec} and e_l in Formulas (1) and (11), estimates of emissions may be used. If the organization uses estimates of emissions, the following provisions shall be taken into account:

a) the approach detailed in Annex VI of Implementing Regulation (EU) 2022/996 shall be followed.
b) The regional differences for emission factors shall be considered when using these data. Estimates of emissions from agriculture biomass cultivation may be derived from the use of regional averages for cultivation emissions included in the reports referred to in Article 31(4) of RED recast or the information on the disaggregated default values for cultivation emissions included in this Annex, as an alternative to using actual values. At this time, REDII NUTS2 (or equivalent) are available for Argentina.
   In the absence of relevant information in those reports it is allowed to calculate averages based on local farming practices based for instance on data of a group of farms, as an alternative to using actual values. This approach can only be applied for a group of farmers where the units have similar production systems and types of crops.
c) Emission factors should primarily be based on official statistical data from government bodies, if available and of good quality. If not available, statistical data published by independent bodies may be used. Alternatively, the emission factors may be based on scientifically peer-reviewed work, with the precondition that data used lies within the commonly accepted data range, if available.
d) The data used shall be based on the most recent available data from the sources mentioned under a) and b). Typically, the data should be updated over time, unless there is no significant variability of the data over time.
e) For fertilizer and pesticide use, the typical type and quantity of fertilizer used for the crop in the region concerned may be used. Emission factors for fertiliser and pesticide production and for fuel and electricity shall be taken from Annex IX of the implementing Regulation.

7.3.5 Concerning the NUTS-2 levels as referred to in 7.3.4, European member states or competent authorities of other countries may submit to the European Commission reports including data on typical emissions from cultivation of raw material. The organization may apply these values as an alternative to actual values, provided these values are available in the unit gCO_{2eq}/dry-ton of raw material on the website of the European Commission. The values included in the NUTS-2 reports do not represent disaggregated default values. Therefore, they can only be used as an input for the calculation of actual values, but cannot be used to report emissions from cultivation in the unit gCO_{2eq}/MJ of bioenergy.

NOTE The calculation of alternative averages for areas and crops which are covered by the NUTS-2 reports are not appropriate, as the appropriate averages have already been calculated by the national authorities.

Annex A
(normative)

Requirements and guidance for determining emissions from extraction or cultivation of raw materials

A.1 General

This annex specifies requirements for actual emissions calculations from extraction or cultivation of raw materials (e_{ec}).

A.2 Emissions from the extraction or cultivation process itself

A.2.1 General

The emissions from the extraction or cultivation process itself shall include all emissions from:

a) the provision of the fuels for farm machinery used (see A.2.2);

a) the production of seeding material for crop cultivation (see A.2.3);

b) the production of fertilizers and pesticides (see A.2.4);

c) fertilizer acidification and liming application (see A.2.5);

d) soil emissions from crop cultivation (see A.2.6).

A.2.2 Fuels use for farm machinery

A.2.2.1 The greenhouse gas emissions from crop cultivation (e.g. field preparation, seeding, fertilizer and pesticide application, harvesting, collection) shall include all emissions from the use of fuels in farm machinery, such as diesel oil, gasoline, heavy fuel oil, biofuels or other fuels. The amount of fuel use in farm machinery shall be duly documented.

A.2.2.2 Appropriate emission factors of the fuels shall be used in accordance with Annex IX of Commission implementing regulation (EU) 2022/996. Where biofuels are used, the default greenhouse gas emissions laid down in Annex V of Directive (EU) 2018/2001 shall be used.

A.2.3 Seeding material

A.2.3.1 The calculation of cultivation emissions from the production of seeding material for crop cultivation shall be based on actual data on the seeding material used.

A.2.3.2 Emission factors for the production and supply of seeding material can be used to account for emissions associated with the production of seeds. The standard values for emission factors set out in Annex IX of Commission implementing regulation (EU) 2022/996 shall be used. For seeds not listed in Annex IX, literature values from the following hierarchy shall be used:

a) version 5 of JEC-WTW report;

b) ECOINVENT database;

c) ‘official’ sources, such as Intergovernmental Panel on Climate Change (IPCC), International Energy Agency (IEA) or governments;

d) other reviewed sources of data, such as E3 database, GEMIS database;

e) peer-reviewed publications;

f) duly documented own estimates.

