Methodology for the Calculation of GHG Emissions

of

"Biofuels"

"Biogas"

"Bioliquids"

"Biomass fuels for Heat and/or Cooling & Power"

Note on the status of this document:

This reference document is an integral part of the 2BS voluntary scheme developed by the 2BS Association.

This update aims to comply with the current European Union Directive 2018/2001(RED II).

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Traceability of changes in this procedure[1]

Date	Section	Paragraph	Deleted text	Added text	Change of version

[1] *After its initial validation by the EC*

1. Introduction

1.1. General context

European Union Directive 2018/2001 (RED II) sets sustainability criteria for biofuels, bioliquids, and biomass fuels consumed in the European Union and contribute to its renewable energy use targets, either produced in European Union member states or third countries.

One of these criteria relates to greenhouse gas (GHG) emissions generated during the life cycle of biofuels, biogas, recycled carbon fuels, renewable fuels of non-biological origin and biomass fuels for heat, cooling & power. It requires a minimum saving of these emissions compared to those resulting from the use of fossil fuels, as set out below:

- **50 %** for biofuels, bioliquids, biogas consumed in the transport sector and biomass fuels produced in installations in operation on or before 5 October 2015;
- **60 %** for biofuels, bioliquids, biogas consumed in the transport sector and biomass fuels produced in installations starting operation from 6 October 2015 until 31 December 2020;
- **65 %** for biofuels, bioliquids, biogas consumed in the transport sector and biomass fuels produced in installations starting operation from 1 January 2021;
- **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;
- **70 %** from 1 January 2021 from using renewable liquid and gaseous transport fuels of non-biological origin.

At this time it is not possible to calculate GHG emissions for fuels produced from "liquid or solid or gaseous waste streams of non-renewable origin" (as the relevant delegated act has not yet been finalised).

This method complies with European Union Directive 2018/2001(RED II) and the communications from the European Commission listed in Section 6 References. European Union Directive 2018/2001(RED II) gives operators a choice between calculating actual GHG emission values, using default values, or using a combination of disaggregated default values and calculated actual values. The default values are in Annexes V and VI to RED II.

Th document sets out the conditions for using actual and default values, together with rules for calculating the actual values.

Economic operators are required to keep all evidence necessary to comply with the RED II and Implementing Regulation (EU) 2022/996 for a minimum of 5 years or longer where it is required by the relevant national authority.

1.2. GHG Emission Savings

The GHG emissions savings from biofuels and biomass fuels used as *transport fuels* are calculated as follows

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

Where

- E_B = Total GHG emissions from the biofuel or biomass fuels used as transport fuels ($gCO_{2\ eq}$ /MJ)
- $E_{F(t)}$= Total GHG emissions from the fossil fuel comparator for transport ($gCO_{2\ eq}$ /MJ).

The GHG emission saving from *heat and cooling and electricity* generated from bioliquids and biomass fuels is calculated as follows:

$$\textbf{SAVING} = (EC_{F(h\&c,el)} - EC_{B(h\&c,el)})/EC_{F\ (h\&c,el)}$$

Where :

$EC_{F(h\&c,el)}$ = Total emissions from heat or electricity

$EC_{F\ (h\&c,el)}$ = Total emissions from the fossil fuel comparator for useful heat and electricity

The fossil fuel comparator for

- transport is **94 gCO_2eq/MJ**
- heating and/or cooling is **80 gCO_2eq/MJ**
- the production of electricity is **183 gCO_2eq/MJ**

The greenhouse gases covered by the RED II are

- carbon dioxide (**CO_2**),
- methane (**CH_4**) and
- nitrous oxide (**N_2O**)[2].

The GHG emissions calculation of other gases **shall** not be considered.

[2] *EU Directive 2018/2001 - Annex V and Annex VI*

1.3. Use of the 2BS voluntary scheme

1.3.1. Scope of application

The 2BS methodology, described in Section 2, **shall** be used to calculate the GHG emission savings for the whole value chain. The total emissions from a biofuel, "**E**", are calculated by summing emissions from the different processes which make up fuel production, e.g., cultivation (e_{ec}), processing (e_p), etc.

"**E**" is defined by the following formula, which is explained in Section 2.

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr}$$

All economic operators of the value chain **shall** calculate the emissions resulting from their operation and pass this information, together with that which they received from their supplier(s) to their customer(s).

The list of recognised national and voluntary systems is available on the 2BS internet site.

When an economic operator certified under the 2BS voluntary scheme receives material from another economic operator (biomass supplier, intermediate product supplier or final product supplier) that has been certified by another voluntary scheme recognised by both the European Commission and 2BS, the total GHG emission value obtained by the calculation methodology of this other scheme for this material is used as input data to calculate GHG emissions of the product after transformation by the 2BS-certified operator, following the 2BS GHG methodology.

When an economic operator receives raw materials and interim products from another voluntary scheme, they **must** be in the appropriate units (e.g., gCO_2eq/dry-ton of feedstock or gCO_2eq/dry-ton intermediary product, respectively).
Farmers, for example, cannot report cultivation GHG emissions in the unit gCO_2eq/MJ of fuel because this would require knowing how efficiently these are converted into final fuels.

Economic operators **must** consider the latest values or methodological aspects issued by the European Commission.

This part of the scheme **shall** be updated by a decision of the 2BS association in the case of:

- A new update to RED II
- Development of additional emissions factors (significant changes to databases)
- A recommendation from the European Commission leading to a change in the scheme

If in doubt, the information issued by the European Commission in the Official Journal **shall** precede the methodology in this report.

1.3.2. Main rules – Transmission of information through the chain of custody

1.3.2.1. Rule 1 – GHG requirements for suppliers

The 2BS certified economic operator **shall obtain, in writing from his supplier**, information about the GHG emission value.

Two situations can occur:

1. The supplier did not do a calculation and **used default values**.

   In this case, in order to simplify the administrative burden and avoid mistakes, an operator **must only transmit** that the default value is used. It will be the responsibility of downstream operators to include information concerning the default emission value for the final fuel. GHG emission data should only be included in documentation if actual values have been calculated.

2. The supplier **does a GHG emission calculation**.

   In this case, the supplier **must transmit** to the downstream operator:

   a. A GHG emission value broken-down into emissions from the different processes. These values **must be expressed** in gCO_2eq per dry-ton of material or intermediate product (e.g., gCO_2eq/dry-ton of feedstock) unless the supplier is a “final economic operator”. In this case, values **must** be expressed in gCO_2eq/MJ.

   b. **Information concerning the date** that the biogas, biofuels, bioliquids and biomass fuel installation came into operation **must also be included** in the documentation. An installation **shall** be in operation once the physical production of fuels, including biofuels, biogas or bioliquids, or production of heat, cooling or electricity from biomass fuels has started.

<u>To obtain the **GHG emission value in gCO_2eq per “dry ton”**</u> where the calculation provides a result in gCO_2eq per “moist ton”, the following formula **must be applied**[3]

$$\boldsymbol{e_{ec}feedstock_{1\,Dry}} = \frac{\boldsymbol{e_{ec}feedstock_{1\,Moist}}}{\boldsymbol{(1 - Moisture\ Content)}}$$

- $e_{ec}feedstock_{1\,Dry}$: Total emissions of $feedstock_{1\,Dry}$ in ($gCO_{2\,eq}$ /kg_{Dry})
- $e_{ec}feedstock_{1\,Moist}$: Total emissions of $feedstock_{1\,Moist}$ in ($gCO_{2\,eq}$ /kg_{Moist})
- $Moisture\ Content$: Moisture content in % expressed in decimal value

The moisture content should be the value measured before or after delivery. If this value is not known, the maximum value allowed by the delivery contract **shall be applied**.

1.3.2.2. Rule 2 – Units of GHG emissions

When actual GHG emission values corresponding to raw material or an intermediate product of the fuel production chain are provided in gCO_2eq/MJ of the specified fuel, the downstream operator **must use** default values for the upstream operations carried out by the supplier instead of the actual values, because of the impossibility of using actual GHG emissions given in gCO_2eq/MJ without making assumptions about yields and allocations.

1.3.2.3. Rule 3 – GHG information to be passed downstream

GHG emission data should only be included in documentation if actual values have been applied and should only be reported in gCO_2eq/MJ of final fuel by the final economic operator (last interfaced). If disaggregated default values are used, it is necessary to report this information without including any numerical value.

When a biomass supplier certified under 2BS or another EC-recognised voluntary or national scheme provides a default value or a disaggregated default value to a downstream operator, **the supplier shall be responsible for ensuring** that the biomass complies with the requirements of Annexes V and VI of European Union Directive 2018/2001(RED II).

The supplier shall indicate no emissions due to land use change.

The supplier **shall also include** other information, for example, the country of origin of the raw material, such that compliance with Annexes V and VI can be confirmed.

The supplier shall transmit this information in gCO_2eq per dry-ton of material or intermediate product (e.g., gCO_2eq/dry-ton of feedstock). For the sugar beet, the unit is gCO_2eq/kg sugar beet wet (16% sugar).

1.3.2.4. Rule 4 - Upstream check

The auditor shall check that the economic operator has obtained the necessary voluntary scheme certificate from its supplier, which is valid for all relevant deliveries and the GHG information for each batch of material.

Although the accuracy of the GHG values is the responsibility of the previous economic operator and its voluntary scheme, **the auditor shall check** that the values provided are realistic, within the normal range of values, based on available and reliable sources such as default values.

1.3.2.5. Rule 5 – Transportation phase

The GHG emissions attributed to the transportation phase **shall be** decided according to the information transmitted down the supply chain:

- **With** applicable transport, storage or distribution, actual emission values covered by $\mathbf{e_{td}}$[4]. A complete calculation of $\mathbf{e_{td}}$ can be done if emissions of all transport steps are recorded and transmitted through the chain of custody.

[4] *e_{td} value covers emissions from the transport and storage for raw material and semi-finished materials and from the storage and distribution for finished materials.*

- **Without** applicable transport, storage or distribution, actual emission values covered by $\mathbf{e_{td}}$
  - If no value for $\mathbf{e_{td}}$ is provided, or if the GHG emission value doesn't include the transport and storage or storage and distribution, the $\mathbf{e_{td}}$ default value **shall be** added by the last economic operator to obtain the final GHG emission value for the finished material.
  - If a value for transport and storage or storage and distribution is provided separately, it should be discarded if and when the $\mathbf{e_{td}}$, default value is added by the last economic operator.

Actual values of emissions from transport can only be determined if emissions of all transport steps are recorded and transmitted through the chain of custody.

1.3.2.6. Rule 6 – Processing phase (conversion instructions)

When the biomass producer provides an actual emission value in **gCO_{2eq}/Kg of dry biomass** to the next operator of the chain, and if the latter wants to use a disaggregated default value for the processing phase, the final processor **shall** convert the emissions provided by the biomass supplier from **gCO_{2eq}/Kg of dry biomass to gCO_{2eq}/MJ**, to calculate total GHG emissions of the fuel production chain.

This conversion shall be done according to the actual yields and allocations between products and co-products of the whole processing phase (even if default values are used for the processing phase)[5].

1.3.2.7. Rule 7 – Use of actual values for processing

The use of actual values for processing is only possible if all necessary information on the emissions of all processing steps is included at the appropriate processing step and transmitted adequately along the chain of custody.

1.3.2.8. Rule 8 – Last interfaces (splitting of the total amount of GHG emissions)

When actual values are calculated, it is necessary to split the total amount of emissions into all elements of the GHG emission calculation formula that are relevant. This also applies to the elements of the formula which are not included in the default values, such as "$\mathbf{e_l}$", "$\mathbf{e_{sca}}$", "$\mathbf{e_{ccr}}$" and "$\mathbf{e_{ccs}}$".