A.2.4 Chemical fertilizers and pesticides

A.2.4.1 The emissions from the use of chemical fertilizers and pesticides for the cultivation of raw materials shall include all related emissions from the manufacture of chemical fertilizers and pesticides. The amount of the chemical fertilisers and pesticides, depending on the crop, local conditions and farming practices, shall be duly documented.

NOTE Pesticides means all plant protection products, including herbicides, fungicides, etc.

A.2.4.2 Appropriate emission factors, including upstream emissions, shall be used to account for the emissions from the production of chemical fertilizers and pesticides in accordance with Annex IX of Commission implementing regulation (EU) 2022/996. If the organization knows the factory producing the fertilizer and this factory falls under the EU emissions trading system (ETS), then the organization can use the production emissions declared under ETS, adding the upstream emissions for natural gas. The If the organization does not know the factory producing the fertilizer, the organization should use the standard values provided for in Annex IX of Commission implementing regulation (EU) 2022/996. Transport of the fertilizers shall also be included, using the emissions from transport modes listed in Annex IX of Commission implementing regulation (EU) 2022/996.

A.2.5 Emissions from fertilizer acidification and liming application

A.2.5.1 The emissions from the neutralisation of fertiliser acidification and application of aglime shall account for the CO_2 emissions from neutralization of acidity from nitrogen fertilizers or from aglime reactions in the soil.

A.2.5.2 The emissions resulting from acidification caused by nitrogen fertilizer use in the field shall be accounted for in the emission calculation, based on the amount of nitrogen fertilizers used. The emissions from the neutralization of nitrogen fertilizers in the soil shall be 0,783 kg CO_2 per kg N for nitrate fertilizers and 0,806 kg CO_2 per kg N for urea fertilizers.

A.2.5.3 If aglime is applied to neutralize the acid from nitrogen fertilizers, the amount of aglime used shall be duly documented, The emissions shall be calculated as follows:

1. on acid soils, where pH is less than 6,4, aglime is dissolved by soil acids to form predominantly CO_2 rather than bicarbonate, releasing almost all of the CO_2 into the aglime (0,44 kg CO_2 per kg $CaCO_3$ equivalent aglime).

2. if soil pH is more than 6,4, an emission factor of 0,98/12,44 = 0,079 kg CO2/(kg CaCO3-equivalent) aglime applied shall be taken into account in the calculation, in addition to the emissions due to the neutralisation of acidification caused by the fertiliser.

3. The liming emissions calculated from actual lime use, calculated in points 1 and 2 above, may be greater than the fertilizer neutralization emissions calculated in A.2.5.2 if the fertilizer acidification was neutralized by the applied lime. In such a case, the fertilizer neutralization emissions (in

A.2.5.2) may be subtracted from the calculated liming emissions to avoid that its emissions are counted twice.

A.2.5.4 The emissions from fertilizer acidification may exceed those attributed to liming. In such a case, the subtraction would result in apparently negative net liming emissions because not all of the fertilizer-acidity is neutralized by aglime but also partly by naturally-occurring carbonates. In this case, the net liming emissions shall be counted zero, but the fertilizer- acidification emissions that occur anyway shall be maintained in line with section A.2.5.2.

A.2.5.5 If data on actual aglime use is not available, the aglime use recommended by the Agricultural Lime Association shall be assumed. This shall be a function of the type of crop, measured soil pH, soil type and type of liming material. The accompanying CO2 emissions shall be calculated using points 1 and 2 of A.2.5.3. However, the subtraction specified in point 3 of A.2.5.3 shall not be applied in this case, since the recommended use of aglime does not include aglime used to neutralize fertilizer applied in the same year, so there is no possible double counting of fertilizer neutralization emissions.:

A.2.5.5 When aglime is used to counter acidity from nitrogen fertilizers, the CO_2 emissions from acidification caused by the nitrogen fertilizer shall be subtracted from the estimates of emissions from liming. The remaining net emissions from liming shall represent the emissions from the agricultural lime that are used to counter naturally-occurring acidity in the soil.

A.2.6 Soil (nitrous oxide/N2O) emissions from crop cultivation

A.2.6.1 The calculation of N_2O emissions from managed soils shall follow the IPCC methodology. The use of disaggregated crop-specific emission factors for different environmental conditions, corresponding to Tier 2 of the IPCC methodology, shall be used to calculate the N_2O emissions resulting from crop cultivation.