1.4. Main audit results

1.4.1. Rule 1 – Reporting GHG emission savings (%)

Auditors shall record in the audit report savings achieved from:

- The agricultural step whenever actual values have been used instead of NUTS 2 values;

[5] *For more details on the calculation methodology, see section 2.8 "Adjusting actual values calculated for each step".*

- The processing emissions occurring at the audited site (emissions after allocation) and, if relevant, the savings achieved;
- Where emissions savings deviate significantly from typical values[6] (i.e., **greater than 10%**), or calculated actual values of emissions savings are abnormally high (**greater than 30% deviation from default values**), the report must include information that explains these deviations". **Certification bodies must immediately inform 2BSvs of such deviations**.

1.4.2. Rule 2 – Use of actual values

Economic operators are only allowed to use actual values after the capability to conduct such a calculation, according to the GHG emission calculation methodology, has been verified by an auditor. Such verification **shall** be performed during the audit of the economic operator before participation in the voluntary scheme.

2. Methodology for calculating greenhouse gas emissions

2.1. Introduction

According to Annex V Part C of RED II, greenhouse gas emissions from the production and use of biofuels and bioliquids **shall** be calculated according to the following formula:

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} \quad \text{where :}$$

- **E** = total emissions from the use of the fuel, ($gCO_{2\,eq}$ /MJ)
- e_{ec} = emissions from the extraction or cultivation of raw materials, ($gCO_{2\,eq}$ /MJ)
- e_l = annualised emissions from carbon stock changes caused by land-use change, ($gCO_{2\,eq}$ /MJ)
- e_p = emissions from processing, ($gCO_{2\,eq}$ /MJ)
- e_{td} = emissions from transport and distribution, ($gCO_{2\,eq}$ /MJ)
- e_u = emissions from the fuel in use, ($gCO_{2\,eq}$ /MJ)
- e_{sca} = emission saving from soil carbon accumulation via improved agricultural management, ($gCO_{2\,eq}$ /MJ)
- e_{ccs} = emission saving from carbon capture and geological storage, ($gCO_{2\,eq}$ /MJ)
- e_{ccr} = emission saving from carbon capture and replacement, ($gCO_{2\,eq}$ /MJ)

e_u is considered to be zero for biofuels. However, emissions of non-CO_2 greenhouse gases (N_2O and CH_4) of the fuel in use shall be included in the e_u factor for bioliquids.

The calculations to determine the terms of this formula will be detailed in point "2.7 Calculation of actual values" of this methodology.

[6] *See Typical GHG emissions savings in Annex V (section A) for biofuels and in Annexe VI (section A) for biomass fuels of the European Union Directive (EU) 2018/2001 (RED II)*

The economic operators **shall** use the latest methodology version and the emission factor values available on the European Commission website. A national grid emission factor can be used if it reflects the emissions intensity of the national energy mix.

The formula above demonstrates that in the end, it is necessary to have available all emissions in gCO_2 eq /MJ of the final fuel (biofuel, bioliquid and biomass fuels).

But the first economic operator in the chain of custody can't know which process will be used by the following operator in the chain. As a consequence, some emissions **must be calculated** in two steps:

1. **Firstly**, the calculation of CO_2eq emissions gives "initial values" for emissions in gCO_2eq/kg of (dry) intermediate products,
2. **Secondly,** calculation by the "final economic operator" who has the knowledge of all processes used to produce the fuel and **must transform** "initial values" for emissions available in gCO_2eq/kg of (dry) intermediate products into "final" emissions in gCO_2 eq /MJ[7].

2.2. Scope of application

2.2.1. Conditions of application of default, average and actual values

European Union Directive 2018/2001(RED II) gives two types of default values:

a. *Aggregated GHG emission saving values* for certain biofuels, bioliquids and biomass fuel pathways.
b. *Disaggregated values* for the terms in the formula for E, the total emissions from biofuels, bioliquids and biomass fuels.

These default values are subject to the conditions set out in the following paragraphs.

2.2.1.1. Use of default ("aggregated"[8]) GHG emission saving values

The use of aggregated GHG emission saving values is subject to two conditions:

- **CONDITION 1**:
  - An aggregated default value for the biomass concerned is defined by the RED II. These default values **must** be used only when process technology and feedstock used for the production of the biofuels, bioliquids and biomass fuel match their description and scope.
  - When the value is given for a feedstock without any reference to a specific process or specific energy for the process, there is no further verification needed.

[7] *For more details on the calculation methodology see Ch 2.8 "Adjusting actual values calculated for each step".*
[8] *European Union Directive 2018/2001(RED II) - Annex V - Parts A and B and Annex VI*

- When the value is given for a feedstock with reference to a specific process or energy for the operation, auditors shall verify that the reality of the actual process matches the specification of the one used for calculating the default value[9].

  And

- **CONDITION 2:**
  - GHG emissions due to land use changes are **0 or less, i.e., $e_l \leq 0$**.
  - $e_l \leq 0$ means that there is no land use change or that the carbon stock of the new land use is greater than that of the previous use. e_l **must** be calculated in compliance with the method described in section 2.7.3.

  Note that revised default/disaggregated default values published in the REDII Corrigenda **shall** be used.[10]

2.2.1.2. Use of actual, disaggregated default, and average emissions values

If an economic operator so wishes or is unable to use a default value, the operator should calculate "**E**":

- **Either** by calculating the "actual GHG emissions" generated by biomass production using a methodology compliant with European Union Directive 2018/2001(RED II) as described in this document.
- **Or** by using a mix of disaggregated default values and actual values for the factors in the formula given for E. In this case, actual values **must** be calculated in compliance with section 2.7.

  In place of the default value for the cultivation of raw materials, $\mathbf{e_{ec}}$, it is also possible to use:

  For the EU, an average value specific to the NUTS 2 area concerned is supplied by the relevant member state. GHG values included in the NUTS 2 reports do not represent disaggregated default values. Therefore, they can be used as input for the calculation of actual values but cannot be used to report emissions from cultivation in the unit gCO_2eq/MJ of fuel. Additionally, these values are subject to a Commission decision in line with Article 31(4) of Directive 2018/2011 in the following unit: gCO_2eq/ dry kg of feedstock to be considered usable.

- A similar approach would also be appropriate for countries outside the EU. In this case, the same rules as described above **must** be respected. So, it is mandatory to have an official report sent and validated by the Commission and values available on the commission website for a member state of the EU.

  Or

- An average emission value for a more fine-grained area than NUTS 2, with the same level of guarantee as described previously at the NUTS 2 level. In this case, the calculation **must** respect all rules

[9] *See Note to Voluntary Schemes on The Conducting and Verifying Actual Calculations of GHG Emission Savings version 2.0. https://ec.europa.eu/energy/sites/default/files/documents/note_on_ghg_final_update_v2_0.pdf*

[10] *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001R(04)&from=EN*

described in this methodology following EU rules and is acceptable only at the group farm level and not at the farm level.

It should be noted that the calculation of alternative averages for areas and crops which are covered by the NUTS 2 reports is not allowed under normal conditions as the appropriate averages have already been calculated by the national authorities.

These values should be primarily based on:

1. A method that takes into account soil characteristics, climate, and expected raw material yields.

2. One of the following sources:
   - Official statistical data from government bodies were available and of good quality.
   - If no official statistical data from government bodies are available, statistical data published by independent bodies may be used.
   - If these values are not available, the numbers may be based on scientifically peer-reviewed work with the precondition that data lies within the commonly accepted data range.

3. The most recent available data shall be from the sources mentioned earlier. The data should be updated over time unless there is no significant variability in the data.

The typical values given in European Union Directive 2018/2001(RED II) cannot be used by economic operators.

2.2.2. Emission factors

The Standard Values of Emission Factors **shall** be taken from Annex IX of the COMMISSION IMPLEMENTING REGULATION (EU) 2022/996 of 14 June 2022.

Where biofuels are used instead of diesel or other fossil fuels, the default GHG emissions set out in Directive 2018/2001 must be used.

If an emission factor required for calculating GHG emission savings is not supplied in this list, it is nevertheless possible to use an emission factor taken from another source if:

- The emission factor is representative of the emissions caused, and
- The values should be primarily based on:
  a. Official statistical data from government bodies when available.
  b. If no official statistical data from government bodies are available, statistical data published by independent bodies may be used.
  c. If these values are not available, the numbers may be based on scientifically peer-reviewed work with the precondition that data lies within the commonly accepted data range.

- The data used **shall** be based on the most recent available data from the above-mentioned sources. The data should be updated over time unless there is no significant variability in the data.

The unit of the emission factor for input or output **must** be in grams or kilograms of CO_2 equivalent per unit of measure of "input" or "output".

All the emission factors must be based on **G**lobal **W**arming **P**otential (**GWP**), e.g.,

- **1** for **CO_2**,
- **25** for **CH_4**, and
- **298** for **N_2O**.

If the European Commission revises the GWP of these GHGs, then the emission factors **shall** be updated. The economic operator shall use emission factors based on the appropriate GWP in such a case.

2.3. System boundaries

The system boundaries specify all the component processes to be included in the calculation of the GHG emissions, as well as the level of detail with which these processes are to be handled.

- **Inclusions**

  The boundaries of the system under study **shall** consider all emissions **from raw material production up to the point at which the fuel is consumed**.

  Emissions from processes involving both the fuel and the fossil fuel in which it is incorporated (ex: electricity consumption at blending and at final distribution) are allocated pro rata according to relative energy content.

  In the agricultural phase, emissions related to applying fertilisers during the whole farming cycle, including those used before sowing biomass for soil preparation, are included within the system boundaries.

- **Exclusions**

  GHG emissions associated with the manufacture of machinery and equipment, as well as GHG emissions related to the repair and maintenance of equipment and infrastructure, are not included in the GHG emissions saving calculation. It is assumed that carbon sequestered during the growth of the biomass is not included within the system boundaries.

- **Wastes and residues**:

  Biogenic wastes and residues are considered to have zero GHG emissions at the point of arising, i.e., at the process where they are created.

  Waste and residue feedstocks can be considered to have zero GHG emissions up to the process of their collection, according to European Union Directive 2018/2001(RED II).

  Wastes and residues, including **treetops 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 life-cycle greenhouse gas emissions up to the process of collection** irrespective of whether they are processed to interim products before being transformed into the final product.

The end-of-life processing of wastes and residues produced during the life cycle of fuel and right up to the end-of-life processing stage **must** be taken into account using the appropriate factor (in $\mathbf{e_{ec}}$ or $\mathbf{e_p}$ depending on where the wastes or residues are produced).

Sedimentation and filtration of liquid wastes and residues such as used cooking oil are not GHG emissions generating processes.

Wastes and residues	Used as raw material in a lifecycle process of the biofuel/bioliquid	Non-recycled, produced by a lifecycle process of the biofuel/bioliquid	Produced by a lifecycle process of the biofuel/bioliquid and recycled in the production of another product
Transport for collection and storage	Practical cases: **=>** a biodiesel production unit that organises the collection of "UCO" with its means of transport, without any intermediary with restaurants **must** integrate the GHG emissions from the transportation of the UCO from the point of origin to the production site; => a production unit that purchases "UCO" from an entity certified as a UCO collection point **must** integrate the GHG emissions from the transport of the "UCO" between the collection point and the fuel production site. => the GHG emissions at the "UCO" collection point from different points of origin are zero.	**Included** from the process of the collection up to the end-of-life processing of those materials	**Excluded**[11]
End-of-life processing	**Not applicable**	**Included**	**Excluded (recycling process)**

[11] Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels (2010/C 160/02) Annex II. This exclusion refers to the economic operator that generates these wastes/residues. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:160:0008:0016:EN:PDF

- Cross-reference between system boundaries and factors given by European Union Directive 2018/2001(RED II).