A.2.6.2 Specific emission factors for different environmental conditions, soil conditions and different crops should be taken into account. Economic operators may use validated models to calculate those emission factors, provided that the models take these aspects into account. In line with the IPCC guidelines [ref], both direct and indirect N_2O emissions shall be taken into account. The GNOC tool [ref] shall be used, which is based on Formula (A.1), following the naming conventions in the IPCC guidelines:

$$N_2O_{total} - N = (N_2O_{direct} - N) + (N_2O_{indirect} - N) \qquad \text{(A.1)}$$

in which the part $(N_2O_{direct} - N)$ shall be calculated as follows:

— for mineral soils according to Formula (A.2):

$$(N_2O_{direct} - N) = [(F_{SN} + F_{ON}) \times EF_{1ij}] + [F_{CR} \times E_{F1}] \qquad \text{(A.2)}$$

— for organic soils according to Formula (A.3):

$$(N_2O_{direct} - N) = [(F_{SN} + F_{ON}) \times EF_1] + [F_{CR} \times E_{F1}] + [F_{OS,CG,Temp} \times EF_{2CG,Temp}] + [F_{CROS,CG,Trop} \times E_{2CG,Trop}] \qquad \text{(A.3)}$$

— for both mineral and organic soils according to Formula (A.4):

$$(N_2O_{direct} - N) = [((F_{SN} \times Frac_{GASF}) + (F_{ON} \times Erac_{GASM}) \times EF_4] + [(F_{SN} + F_{ON} + F_{CR}) \times Frac_{Leach-(H)} \times EF_5] \qquad \text{(A.4)}$$

in which crop residue N input shall be calculated for:

— sugar beet and sugar cane according to IPCC (2006) Vol. 4 Chapter 11, Equation 11.6, not considering belowground residues and with the addition of N input from vignasse and filter cake in the case of sugar cane, as presented in Formula (A.5):

$$F_{CR} = Yield \times DRY \times \left(1 - Frac_{Burnt} \times C_f\right) \times \left[R_{AG} \times N_{AG} \times (1 - Frac_{Remove})\right] + F_{VF} \quad \text{(A.5)}$$

— coconut and oil palm plantations applying a fixed N input based on literature as IPCC (2006) provides no default calculation method for standard emission factors in accordance with Annex IX of Commission implementing regulation (EU) 2022/996.;

— all other crops according to IPCC (2006) Vol. 4 Chapter 11, Equations 11.7a 11, 12, as presented in Formula (A.6):

$$F_{CR} = \left(1 - Frac_{Burnt} \times C_f\right) \times AG_{DM} \times N_{AG} \times (1 - Frac_{Remove}) + (AG_{DM} + Yield \times DRY) \times R_{BG-BIO} \times N_{BG} \quad \text{(A.6)}$$

where

N_2O_{total}–N is the direct and indirect annual N_2O–N emissions produced from managed soils, expressed in kg N_2O–N per ha per year;

N_2O_{direct}–N is the annual direct N_2O–N emissions produced from managed soils, expressed in kg N_2O–N per ha per year;

$N_2O_{indirect}$–N is the annual indirect N_2O–N emissions (i.e. the annual amount of N_2O–N produced from atmospheric deposition of N volatilized from managed soils and annual amount of N_2O–N produced from leaching and run-off of N additions to managed soils in regions where leaching/run-off occurs), expressed in kg N_2O–N per ha per year;

F_{SN} is the annual synthetic nitrogen fertilizer input, expressed in kg N per ha per year;

F_{ON} is the annual animal manure N applied as fertilizer, expressed in kg N per ha per year;

F_{CR} is the annual amount of N in crop residues (both aboveground and belowground), expressed in kg N per ha per year;

$F_{OS,CG,Temp}$ is the annual area of managed/drained organic soils under cropland in temperate climate, expressed in ha per year;

$F_{OS,CG,Trop}$ is the annual area of managed/drained organic soils under cropland in tropical climate, expressed in ha per year;

$Frac_{GASF}$ is 0,10 kg (N NH_3–N + NO_x–N) per kg N applied, concerning volatilization from synthetic fertilizer;

$Frac_{GASM}$ is 0,20 kg (N NH_3–N + NO_x–N) per kg N applied, concerning volatilization from all organic nitrogen fertilizers applied;

$Frac_{Leach-(H)}$ is 0,30 kg N per kg N additions, concerning N losses by leaching/run-off for regions where leaching/run-off occurs;