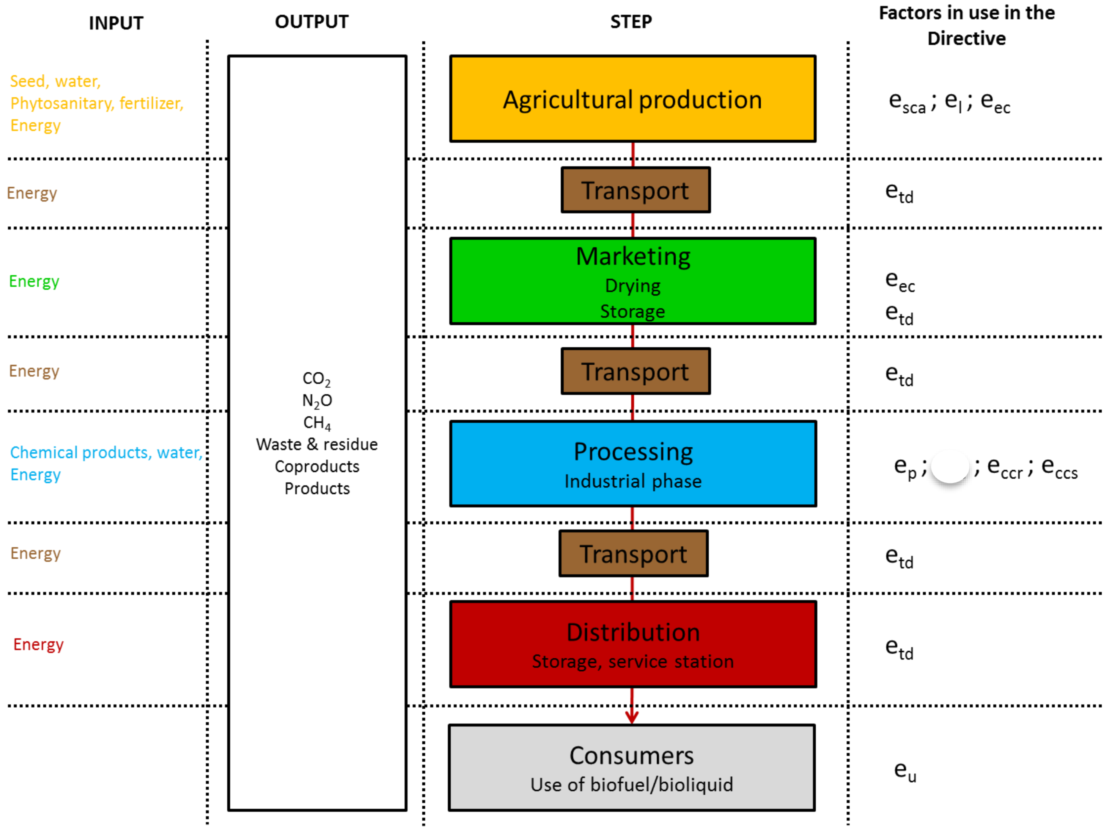


Figure 1: Factors used in the formula of the European Union Directive 2018/2001(RED II) associated with stages in the life cycle of fuels

2.3.1. Cut-off rule

In the case of actual value calculations, all inputs and outputs of the production processes of the fuel should be taken into account. However, it is possible to omit specific processes, inputs and outputs.

This exclusion is exclusively allowed if it does not significantly alter the GHG emission saving calculation results. **The omitted emissions must not exceed 0.5% of the total emissions**.

All excluded inputs and outputs must be clearly stated in a report, and the reasons for and implications of excluding them must be justified.

2.4. Auditability

To facilitate auditing principle 2 “Greenhouse gas emissions saving” of the 2BS voluntary scheme, **the economic operator must make available to the auditor in advance of the planned audit a report detailing as a minimum**:

- Input data and any relevant evidence, information on the emission factors and standard values applied and their reference sources, GHG emission calculations and evidence relating to the application of GHG emission saving credits ($\mathbf{e}_{ccr}$, $\mathbf{e}_{ccs}$, $\mathbf{e}_{sca}$).
- All assumptions made and the justification for them,
- Compliance with the cut-off rule,
- List of elements ignored,
- And a description of the system (crop management techniques, residues and waste collecting processes, conversion processes, operations and transport chain, etc.).

The economic operator may supply any document considered to be relevant to justify the use of the values supplied using internal or external documents (e.g., production audit, invoice, process overview, third-party certificate or report, measurement tool records, etc.).

The documents **must** be referenced, transparent and verifiable so that an auditor can verify the origin and relevance of the values supplied. Where some unusual values are used, the economic operator **must** flag these particular values and explain in detail in its documentation the reason for using these values.

2.5. Data collection

When calculating an actual value, data must meet the following conditions:

- The data **must represent** all the inputs and outputs from a geographical, technological and time point of view.
- Cultivation data may be collected from growers, or representative average values at the level of a NUTS 2 or equivalent (outside EU) area or smaller may be used. The aggregation method and rules for calculating the final values used must be documented when using representative average values.
- Temporal representativeness: the collected data **must be** representative of the technology used in each phase of the life cycle of the fuel released for consumption. In the case of the post-agricultural stages, the data may be representative of the year preceding the relevant phase.
- Lower Heating Value (LHV):
  The Lower Heating Value (LHV) of a parameter required for calculating GHG emission savings is not provided in the Commission Implementing Regulation (EU) 2022/996 of 14 June 2022, Annex IX *(Standard Values of Emission Factors)*. In that case, it is then possible to use a value from another source. This source **must meet** the following conditions:

- The LHV is representative of the material concerned and refers to the energy content of the raw material and should be that of the entire (co-product and not only of its dry fraction).

- The source **must be** a scientifically peer-reviewed publication/database with the precondition that data lies within the commonly accepted data range or from data measurement that an accredited external third-party body has independently verified.

- The source of the LHV value **must be** documented (at least the date of publication, author or organisation and title **must** be provided)

2.6. Allocation criterion and rule for application

2.6.1. Energy content-based allocation criterion

Some production processes for fuels produce one or more co-products. In this case, GHG emissions should be allocated between the production of the fuel and the co-products according to energy content.

- <u>Use of LHV of wet biomass for making allocations on energy content criterion:</u>

For the purpose of making an allocation according to the energy content criterion, economic operators **must use** the LHV of wet biomass of co-products. If the LHV of the dry fraction of the products and co-products is only available to economic operators, they may use the following formula to calculate the gross LHV.

$$LHV_G = LHV_D * \frac{100 - T_H}{100} - \frac{T_H * Lv}{100}$$

Where:

- Lv: is the lower heat of water evaporation at 25°C, i.e., 2.447 MJ/kg
- LHV_G: LHV of the wet material (in MJ/kg)
- LHV_D: LHV of the dry material (in MJ/kg)
- T_H: moisture content (in %)

<u>Allocation factor</u>

$$A_P = \frac{LHV_{G\ PRODUCT} * M_{G\ PRODUCT}}{LHV_{G\ PRODUCT} * M_{G\ PRODUCT} + \sum LHV_{G\ COPRODUCT} * M_{G\ COPRODUCT}}$$

$$A_{CP} = \frac{LHV_{G\ COPRODUCT} * M_{G\ COPRODUCT}}{LHV_{G\ PRODUCT} * M_{G\ PRODUCT} + \sum LHV_{G\ COPRODUCT} * M_{G\ COPRODUCT}}$$

Where:

- A_P: Allocation factor to the main product (in %)
- A_{CP}: Allocation factor to the co-product (in %)
- M_G: Wet mass of product or co-product (e.g., kg)

Where a fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (co-products), the emissions of the biofuel/bioliquids **shall be** multiplied by the **allocation factor.**

The emissions to be divided **shall be** $\mathbf{e_{ec} + e_l + e_{sca}}$ and those fractions of $\mathbf{e_p}$, $\mathbf{e_{td}}$, $\mathbf{e_{ccs}}$, and $\mathbf{e_{ccr}}$ 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 life cycle, the fraction of those emissions assigned in the last such process step to the intermediate fuel product **shall be** used for this purpose instead of the total of those emissions.

For calculating allocations between the product and the co-products, the following formulas apply:

$$X_P = A_P * (\sum FE_A * Q_A)$$

$$X_{CP} = A_{CP} * (\sum FE_A * Q_A)$$

Where:

- X_P: Emissions allocated to biofuel/bioliquid (in $gCO_{2\,eq}$/MJ)
- Q_A: Quantity used/emitted of input/output per MJ of biofuel/bioliquid (e.g., kg/MJ, t/MJ…)
- FE_A: Emission factor associated with each input/output (in $gCO_{2\,eq}$/input e.g.: $gCO_{2\,eq}$/kg)
- X_{CP}: Emissions allocated to co-products (in $gCO_{2\,eq}$/MJ)

2.6.2. The rule for application of allocation criterion

GHG emissions from the further processing of co-products are

- **excluded if** the co-products leave the system boundary
- **included if** outputs from the processing return upstream of the process by material or energy loopback.

- **Case 1**: No material or energy feedback loops (open loop processing by way of storage or sale of co-products):

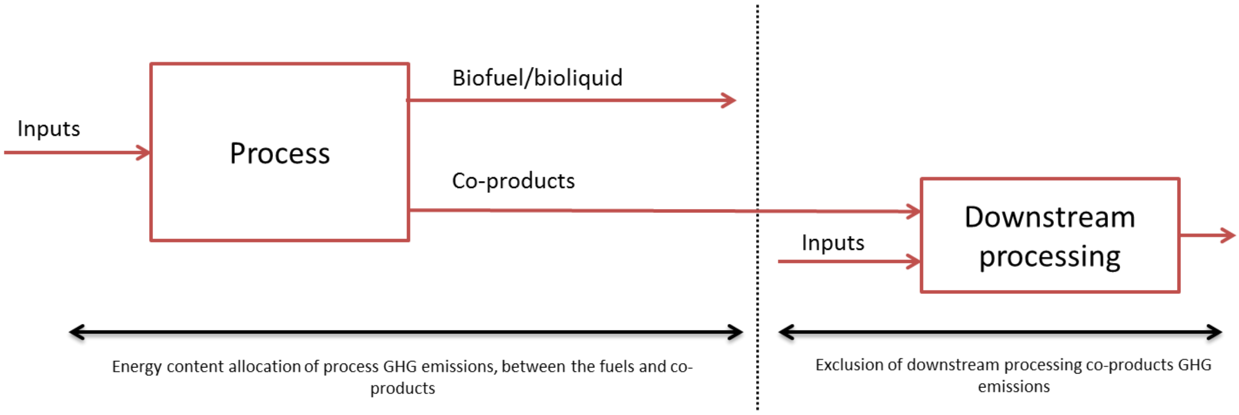


Figure 2 - Allocation based on criterion of energy content of products and co-products (without material or energy feedback loops)

- **Case 2**: Material or energy feedback loops (closed loop processing of co-products):

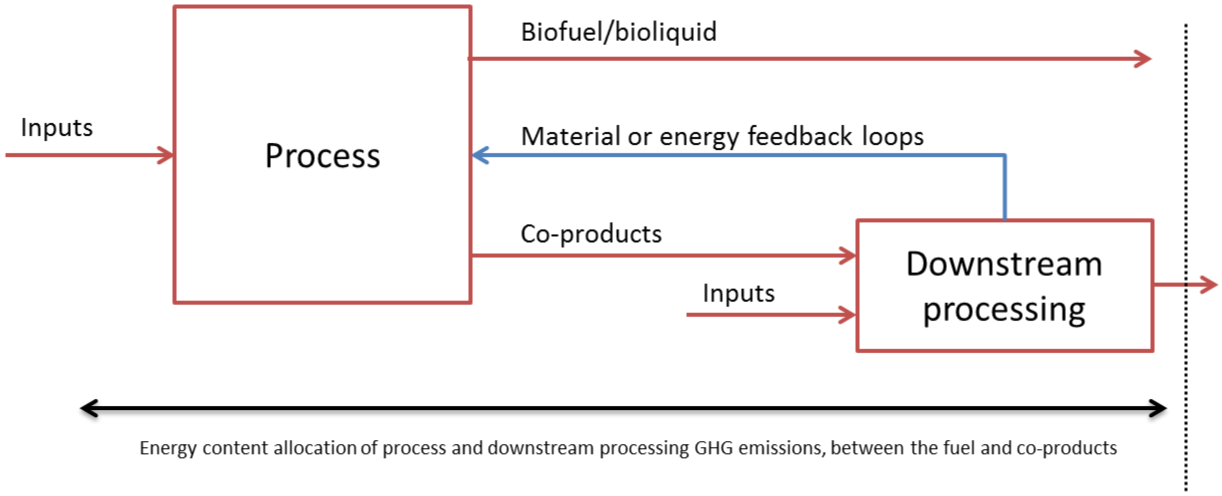


Figure 3 - Allocation based on the criterion of the energy content of products and co-products (with material or energy feedback loops)

GHG emissions cannot be assigned to wastes and residues produced by the process.

2.6.3. Allocation of emissions to excess useful heat and electricity

Where excess useful heat *or* excess electricity is also produced by the process, either directly or via a cogeneration/CHP unit, they are treated as co-products to which emissions can be assigned.

However, the emissions assigned to the co-products **must be** calculated assuming that the greenhouse gas intensity of the excess electricity or useful heat is the same as the greenhouse gas intensity of heat or electricity delivered to the fuel production process.

The greenhouse gas intensity of input heat or electricity **must include** the 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.

Where *both* excess electricity and useful heat are produced, the emissions **shall be** divided between the electricity and the useful heat according to the temperature of the heat.

The useful heat is found by multiplying its energy content with the **Carnot efficiency**, **C_h**, calculated as follows:

$$C_h = (T_h - T_0) / T_h$$

- **T_h** =Temperature, measured in absolute temperature (kelvin) of the useful heat at point of delivery.
- **T_0** =Temperature of surroundings, set at 273.15 kelvin (equal to 0 °C)

If the excess heat is driven for heating of buildings at a temperature below 150 °C (423.15 kelvin), **C_h** can alternatively be defined as follows:

- **C_h** =Carnot efficiency in heat at 150 °C (423.15 kelvin), which is: 0.3546

For that calculation, the current efficiencies **shall** be used, defined as the annual mechanical energy, electricity and heat produced, divided by the annual energy input.

To assign emissions to the **"useful heat"**, the operator **shall** show that it satisfies an economically justified demand for heat, which does not exceed market demand. **The auditor shall verify** these conditions are met. If it is not the case, the heat is '**waste heat'** to which emissions cannot be allocated.

The emissions to be divided **shall** be **e_{ec} + e_l + e_{sca}** + those fractions of **e_p, e_{td}, e_{ccs}, and e_{ccr}** that take place up to and including the process step at which the heat or electricity is produced.

If any allocation to co-products has taken place at an earlier process step in the life cycle, **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.

2.7. Calculation of actual values by type of GHG emission

All data must be justified and documented for the calculation of actual values following the criteria in section "2.4 Auditability".

Each time there is a risk of not having enough documented information, default values (aggregated or disaggregated) **must be** used.

Some calculations reported in this chapter allow "approximate" emissions in gCO_2eq/kg of (dry) intermediate product to be obtained (see Chapter 2.1 Introduction)

2.7.1. Generic calculation rule

2.7.1.1. Actual values:

If the economic operators use actual values, **they shall** refer to the method and source used for determining actual values (e.g., geographical and temporal representativeness for average values).

Reference **shall also be made to the Commission's website** to indicate that all rules are correctly respected.

2.7.1.2. Electricity grid:

The Directive requires using the average emission intensity for a 'defined region'. In the case of the European Union, the national grid emission factors for the electricity grid are supplied in Annex IX of the COMMISSION IMPLEMENTING REGULATION (EU) 2022/996 of 14 June 2022 on rules to verify sustainability and greenhouse gas emissions saving criteria and low indirect land-use change-risk criteria'

National emission factors for countries outside the EU are available in the Commission Implementing Regulation (EU) 2022/996 of 14 June 2022, Annex IX (Standard Values for Emission Factors).

2.7.2. GHG emissions from the extraction or cultivation of raw materials: e_{ec}

2.7.2.1. General

For the calculation of factor **e_{ec},** all significant inputs **must be taken into account**:

$$\boldsymbol{e_{eci}} = \frac{\sum(\boldsymbol{FE_i} * \boldsymbol{Q_i}) + \sum(\boldsymbol{FE_e} * \boldsymbol{Q_e}) + \sum(\boldsymbol{E_{acid}} + \boldsymbol{E_{lime}})}{\boldsymbol{Y}} * \boldsymbol{a_{ec}}$$

Where:

- **e_{eci}** : GHG emissions of the extraction or cultivation of raw materials (in gCO_{2eq}/kg of biomass)
- **Q_i**: quantities of inputs used at raw materials production stage per hectare and per year (e.g.: kg fertiliser/(ha*yr))
- **FE_i**: emission factors of inputs at raw materials production stage (in $gCO_{2\,eq}$/input e.g.: $gCO_{2\,eq}$/kg of fertiliser)

- **Q_e**: quantities of N_2O emitted at raw materials production stage per hectare and per year (e.g.: kg N_2O/(ha*yr))
- **FE_e**: emission factor of N_2O [12]
- **E_{acid}** **:** emissions from acidification
- **E_{lime}**: emissions from lime
- **a_{ec}**: energy allocation factor between raw material for biofuel/bioliquid production and agricultural co-products (in MJ/MJ)
- **Y:** crop yield of the main product, (in kg/(ha*yr))

The capture of CO2 in the cultivation of raw materials shall be excluded.

When an economic operator has to provide an actual GHG value for factor e_{ec}, **the value for factor e_{ec} shall be given in gCO_{2eq}/kg of dry biomass to the next economic operator** since the conversion in gCO_{2eq}/MJ of biofuel/bioliquid depends on the yield of the processes and allocation between intermediate/final products and co-products and should be done by the final economic operator[13].

If the calculation provides an "initial" result in gCO_{2eq}/kg of "wet biomass", it is necessary to transform this result into gCO_{2eq}/kg of "dry biomass" (see Rule 1 on Chapter 1.2.1 Scope of application).

This factor includes GHG emissions related to the production of raw materials and their collection, as well as the production and supply of inputs. It is the reason why this calculation can only be done at the origin of the chain of custody. The calculation is possible by gathering at least the following data[14]:

- Amount of pesticides (in kg/(ha*yr))
- Amount of seeds (in kg/(ha*yr))
- Amount and type of fertilisers (in kg/(ha*yr))
- Amount and type of lime (in kg/(ha*yr))
- Representative pH immediately before lime is applied
- The emissions of N_2O from soils (kg/(ha*yr))
- Diesel and other fuel consumption (in l/(ha*yr))
- Electricity consumption (in kWh/(ha*yr))
- Crop yield of product (yield of the main product in kg/(ha*yr))
- The yield of co-products (in kg/ha)
- The lower heating values of products and co-products (in MJ/kg)
- The transport distance of raw materials up to the collection site (in km)
- All other relevant processes

Step-by-step methodology for determining the emissions from the extraction, or cultivation, of raw materials (**eec**) as specified in the Commisssion Implementing Regulation (EU) 2022/996 of 14 June 2022 is available in the **Annex A of this procedure**.

[12] *Economic operators* ***must*** *ensure that they take into account the latest value of CO_2 equivalence for N_2O issued by the European Commission.*
[13] *For more details on the calculation methodology, see Ch 2.8 "Adjusting actual values calculated for each step".*
[14] *Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels (2010/C 160/02) Annex2: Cultivation*

It is only possible to use NUTS2 level data ($kgCO_2$/ dry-Kg of feedstock) that has been subject to a Commission decision in line with Article 31(4) of Directive 2018/2011 by a Member state in the EU or a Third country.

2.7.3. Annualised GHG emissions from carbon stock changes caused by land-use change: e_l

The term "land use changes" refers to the six land categories recognised by the IPCC (forest land, grassland, cropland, wetlands, settlements and other lands). Cropland and perennial cropland **shall be regarded as one land use**.

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.

Annualised GHG emissions from changes in carbon stocks due to land-use change are calculated using the following formula taken from European Union Directive 2018/2001(RED II) Annex V – Part C):

$$e_l = (CS_R - CS_A) * 3.664 * \frac{1}{20} * \frac{1}{P} - e_B$$

Where.

- **CS_R**: the carbon stock per unit area associated with the reference land use (measured as mass of carbon per unit area, including soil and vegetation). The reference land use **shall be** the land use in January 2008 or 20 years before the raw material was obtained, whichever was the later, i.e., CS_R is the carbon stock 20 years before gathering the biomass or in 2008 if the biomass is harvested before 2028. (In gCO_{2eq}/ha)

- **CS_A**: the carbon stock per unit area associated with the actual land use (measured as mass of carbon per unit area, including both soil and vegetation). In cases where the carbon stock accumulates over more than one year, the value attributed to CS_A **shall** be the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever is the earlier, i.e., in the case of biomass whose cultivation takes more than 20 years CS_A is the carbon stock in its 20th year of cultivation. (in gCO_{2eq}/ha)
- **P**: the productivity of the crop (in MJ/ha/year)
- **e_B**: bonus of 29 gCO_2eq/MJ biofuel/bioliquid if biomass is obtained from restored degraded land. Evidence **must** be 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. The bonus of 29 gCO_2eq/MJ **shall** apply 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. Severely degraded land is defined in the Definitions section and European Union Directive 2018/2001(RED II).

A change in land management activities is not considered a change of land use. It is taken into account in factor **e_{sca}**

When **e_l** is not zero, the annualised GHG emissions from changes in carbon stocks due to land use **shall be** transferred by the biomass operator to the following economic operator in gCO_{2eq}/kg of dry biomass.

The conversion to gCO_{2eq}/MJ of biofuel/bioliquid depends on the yield of the processes and allocation between intermediate/final products and co-products and shall be carried out by the last interface[15].

Therefore, the biomass producer **shall use** the same formulae as above with productivity of the crop (P) expressed in Tons of biomass per ha and per year.