EF_{1ij} is the crop and site-specific emission factor for N_2O emissions from synthetic fertilizer and organic N application to mineral soils, expressed in kg N_2O–N per kg N input;

EF_1 is 0,01 kg (N_2O–N) per kg N input;

$EF_{2CG,Temp}$ is 8 kg N per ha per year for temperate organic crop and grassland soils;

$EF_{2CG,Trop}$ is 16 kg N per ha per year for tropical organic crop and grassland soils;

EF_4 is 0,01 kg (N_2O–N) per kg (N NH_3–N + NO_x–N volatilised);

EF_5 is 0,007 5 kg (N_2O–N) per kg (N leaching/run-off);

Yield is the annual fresh yield of the crop, expressed in kg per ha;

DRY is the dry matter fraction of harvested product, expressed in kg dry matter per kg fresh weight in accordance with Table A.1;

$Frac_{Burnt}$ is the fraction of crop area burnt annually, expressed in ha per ha;

C_f is the combustion factor in accordance with Table A.1;

R_{AG} is the ratio of aboveground residues, dry matter to harvested dry matter yield, for the crop, expressed in kg dry matter per kg dry matter in accordance with Table A.2;

N_{AG} is the N content of aboveground residues, expressed in kg N per kg dry matter in accordance with Table A.1;

$Frac_{Remove}$ is the fraction of aboveground residues removed from field, expressed in kg dry matter per kg AG_{DM};

F_{VF} is the annual amount of N in sugar cane vignasse and filter cake returned to the field, expressed in kg N per ha, and calculated as Yield × 0,000 508;

AG is the aboveground residue dry matter, expressed in kg dry matter per ha.

A.2.6.3 N_2O emissions from soils under agricultural use, in different agricultural fields under different environmental conditions and agricultural land use classes can be determined following the Stehfest and Bouwman statistical model [ref] (hereinafter referred to as 'the S&B model') per Formula (A.7):

$$E = \exp\,(-1{,}516 + \sum ev \qquad \text{(A.7)}$$

where

E is the N_2O emission, expressed in kg N_2O–N per ha per year;

ev is the effect value for different drivers in accordance with Table A.2;

The EF_{1ij} for the biofuel crop *i* at location *j* shall be calculated according to the S&B model per Formula (A.8):

$$EF_{1ij} = \frac{(E_{fert,ij} - E_{unfert,ij})}{N_{appl,ij}} \qquad \text{(A.8)}$$

where:

$E_{fert,ij}$ is the N_2O emission, expressed in kg N_2O–N per ha per year, based on the S&B model, where the fertilizer input is the actual N application rate (mineral fertiliser and manure) to the crop *i* at location *j*;

$E_{unfert,ij}$ is the N_2O emission of the crop *i* at location *j*, expressed in kg N_2O–N per ha per year, based on the S&B model, where the N application rate is set to 0 and all the other parameters are kept the same;

$N_{appl,ij}$ is the N input from mineral fertilizer and manure, expressed in kg N per ha per year, to the crop *i* at location *j*.

The IPCC (2006) factor EF_1 for direct N_2O emissions from fertilizer input based on a global mean shall be replaced by the crop- and site-specific EF_{1ij} for direct emissions from mineral fertiliser and manure N input, based on the crop- and site-specific EF_{1ij}, applying the S&B model.

Table A.1 — Crop-specific parameters to calculate N input from crop residues [a]

Crop	Calculation method	DRY	LHV	N_{AG}	Slope
Barley	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,865	17	0,007	0,98
Cassava	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,302	16,15	0,019	0,1
Coconuts	Fixed N from crop residues	0,94	32,07		
Cotton	No information on crop residues	0,91	22,64		
Maize	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,86	17,3	0,006	1,03
Oil palm fruit	Fixed N from crop residues	0,66	24		
Rapeseed	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,91	26,976	0,011	1,5
Rye	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,86	17,1	0,005	1,09
Safflower seed	No information on crop residues	0,91	25,9		
Sorghum (grain)	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,89	17,3	0,007	0,88
Soybeans	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,87	23	0,008	0,93
Sugar beets	IPCC (2006) Vol 4, Ch 11, Eq 11.6	0,25	16,3	0,004	
Sugar cane	IPCC (2006) Vol 4, Ch 11, Eq 11.6	0,275	19,6	0,004	
Sunflower seed	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,9	26,4	0,007	2,1
Triticale	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,86	16,9	0,006	1,09
Wheat	IPCC (2006) Vol 4, Ch 11, Eq 11.7a	0,84	17	0,006	1,51