2.7.4. GHG emissions from processing: e_p

For the calculation of factor e_p, all significant inputs **must be** taken into account:

$$e_P = \sum FE_y * Q_y$$

Where:

- **FE_y**: emission factors of inputs at the processing stage (in $gCO_{2\ eq}$/input, e.g., $gCO_{2\ eq}$/kg); these emission factors shall be taken from the Commission Implementing Regulation (EU) 2022/996 of 14 June 2022, Annex IX (Standard Values of Emissions Factors)

- **Q_y**: quantities of inputs used at the processing stage per MJ of biofuel/bioliquid (e.g., kg/MJ)

The factor **e_p** includes GHG emissions related to the processing itself, to the wastes, and to the production of chemicals or other products used in processing. The following data **must be** gathered as a minimum.:

- Fuel consumption (in MJ/MJ biofuel/bioliquid)
- Electricity consumption (in kWh/(MJ biofuel/bioliquid) from external sources, i.e. not produced in an internal combined heat & power production plant)
- Amount and type of raw materials transformed (in kg/MJ biofuel/bioliquid, this value is dependent on the yield of processing)
- Amount of co-product (in kg/MJ biofuel/bioliquid)
- The yield of each step in the production of the biofuel/bioliquid (in MJ Biofuel/MJ input)
- The lower heating values of products and co-products (in MJ/kg)
- Amount of chemicals used in processing (in kg/MJ biofuel)
- Emissions from the processing plant to the air, namely on biofuel/bioliquid/biomethane processing plants
- Amount of wastes treated (in kg/MJ or m3/MJ)
- All other relevant processes or inputs

Actual values for emissions from processing steps (**e_p**) in the production chain **must** be measured or based on the technical specifications of the processing installation.

When the range of emissions values for a group of processing facilities to which the installation concerned belongs is available, the most conservative number for that group **shall be** used.

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

[15] For more details on the calculation methodology, see section 2.8 "Adjusting actual values calculated for each step".

region. However, 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 due to end-of-life treatment of wastes or residues produced during the processing need to be considered (e.g., wastewater treatment or landfill for solid waste).

For the calculation of GHG emissions from wastes and residues collection and end of life processing, emissions **shall** be allocated according to the energy content of the products and co-products.

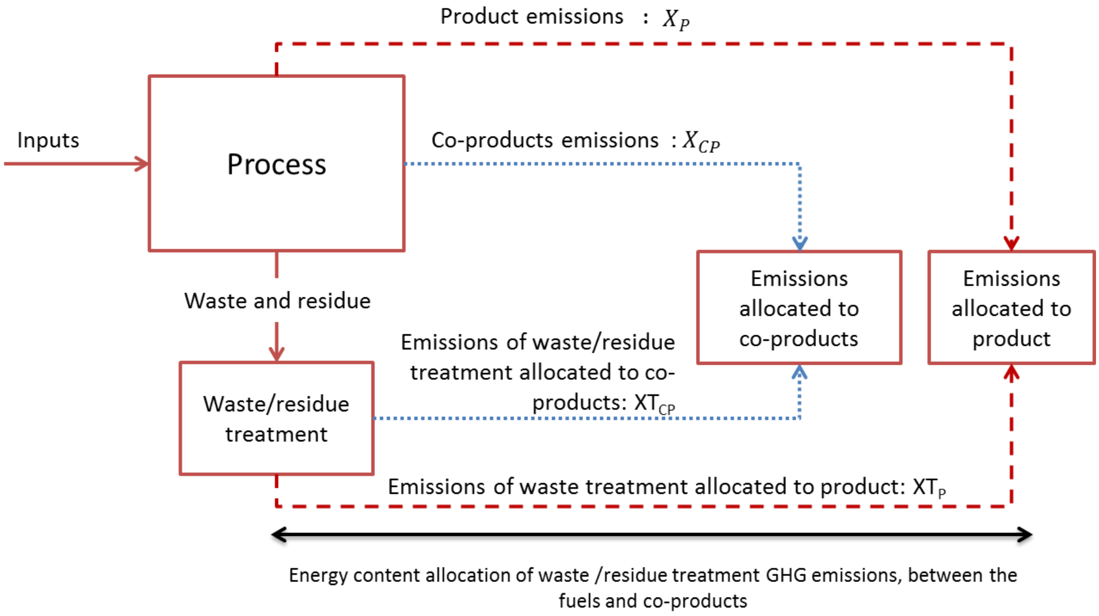


Figure 4: Accounting for GHG emissions from wastes and residues

Where:

- X_P: Emissions allocated to biofuel/bioliquid production [see 2.6.1 Energy content-based allocation criterion] (in $gCO_{2\,eq}/MJ$)
- X_{CP}: Emissions allocated to co-product production [see 2.6.1 Energy content-based allocation criterion] (in $gCO_{2\,eq}/MJ$)
- XT_P: GHG emissions from waste collection and processing allocated to biofuel/bioliquid [see 2.6.1 Energy content-based allocation criterion] (in $gCO_{2\,eq}/MJ$)
- XT_{CP}: GHG emissions from waste collection and processing allocated to co-product [see 2.6.1 Energy content-based allocation criterion] (in $gCO_{2\,eq}/MJ$)

And

$$XT_P = A_P * (\sum F_T * Q_T)$$

$$XT_{CP} = A_{CP} * (\sum F_T * Q_T)$$

Where:

- A_P: Allocation factor to the main product (in %)

- A_{CP}: Allocation factor to the co-product (in %)
- Q_T: Quantity of waste processed (solid, liquid or gas) (e.g.: kg)
- F_T: Emission factor for waste/residue processing (in $gCO_{2\,eq}$/waste e.g.: $gCO_{2\,eq}$/kg)

The total GHG emissions from biofuel/bioliquid production are calculated according to the following formula:

$$\mathbf{e_p = X_P + XT_P}$$

2.7.5. GHG emissions from transport and distribution: e_{td}

All emissions from transport and storage of raw materials and semi-finished materials and from the storage and distribution of finished materials **must be** taken into account for the calculation of the factor $\mathbf{e_{td}}$. This is why actual values for transportation can only be calculated when all values are available.

All GHG emissions of each transportation, storage, or distribution step in the supply chain **must be** calculated as follows for each intermediate or final product:

$$\boldsymbol{e}_{\mathbf{td}\boldsymbol{i}} = \left[\frac{\sum_j \boldsymbol{EF}_{\mathbf{TD}\boldsymbol{i(j)}} * \boldsymbol{D}_{\boldsymbol{i(j)}}}{\boldsymbol{\eta}_{\boldsymbol{i}}} + \sum (\boldsymbol{EF}_{\boldsymbol{S}} * \boldsymbol{Q}_{\boldsymbol{S}})\right] * \boldsymbol{a}_{\boldsymbol{i}}$$

- $\mathbf{e_{td\mathit{i}}}$: GHG emissions of the transportation, storage or distribution step i of the supply chain (e.g. transportation of rapeseed grain between the collection site and the extraction site) (in gCO_{2eq}/t of transported, stored or distributed product, respectively)

- $\mathbf{EF_{TDi(j)}}$: Emission factors of the means of transport j used in the transportation step i per ton of intermediate product before transport (e.g.: Truck for dry product, 16-32t (in gCO_{2eq}/(t.km))

- $\mathbf{D_{i(j)}}$: Distance travelled by the means of transport j for the transportation step i (km)
  - $\boldsymbol{\eta_i}$: Mass yield of the transportation step i (ton of product transported / ton of product before transport)
  - $\mathbf{EF_s}$: emission factors of other inputs (in $gCO_{2\,eq}$/input e.g.: $gCO_{2\,eq}$/kWh)
  - $\mathbf{Q_s}$: quantities of inputs used per ton of transported product (in e.g.: kWh/t)
  - $\mathbf{a_i}$: energy allocation factor between product used for fuel production and co-products, referring to step i of the production chain.

The following data is required as a minimum:

- The travelling distance of the materials (in km),
- The mass yield of each step of transportation, storage and distribution of bioliquid/biofuel (e.g., the yield of storage and transport,…) (in tonnes of the product after transport, storage or distribution/tonne of product before transport, storage and distribution respectively)
- Emissions factors for the means of transport **shall be** taken the Commission Implementing Regulation (EU) 2022/996 of 14 June 2022, Annex IX (Standard Values of Emissions Factors)
- Quantities of other inputs used (per tonne of transported product)

In the case of transportation of biomass between two economic operators, the requirement is to give a value for factor $\mathbf{e_{td}}$ in $gCO_{2\ eq}$ per "dry mass" of biomass to the next economic operator using the calculation rule given previously, since the conversion in $gCO_{2\ eq}$/MJ of fuel depends on the yield of the processes and allocation factor(s) of any co-products and should therefore be done by the final economic operator[16].

When calculating the actual value of $\mathbf{e_{td}}$ for the whole supply chain, yields and allocating the different production and transportation steps are necessary. Therefore, only the final operator can carry out this operation.

The factor $\mathbf{e_{td}}$ includes the fuel depot and filling station emissions. These emissions are both related to electricity usage and **must** be taken into account as defined by Biograce[17], e.g. depot: 0.00084 MJ/MJ fuel, filling station: 0.0034 MJ/MJ fuel.

One important point to note is that for imported fuels, several depots may need to be included in the calculation (e.g., import and export terminals).

In the case of organisations storing several types of raw materials, it is possible to use an apportionment formula to allocate a share of the overall energy consumption to each raw material. [See 2.6 Allocation criterion and rule for application.]

2.7.6. Emissions from the fuel in use: $\mathbf{e_u}$

The last interface shall consider

- **Zero emissions** for the biofuels consumption, $\mathbf{e_u}$.
- **Emissions of non-CO2 greenhouse gases** (N_2O and CH_4) of the bioliquids consumption $\mathbf{e_u}$.

2.7.7. Emission saving from soil carbon accumulation via improved agricultural management: $\mathbf{e_{sca}}$

Emission savings from soil carbon accumulation, in g CO2eq/MJ, through improved agricultural management **shall be** calculated according to the following formula

$$e_{sca} = (CS_A - CS_R) * 3.664 * 10^6 \frac{1}{n} * \frac{1}{P} - e_f$$

Where:

- $\mathbf{CS_R}$: The soil carbon stock associated with reference crop management per unit area (in Mg of C per ha)
- $\mathbf{CS_A}$: The mass of estimated soil carbon stock per unit area associated with the current crop management practices after at least ten years of application (in Mg of C per ha).
- **N** : duration of cultivation of the crop considered (in years)

[16] *For more details on the calculation methodology see Ch 2.8 "Adjusting actual values calculated for each step".*
[17] *https://biograce.net/content/ghgcalculationtools/methodology*

- **P**: the productivity of the crop (in MJ/ha/year)
- **e_f** : emissions from increased fertilisers or herbicide use

2.7.7.1. Spatial scale, choice of climate soil type and land use

The approach is based at the farm level because the crop rotation system is measured at the farm level.

The farmer will provide a declaration covering all the plots of his farm. If necessary, he/she can subdivide the farm to form homogeneous groups (soil-climate, tillage, and inputs). The area considered is that of the farm for farmers who can claim complete uniformity of soil carbon accumulation practices (tillage, achievement of cover and organic matter ...) for all plots. For farmers who have different practices from one plot to another, they will have to provide details of their practices for each plot.

The phenomenon of carbon storage is very long, and the stock balances must be compared over a significant period, which depends on practices at the rotation/farm level and not only on the crop. This justifies the farmer's commitment to a renewable 5-year period (section 2.7.7.2).

The same assessment conducted at the crop level is not suitable to analyse how agricultural practices affect other crops and, therefore, C storage or release.

When determining its climate and soil categories, 2BS recommends the use of the IPCC climate maps (Tier 2 type) associated to date with the e_{sca} calculation model.

In case of doubt about the precise location for the climate type (straddling several zones), the climate type with the lowest C stock per hectare should be considered.

2.7.7.2. Commitment to maintain improved management practices

The improved agricultural management practices must be applied continuously. A farmer or economic operator must commit to apply the improved management practice for at least 2 x 5 years.

The economic operator shall provide evidence to the auditor every year that the improved management practices have been implemented for the previous year and thus, that he respects his commitment. Failure to meet this criterion will lead to all e_{sca} values of the current year for the farmer or economic operator being added as emissions to the overall GHG emissions of the energy crop delivered instead of being deducted as GHG emission savings. Operators will also be forbidden to include an e_{sca} value in their GHG calculations for five years, even if they change the certification scheme.

If one of a group of farmers withdraws early from the commitment, the penalties shall apply only to the farmer concerned and not to other members of the group.

2.7.7.3. e_{sca} system management

The management of e_{sca} system is based on three different scenarios. The decision tree and the detailed table of the different scenarios presented in the annexes (see Annex B 5.1 and Annex B 5.2) clarify the methodology to be followed for the following elements:

- the date of commitment to the process

- the determination of the CSR
- the date of submission of the e_{sca} claim
- the determination of the CSA
- the level of the e_{sca} cap

based on two factors:

- the starting date of the improved agriculture management practices
- the submission of an e_{sca} claims prior to the date of entry into force of implementing regulation 2022/996, i.e. 30.06.2022

(i) Improved management practices occurring before the Implementing Regulation with registering of e_{sca} claims

The e_{sca} bonus is based on the calculation of CSR and CSA actual values.
The measurement of CSR shall be carried out before the management practice changes to establish a baseline. Once defined over time, this value is unmodified for a given farm. Then the CSA shall be measured at regular intervals no later than five years apart.

Economic operators, who are already engaged in improved agricultural practices and have made e_{sca} claims before the entry into force of the Implementing Regulation (EU) 2022/996 shall measure the CSR as follows :

- Option 1 : Individual soil test realized before the esca practices.
- Option 2 : Measurement from a neighbouring field if it exists.
- Option 3 : Use of reference in database proposed by 2BS.

The first option shall be prioritized, if the measure does not exist the second or third option shall be used. If the third option is used, the first soil measurement will become the new CSR.

After the commitment date, these operators calculate a CSA based on the model (modeled CSA) for 5 years. The prediction model recommended by 2BS is referenced in section 2.7.7.6. At the 5th year after the commitment date, these operators must perform a first soil analysis (actual CSA) (see section 2.7.7.5).

The date of commitment corresponds to the date of the first declaration of the e_{ec} and e_{sca} values of the farmer to the economic operator.

e_{sca} declaration may be submitted without any delay.

Economic operators may apply a cap of 45 g CO_2eq/MJ biofuel or bioliquid in a transition period until the first measurement of the carbon stock increase is made at the 5th year. This e_{sca} cap is only valid for a CSA that takes place before June 30, 2027. Thereafter, the increase in carbon stock measured at the 5th year (actual CSA) will become a cap for the annual declarations to be submitted in the following 5 years.

(ii) Improved management practices occurring before the Implementing Regulation without registering of e_{sca} claims

If the application of improved agricultural management practices started in the past, but no previous e_{sca} claims were made, a minimum of 3 years of continuous application of the improved management practice is required from the date of commitment, before the farmer or economic operator can submit a declaration. The commitment date corresponds to the date of the beginning of application of the good practices.

Annual retroactive Esca claims can be made but for no longer than three years prior to the moment of Esca certification.

In such case, economic operators shall measure the CSR as follows :

- Option 1 : Individual soil test realized before the esca practices.
- Option 2 : Measurement from a neighbouring field or other fields with similar climatic and soil conditions as well as similar field management history if it exists. If there is no available data from such a neighbouring field, a first measurement shall be done immediately, at the moment of commitment. The next measurement of carbon stock increase will have to be made 5 years later.

The first option shall be prioritized, if the measure does not exist the second option shall be used.

After the commitment date, these operators calculate a CSA based on the model (modelled CSA) for 5 years. The prediction model recommended by 2BS is referenced in section 2.7.7.6. At the 5th year after the commitment date, these operators must perform a first soil analysis (actual CSA) (see section 2.7.7.5).

The maximum possible total value of annual claim for emission savings from soil carbon accumulation due to improved agricultural management (e_{sca}) is capped at 25 g CO_2eq/MJ of biofuel or bioliquid for the entire period of application of the e_{sca} practices.

(iii) Improved management practices occurring after the Implementing Regulation

If the application of improved agricultural management practices started after the Implementing Regulation (EU) 2022/996, a minimum of 3 years of continuous application of the improved management practice is required from the date of commitment, before the farmer or economic operator can submit a declaration. The commitment date corresponds to the date of the beginning of application of the good practices.

In such a case, the CSR value is measured based on soil analysis at the date of commitment.

Between the 3rd and the 5th year, these operators calculate a CSA based on the model (modelled CSA). The prediction model recommended by 2BS is referenced in section 2.7.7.6 At the 5th year after the commitment date, the operator must perform a first soil analysis (actual CSA) (see section 2.7.7.5).

The maximum possible total value of annual claim for emission savings from soil carbon accumulation due to improved agricultural management (e_{sca}) is capped at 25 g CO_2eq/MJ of biofuel or bioliquid for the entire period of application of the e_{sca} practices.

2.7.7.4. Agricultural practices that promote soil carbon storage

The operator shall include in a management system verifiable evidence to show that the soil carbon has increased or that it is reasonable to expect it to have increased over the period in which the raw materials concerned were cultivated.

The details of all land, the improved practices employed and the dates these practices commenced shall be documented. The GHG emissions savings can only be claimed for the area with a similar climate and soil type, covered by the improved management practices.

The objective is to demonstrate that the farmer is implementing improved agricultural management practices that promote soil carbon storage.
Improved agriculture management practices, accepted for the purpose of achieving emission savings from soil carbon accumulation, include shifting to reduced or zero-tillage, improved crop/rotation, the use of cover crops, including crop residue management, and the use of organic soil improver (e.g. compost, manure fermentation, digestate, biochar, etc.). These practices are defined in Annex B 5.3.[18] To facilitate the use of the IPCC model, a correlation table is available to select the right category according to the IPCC 2019 document.

Fields from different farms can be grouped, providing they have a similar climate, soil type and the same improved management practices.

If different management practices are applied, a claim of GHG emission savings shall be calculated and claimed individually for each method.

2.7.7.5. Soil sampling

The soil sampling must be performed according to the method listed in Annex B 5.4.

To ensure reduced year-to-year fluctuations in the measured soil carbon stocks and to reduce associated errors, it is possible to pool samples taken from different fields (fields being of maximum 5 ha) with a maximum cumulative area of 20ha. These fields must have the same soil and climate characteristics, similar management history in terms of tillage and carbon input to soil and that will be subject to the same improved management practice. In such case samples may be grouped for analysis, including those from fields belonging to different farmers.

Sampling is done either by a sampler or by the farmer. In both cases, the sampling must respect the sampling protocols.

2.7.7.6. Soil analyses

Measurements of soil carbon stocks shall preferably be performed by accredited laboratories[19] (ISO 17025 or equivalent). When such laboratories are not available, the measurements could be conducted by an independent certified laboratory with evidence of impartiality (this evidence must be provided during the audit). When using certified laboratories, preference should be given to laboratories which are in the process of accreditation (ISO 17025).

[18] *An update of the practices is possible under the condition of a prior submission to 2BS for validation.*
[19] *In France, accredited laboratories must also be on the list approved by the French Ministry of Agriculture or on a list of approvals from an equivalent body in a foreign country.*

The soil analysis (soil carbon content, dry bulk density) must be performed according to the method listed in Annex B 5.4 or alternatively according to the following default standards (or any national standard that has demonstrated its equivalence):

- ISO 23400:2021 (Guidelines for the determination of organic carbon and nitrogen stocks and their variations in mineral soils at the plot of land scale) or,
- Organic carbon standard: NF ISO 14235 (Anne method) or NF ISO 10694 (Dumas method). The latter will require in addition to measure the limestone (NF ISO 10693) to determine the organic carbon, or,
- NF EN ISO 11272 - Soil quality - Determination of dry bulk density.

It is recommended to refer to the sample storage time as provided for in the ISO 17025 accreditation of accredited laboratories; this condition also applies when using non-accredited laboratories.

In order to be compared with the model, the soil analysis result must take into account the measurement uncertainty and the sampling uncertainty. These uncertainties are communicated in the analysis reports by the accredited laboratories.

2.7.7.7. 2BS modelling method

After the first measurement of the baseline, the increase in soil carbon can be estimated based on either representative experiments or a range of accepted soil models before a second measurement of the growth in carbon stock is made.

2BS recommended model may be used to estimate soil carbon values when measurements are not carried out.

However, after the second measurement, if the measured value is different from the modeled value, the model used shall be calibrated based on the actual values measured and approved by 2BS. Actual measurements of soil carbon shall be fed back into the 2BS model, as applied by the economic operator, to improve its predictive value and adjust the annual emissions savings from soil carbon accumulation via agricultural management in subsequent years.

Model updating

The Implementing Regulation (EU) 2022/996 allows for models only to estimate annual values for the years between the compulsory soil carbon analysis years indicated in the Implementing Regulation (EU) 2022/996. The general guidelines to identify the rightful model to apply can be found in the following document :https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch02_Generic%20Methods.pdf

Allometric models for quantifying volume, biomass and carbon stocks in land uses containing vegetation, can be used with country specific data to estimate carbon stocks at the Tier 2 level.

A Tier refers to a description of the overall complexity of a methodology and its data requirements. Higher tier methods are generally more complex and data-intensive than lower tier methods. The guidance for each category should contain at least a Tier 1 method, and in many cases, there will be a Tier 2 and Tier 3. Tier 1 models is no longer adapted to the new requirements laid down in the Implementing Regulation

(EU) 2022/996, they are too macroscopic to measure e_{sca} at parcel level. Models used must cope with the new requirements. Tier 3 soil models that requires very detailed data may fit the purpose but not the world availability. The general expectation is that Tier 2 and Tier 3 methods will both be consistent with good practice guidance for key sources.

These guidelines requires that at least Tier 2 model shall be used they may be a practical way to estimate e_{sca} with balance approach between better accuracy and administrative tasks as they are used only to estimate intermediate values as they can be used with country specific data to estimate carbon stocks. The model refers here to soil model for mineral soils.
The guidance is that the model used contains at least one Tier 2 approach among the four following components : Defining management systems, Climate regions and soil types, Reference C stocks, Stock change factors

The IPCC Tier 2 methods should in principle follow the same methodological approach as Tier 1 but allow for higher resolution country specific emissions factors and activity data. Carbon Stock changes in organic soils are based on emission factors that represent the annual loss of organic C throughout the profile due to drainage and associated management activity. The use of regionally aggregated emission factor analysis (i.e., using average estimates for different forest types, or change trajectories) helps to reduce inherent pixel-level uncertainties in carbon storage data for national-scale estimations.

Climate regions and soil types
Countries that have detailed soil classifications and climatic data have the option of developing country-specific classifications. Moreover, it is considered good practice to specify better climate regions and soil types during the development of a Tier 2 inventory if the new classification improves the specification of reference C stocks and/or stock change factors.

The working principles of the IPCC model are explained in the EC document (2010/335/EU). The 2019 version of IPCC dataset is included in these guidelines.
The principle is to compare a reference C stock to a current stock to have a time evolution.