Crop	Intercept	R_{BG_BIO}	N_{BG}	Cf	R_{AG}	N in crop residues [b]	Data sources
Barley	0,59	0,22	0,014	0,8			1, 2
Cassava	1,06	0,2	0,014	0,8			1,2
Coconuts						44	1, 3
Cotton							
Maize	0,61	0,22	0,007	0,8			1, 2
Oil palm fruit						159	1, 4
Rapeseed	0	0,19	0,017	0,8			1, 5
Rye	0,88	0,22	0,011	0,8			1, 6
Safflower seed							
Sorghum (grain)	1,33	0,22	0,006	0,8			1, 7
Soybeans	1,35	0,19	0,087	0,8			1, 8
Sugar beets				0,8	0,5		1, 9
Sugar cane				0,8	0,43		1, 10
Sunflower seed	0	0,22	0,007	0,8			1, 11
Triticale	0,88	0,22	0,009	0,8			1, 2
Wheat	0,52	0,24	0,009	0,9			1, 2

[a] Data source: JRC report "Definition of input data to assess GHG default emissions from biofuels in EU legislation", JRC 2019 (EUR 28349 EN); see: https://op.europa.eu/en/publication-detail/-/publication/7d6dd4ba-720a-11e9-9f05-01aa75ed71a1.

[b] It concerns fixed amount of N in crop residues, expressed in kg N per ha.

Table A.2 — Effect values for calculating N_2O emissions from agricultural fields based on the S&B model [a]

Parameter	**Parameter class or unit**	**Effect value, *ev***
Fertilizer input		0,003 8 × N application rate [b]
Soil organic C content	< 1 %	0
	1 % - 3 %	0,052 6
	> 3 %	0,633 4
pH	< 5,5	0
	5.5 – 7.3	-0,0069 3
	> 7.3	-0,483 6
Soil texture	Coarse	0
	Medium	-0,152 8
	Fine	0,431 2
Climate	Subtropical climate	0,611 7
	Temperate continental climate	0
	Temperate oceanic climate	0,022 6
	Tropical climate	-0,302 2
Vegetation	Cereals	0
	Grass	-0,350 2
	Legume	0,378 3
	None	0,587 0
	Other	0,442 0
	Wetland rice	-0,885 0
Length of experiment	1 year	1,991 0

[a] In all cases a constant value of -1,516 applies.

[b] Expressed in kg N per ha per year.

A.3 Emissions from the collection, drying and storage of raw materials

A.3.1 Emissions from the collection, drying and storage of raw materials shall include all emissions related to fuel use in the collection, drying and storage of raw materials.

A.3.2 Emissions from the collection of raw materials shall include all the emissions resulting from the collection of raw materials and their transport to storage. The emissions shall be calculated using appropriate emission factors for the type of fuel used (diesel oil, gasoline, heavy fuel oil, biofuels or other fuels).

A.3.3 The cultivation emissions shall include emissions from drying before storage as well as from storage and handling of biomass raw materials. Data on energy use for drying before storage shall include actual data on the drying process used to conform with the requirements of storage, depending on the biomass type, particle size, moisture content, weather conditions, etc. The emissions shall be calculated using appropriate emission factors, including upstream emissions, to account for the emissions from the use of fuels to produce heat or electricity used for drying. Emissions for drying include only emissions for the drying process needed to ensure adequate storage of raw materials and does not include drying of materials during processing.

A.4 Accounting for emissions for electricity used in farming operations

When accounting for the consumption of electricity not produced within the fuel production plant, the greenhouse gas emissions intensity of the produced and distributed electricity shall be assumed to be equal to the average emission intensity of the produced and distributed electricity in a defined region. The defined region can be the national level or a NUTS2 region (if available and recognised by the European Commission).

By way of derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant if it is not connected to the electricity grid and sufficient information is available to derive an emission factor.

Bibliography

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[3] ISO 14064-1, *Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*

[4] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide

[5] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources

[6] *Global Nitrous Oxide Calculator (GNOC)*, Joint Research Centre of the European Commission, https://gnoc.jrc.ec.europa.eu/ [last viewed on 2021-10-27]

[7] *IPCC Guidelines for National Greenhouse Gas Inventories*, Intergovernmental Panel on Climate Change (IPCC)

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[9] Regeling conformiteitsbeoordeling vaste biomassa voor energietoepassingen