The calculation formula is the following for annual crops:

$$\boldsymbol{e_{sca} = (CS_A - CS_R) * 3.664 * 10^6 \frac{1}{n} * \frac{1}{P} - e_f}$$

CSR is the reference stock (mgC/ha) and CSA the current stock. 3.664 x 10^6 the conversion from mgC/ha to tCO_2eq/ha. The model calculates stocks over 20 years, so n=20 in the above formula. This gives a value per ha/year consistent with the model. P is the productivity in MJ/ha.

Productivity refers to the yield of the seed multiplied by the PCI. The factor is calculated by hectare to then be transformed into gCO_2eq/kg of dry feedstock after division by the dry yield (value given by the FGP) to give gCO_2eq/MJ.

The model takes a reference stock C by type of soil, climate, and ground. Then depending on the type of agriculture carried out, there will be either a positive or negative impact on the reference stock C.
The "ef" corresponds to the emissions from the increase in the use of fertilizers or herbicides. It is calculated according to their consumption per ha/year according to the formulas provided for the calculation of "e_{ec}" in Annex VII of the Implementing Regulation (EU) 2022/996.

The increase in the use of fertilizers and herbicides is calculated by comparing consumption before (last year for the same crop) and after the adoption of the practices for the same crop at the farm level.

"Ef "may be zero, positive or negative. It must not be double counted (at the e_{ec} level).
Tier 2 may be used as a proxy as potential artifacts will be mitigated through the 25 gCO_2/MJ cap (45 g/MJ with the introduction of biochar] and the calculated carbon accumulation trend over 20 years instead of the 5 or 10 years in the e_{sca}. As accumulation seems to follow a log pattern, it should be higher over ten years than over 20 years. Nevertheless, inherent error range due to uncertainties in soil analysis, the soil variable spatial composition and the slow carbon accumulation rate mean that modelisation and measures will only approximate the variation of the carbon soil content[20].

Calibration of the model

The calibration of the model[21] is under the responsibility of the economic operator. It will be checked during the audits as soon as the CSA is measured. 2BS will give the rules in the calculator for the calibration. The model calibration will aim the specific stock change factors (FLU, FMG and FI) to have a more regional specific model. The difference between the CSR and the first CSA will help the economic operator to calibrate the model. The model calibration is not mandatory if the model is verified by the first CSA measurement.

2.7.7.8. Distribution of the e_{sca} bonus

In the case of two energy crops on the same parcel and in the same year, the e_{sca} value is allocated in proportion to the LHV (MJ/kg) of the raw material.

Concerning the production of biogas and biomethane: 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 to produce biogas and biomethane.

2.7.7.9. Calculation of "ef" factor

Emissions associated with increased fertiliser and herbicide use **must** be taken into account. Evidence shall be provided on the historical consumption of fertilisers or herbicides that shall be counted as the average for the three years before the application of the new agricultural practices. Nitrogen fixation crops used to reduce the need for additional fertilisers can be considered in the calculations.

2.7.7.10. Use of Biochar

The e_{sca} method allows counting the accumulation of C in the soil by adding biochar as an organic amendment.

The use of biochar as an organic soil improver alone or in combination with other eligible e_{sca} practices induces a cap on e_{sca} at 45gCO_2eq/MJ of biofuel or bioliquid.

[20] For example, France has dedicated soil map and carbon map with higher precision than Tier 1 ones (more than 200 different values for France)
[21] See agricultural GHG calculator - version 5.3 – available on 2bsvs.org

Biochar has recently entered the list of fertilizer materials in Regulation (EU) 2019/1009, which came into force on 16 July 2022. It is included in constituent material category (CMC) 14 defined in Delegated Regulation (EU) 2021/2088. This category includes materials from pyrolysis and gasification.

To calculate the share of biochar, 2BS recommends referring to the IPCC 2019 (Volume 4, Chapter 2, Annex 4).

2.7.7.11. Eligibility rule for group auditing

A (third party) audit of multiple farms may be conducted if they have:

- The similar climate and soil type;
- A similar management history in terms of tillage;
- The same carbon inputs to soil;
- The same farming practices;
- A date of commitment to the approach in the same year

It is the responsibility of the economic operator to create homogeneous groups allowing the third-party auditor to audit the square root of the farmers. The sample size is the square root of the number of farmers and their selection is done based on 75% by risk analysis and 25% randomly.

If a farmer belonging to an audit group disengages from the e_{sca} process, then the penalties apply only to the farmer concerned and not to all other elements of the group.

2.7.7.12. Caps on e_{sca}[22]

Two separate caps apply to the maximum possible total value of annual claim of emission savings from soil carbon accumulation due to improved agricultural management (e_{sca}).

A cap of 45g CO_2eq/MJ of biofuel or bioliquid applies in the following cases:

- The e_{sca} declarations submitted by the EO, before 30.06.2022 (in this case, the 45g CO_2eq/MJ cap applies during a transition period, until the date of the actual 1st CSA)
- The farmer uses biochar as an organic amendment (in this case, the 45g CO_2eq/MJ cap applies for the whole period of application of the e_{sca} practices)

In all other cases, a cap of 25g CO_2eq/MJ of biofuel or bioliquid applies for the entire period of application of the e_{sca} practices

[22] *The Commission may revise the methodological approach described in this annex as well as the caps applied to annual claims of carbon stock accumulation, based on the outcomes of this monitoring or with the aim to align it with evolving knowledge or with new legislation in this area in the future (i.e., EU carbon farming initiative).*

2.7.7.13. Penalties

The methodology calls for a process of shifting penalties to agricultural biomass suppliers (farmers). However, the responsibility for e_{sca} claims on markets is at the level of the economic operator (FGP, if applicable). Any penalties will be accounted for at the level of the economic operator. The economic operator must pass on the penalties to the farmer.

(i) If a farmer withdraws from the e_{sca} system (non-respect of the commitment)

- The farm's e_{sca} values for the current year are added as emissions to the overall GHG emissions of the energy crop delivered, instead of being deducted as a GHG emission savings.
- The farmer is prohibited from including an e_{sca} value in the GHG calculations for the next 5 years.
- The farmer can thus exclusively claim e_{ec} or NUTS2 values.
- The list of farmers who have not complied with the e_{sca} commitment together with the penalties applied are published on 2BS website, shared with all other voluntary schemes as well as included in the annual activity reports to be sent to the Commission.

(ii) If actual CSA < modeled CSA

If the first measurement of the carbon stock increase in the 5th year indicates a lower total annual carbon stock increase compared to the annual claims made, the annual difference (between the modeled and the actual CSA) has to be deducted in its total accordingly from the farmers' or economic operators' declarations by the next annual claim.

Moreover, the model needs to be recalibrated to reflect the reality (see $2.7.7.7). In that respect, future annual claims that would be also based on modelling will be decreased.

Note that the farmer has the possibility to downgrade his production to NUTS2 or real values (e_{ec}) in order to continue selling it on the biofuel market.

(iii) If actual CSA > modeled CSA

If the soil test result (actual CSA) is higher than the value predicted by the model (modeled CSA), the difference between the actual CSA and the modeled CSA is reported on the e_{sca} for the next 5 years.

(iv) If actual CSA > e_{sca} Cap (45 or 25 gCO_2eq/MJ)

In the case where the soil test result exceeds the e_{sca} caps (45 or 25 gCO_2eq/MJ as appropriate), the cap prevails.

2.7.7.14. e_{sca} claim reporting

Annually, the economic operator must communicate to 2BS:

- information about the non-correlation between the model and the measurement. The declaration will include for each claimed batch, the contributors, the necessary and sufficient elements for the determination of the e_{sca}.
- the list of farmers excluded from e_{sca} system together with the list of penalties applied to each farmer.

These elements will allow 2BS to report to the European Commission and can be used for statistical purposes.

2.7.7.15. Specific cases

(i) End of activity and takeover by a farmer (change of ownership)

If a farmer stops working (e.g., retirement) and is taken over by another farmer who wishes to continue the real values approach:

- Case n°1: If the farmer taking over is not already committed, he commits himself to the EO to apply the good practices; the EO shall update the list of committed farmers.
- Case n°2 : If the farmer is already committed on his other farms with similar climatic and soil conditions to this new farm, he must continue to apply his virtuous practices on all the farms to declare an $e_{sca.}$
- Case n°3 : If the farmer is already committed on his other farms but they have different climatic and soil conditions than this new farm, he must apply virtuous practices on the new farm and a specific declaration for this new farm must be made taking into account the adopted practices.

For all 3 cases, the previous EO is responsible for transferring the farmer's e_{sca} declaration history to the new EO or to the farmer who will provide it to his new EO.

The new EO is responsible for collecting and submitting the farmer's e_{sca} declaration history as well as the internal control record of the new e_{sca} declaration.

In case of change of legal structure for the same farmer, 2BS recommends transferring the legal obligations from one EO to another.

(ii) Change of EO structure

A farmer has the possibility to change EO structure without impacting his commitment to the real GHG values approach.

The previous EO is responsible for transferring the farmer's e_{sca} declaration history to the new EO or to the farmer who will provide it to his new EO.

The new EO is responsible for collecting and submitting the farmer's e_{sca} declaration history as well as the internal control record of the new e_{sca} declaration.

(iii) Extension of the surface of a farm

- Case 1: If new land has the same type of soil and similar farming practices, the farmer manages the e_{sca} bonus in the same way as his other parcels.
- Case 2: If new land has different soil types and/or farming practices, a differentiated management of the e_{sca} calculation is required.

2.7.8. Emission savings e_{ccr} and e_{ccs}

Emission savings have not already been accounted for in $\mathbf{e_p}$ can be included where they relate to biomass-derived CO_2, which is captured and stored, or that replaces fossil CO_2 in a commercial process.

The following rules **shall be** followed.

Rule 1 Emissions saved **must** relate directly to the production and transport of the biofuel to which they are attributed. Information on the origin of the CO_2 that is captured **shall** be recorded (i.e., whether the origin of the CO_2 was from extraction, transport, processing and distribution of fuel). There is no justification for allocating arbitrarily different amounts of savings to biofuels obtained from the same process. All biofuels originating from the same process need to be treated equally. Where the CO_2 is not captured continuously, it might be appropriate to deviate from this approach and attribute different amounts of savings to biofuel obtained from the same process. However, in no case should a higher amount of savings be allocated to a given batch of biofuel than the average amount of CO_2 captured per MJ of biofuel in a hypothetical process where the total CO_2 stemming from the production process is captured.

Rule 2 dedicated to $\mathbf{e_{ccr}}$: The captured CO_2 **must be used** in commercial products and services to replace fossil-derived 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 CO_2 seller **must be able** to demonstrate use made of this CO_2 by the buyer.

So the seller **must require** from the buyer a declaration, in writing, that due to the replacement by biogenic CO_2, emissions of fossil CO_2 are avoided[23].

This declaration shall provide explicit information on how the CO_2 that is replaced was generated previously. Despite this declaration, it will be for the auditor to decide case by case whether the requirements of the Renewable Energy Directive are met, including those emissions that are actually avoided.

[23] *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.*

Rule 3 dedicated to $\mathbf{e_{ccs}}$: Emission savings from CO_2 capture and geological storage, $\mathbf{e_{ccs}}$, **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 of the European Parliament and of the Council.
In order to ensure that $\mathbf{e_{ccs}}$ is limited to adequately stored CO_2, CO_2 producers **must** demonstrate the quality of the storage. If the repository is done:

- On-site, **it must be** demonstrated that leakages are non-existent, and the existing storage guarantees that the leakage does not exceed the current state of technology,

- Off-site, the producer **must demonstrate** a contractual relationship with a "well-known" supplier for this type of activity.

Until further notice, there is no requirement to conduct audits on the premises of the buyer or the supplier as the buyer or the supplier are not part of the chain of custody related to the biofuel production unless there is reasonable suspicion that the written declaration contains false information.

Emission savings from CO_2 capture and geological storage, e_{ccs} may only be taken into account where there is valid evidence that CO_2 was effectively captured and safely stored. Where a third party carries out the transport or geological storage, proof of storage may be provided through the relevant contracts with and invoices of that third party.

Rule 4: the following formulae **shall be used** to calculate e_{ccr} (in gCO_{2eq} per MJ) and e_{ccs} (in gCO_{2eq} per MJ):

$$e_{ccr} = \frac{P_{CO2} - EP_{CO2}}{P_{Biofuel} * LHV_{Biofuel}}$$

And

$$e_{ccs} = \frac{P_{CO2} - EP_{CO2}}{P_{Biofuel} * LHV_{Biofuel}}$$

- ✔ e_{ccr}: Emission saving from carbon capture and replacement in ($gCO_{2\ eq}$ /MJ)
- ✔ e_{ccs}: Emission saving from carbon capture and geological storage in ($gCO_{2\ eq}$ /MJ)
- ✔ P_{CO2}: Quantity of biogenic CO_2 captured during the biofuel production process in ($kgCO_2$)
- ✔ EP_{CO2}: Emission of CO_2 linked to the CO_2 capture and liquefaction process in ($kgCO_2$)
- ✔ $P_{Biofuel}$: Produced quantity of biofuel in (T)
- ✔ $LHV_{Biofuel}$: Lower heating for the biofuel in (MJ/kg)

For the calculation of factor EP_{CO2}, all significant inputs **must** be taken into account:

$$EP_{CO2} = \sum FE_y * Q_y$$

Where:

- FE_y: Emission factors of inputs at CO_2 capture and liquefaction stage (in $kgCO_{2\ eq}$/input e.g.: $kgCO_{2\ eq}$/kg or $kgCO_{2\ eq}$/MWh; these emission factors shall be taken from the Commission Implementing Regulation (EU) 2022/996 of 14 June 2022, Annex IX (Standard Values of Emissions Factors)

- Q_y: Quantities of inputs used at CO_2 capture and liquefaction stage (in kg or MWh)

The factor EP_{CO2} includes GHG emissions related to the CO_2 capture and liquefaction stage, wastes and leakages and the production of potential chemicals or products used in the CO_2 capture and liquefaction stage. It is required to gather, as a minimum, the following data:

- Electricity consumption (in MWh) (from external sources, i.e., not produced in an internal combined heat & power production plant) or Fuel consumption (in MJ)
- Amount and type of raw materials used (in kg)
- All other relevant processes or inputs

2.7.9. Adjusting actual values calculated at some steps/calculation by the last operator

As stated previously in this procedure, "when an economic operator has to provide an actual GHG value for e_{ec}, e_l, e_{td} and sometimes e_p (excluding e_p for the final biofuel), the value **shall be** given in $gCO_{2\ eq}$/kg of dry biomass to the next economic operator, since the conversion in $gCO_{2\ eq}$/MJ of biofuel depends on the yield of the processes and allocation between intermediate/final products and co-products and should be done by the final economic operator".

<u>Rule 1</u>: Transformation steps from the initial raw material (Feedstock) to the final biofuel are done in a "transformation chain".

The following global formula **shall be** used for all required emissions from raw material (Feedstock) when processing intermediate products:

$$e_x IP_a = e_x F_a * FF_a * A_a$$

- $\mathbf{e_x}$: can be $\mathbf{e_{ec}}$, $\mathbf{e_l}$, $\mathbf{e_{td}}$ and sometimes $\mathbf{e_p}$ in the case that it is not e_p for the final biofuel
- $\mathbf{e_x IP_a}$: GHG emissions of the **Intermediate Product**$_\mathbf{a}$ in ($gCO_{2\ eq}$ /kg_{Dry})
- $\mathbf{e_x F_a}$: GHG emissions of the **Feedstock**$_\mathbf{a}$ in ($gCO_{2\ eq}$ /kg_{Dry})
- $\mathbf{A_a}$: Allocation Factor of **Intermediate Product**$_\mathbf{a}$ in (%)

$$Allocation\ factor\ intermediate\ product_a = \left[\frac{Energy\ in\ intermediate\ product_a}{Energy\ in\ intermediate\ product\ and\ co-products}\right]$$

- FF_a: Feedstock Factor$_a$ in (%),

$$Feedstock\ factor_a = [Ratio\ of\ kg\ dry\ feedstock\ required\ to\ make\ 1\ kg\ dry\ intermediate\ product]$$

The rules for defining the “Allocation Factor” are described previously in Chapter 2.6 “Allocation criterion and rules for application”.

In order to illustrate this general formula, we will consider one of the most common situations involving **e_{ec}**:

$$e_{ec}IP_a = e_{ec}F_a * FF_a * A_a$$

- $e_{cc}IP_a$: GHG emissions of the production of Intermediate $Product_a$ in ($gCO_{2\,eq}$ /Kg_{Dry})
- $e_{cc}F_a$:: GHG emissions of the extraction or cultivation of $Feedstock_a$ in ($gCO_{2\,eq}$ /Kg_{Dry})
- A_a: Allocation Factor of Intermediate $Product_a$ in (%)

$$Allocation\ factor\ intermediate\ product\ _a = \left[\frac{Energy\ in\ intermediate\ product_a}{Energy\ in\ intermediate\ product\ and\ co-products}\right]$$

- FF_a: Feedstock $Factor_a$ in (%)

$$Feedstock\ factor_a = [Ratio\ of\ kg\ dry\ feedstock\ required\ to\ make\ 1\ kg\ dry\ intermediate\ product]$$

$$Feedstock\ factor\ _{intermediate\ product\ a} = \left[\frac{feedstock_a\ [Kg dry]}{intermediate\ product_a\ [Kg dry]}\right]$$

<u>Rule 2</u>: At the last processing step, the emission estimate needs to be converted into the unit CO_2eq/MJ of final biofuel. For this transformation, the following formula should be applied to emissions from cultivation:

$$e_{ec}fuel_a\left[\frac{gCO_2eq}{MJ\ fuel}\right]_{ec} = \frac{e_{ec}\ feedstock_a\left[\frac{gCO_2eq}{kg_{dry}}\right]}{LHV_a\left[\frac{MJ\ feedstock}{kg\ dry\ feedstock}\right]} * Fuel\ feedstock\ factor_a * Allocation\ factor\ fuel_a$$

The feedstock factor used in conversion of emissions to the unit CO_2eq/MJ of final biofuel is now referred as the “Fuel feedstock factor”.

- e_xBF_a: GHG emissions of the $Biofuel_a$ in ($gCO_{2\,eq}$ /MJ Biofuel)
- e_xF_a: GHG emissions of the $Feedstock_a$ in ($gCO_{2\,eq}$ /Kg_{Dry})
- LHV_a: Lower Heat Value of the dry $Feedstock_a$ (in MJ/ Kg_{Dry})
- A_{ba}: Allocation Factor of Biofuel in (%)
- BFF_a: Fuel Feedstock $Factor_a$ in (%)

In order to illustrate this general formula, we will consider one of the most common situations involving e_{ec}:

$$e_{ec}BF_a = \frac{e_{ec}F_a}{LHV_a} * BFF_a * A_{ba}$$

- ✔ $e_{cc}BF_a$: GHG emissions of the production of $Biofuel_a$ in ($gCO_{2\ eq}$ /MJ Biofuel)
- ✔ $e_{cc}F_a$: GHG emissions of the extraction or cultivation of $Feedstock_a$ in ($gCO_{2\ eq}$ /Kg_{Dry})
- ✔ LHV_a: Lower Heat Value of the dry $Feedstock_a$ (in MJ/ Kg_{Dry})
- ✔ A_{ba}: Allocation Factor of biofuel in (%)
- ✔ BFF_a: Fuel Feedstock $Factor_a$ in (%)

$$BFF_a = \frac{xMJF_a}{1MJBF_a}$$

- ✔ $xMJF_a$: Quantity of MJ (Mega Joule) of the dry $Feedstock_a$
- ✔ $1MJBF_a$: 1 MJ (Mega Joule) of $Biofuel_a$

Please note that for the calculation of the feedstock factor, the LHV values per dry ton need to be applied, while for the calculation of the allocation factor, LHV values for wet biomass[24] need to be used as this approach are also applied for the calculation of the default values.

2.8. Biomethane/biogas for transport fuel, heat and / or cooling & power

2.8.1. Default values

Biogas, consisting of approximately 50%-60% biomethane and 40%-50% carbon dioxide, can be produced from various crops and waste materials by digestion.

The biogas is then purified to produce biomethane with a similar specification to fossil natural gas. Compressed biomethane can be used as a transport fuel or injected into the natural gas grid. Procedure 2BS-PRO-05 provides additional process details.

Article VI of European Union Directive 2018/2001(RED II) provides:

- the **default values for greenhouse gas emissions savings** from a range of compressed biomethane production systems;

[24] For the purposes of allocation only, the 'wet definition LHV' is used. This subtracts from the LHV of the dry matter, the energy needed to evaporate the water in the wet material. Products with negative energy content are treated at this point as having zero energy, and no allocation is made. See also 2009/28/EC, Annex V, part C, point 18.

- the **disaggregated default values for biomethane production**. Where biomethane is compressed for use as a transport fuel, a value of 4.6 gCO_2eq/MJ biomethane **shall** be added to these disaggregated default values.

In the case of co-digestion of a mixture of different feedstocks in a biogas plant for the production of biogas or biomethane, the default values **shall be** summed according to their energy content:

$$\boldsymbol{E = \sum_{1}^{n} S_n \, . E_n}$$

Where,

E =greenhouse gas emissions per MJ biogas or biomethane produced from co-digestion of the mixture of substrates;
S_n = share of feedstock n in energy content
E_n = emission in gCO_2/MJ for pathway n (default value)
S_n is defined as follows

$$S_n = \frac{P_n \cdot W_n}{\sum_1^n \cdot W_n}$$

Where/

P_n =energy yield [MJ] per kilogram of wet input of feedstock n
The following values of P_n **shall** be used for calculating typical and default values:
P(Maize): 4.16 [$MJ_{biogas}/kg_{\text{ wet maize @ 65 \% moisture}}$]
P(Manure): 0.50 [$MJ_{biogas}/kg_{\text{ wet manure @ 90 \% moisture}}$]
P(Biowaste) 3.41 [$MJ_{biogas}/kg_{\text{ wet biowaste @ 76 \% moisture}}$]

W_n = weighting factor of substrate n defined as:

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

Where:

I_n =Annual input to digester of substrate n [tonne of fresh matter]

AM_n =Average annual moisture of substrate n [kg water/kg fresh matter]
SM_n =Standard moisture for substrate n
The following values of Pn **shall** be used for calculating default values:
P(Maize): 4.16 [$MJ_{biogas}/kg_{\text{ wet maize @ 65 \% moisture}}$]
P(Manure): 0.50 [$MJ_{biogas}/kg_{\text{ wet manure @ 90 \% moisture}}$]
P(Biowaste) 3.41 [$MJ_{biogas}/kg_{\text{ wet biowaste @ 76 \% moisture}}$]
The following values of the standard moisture for substrate SM_n **shall** be used:

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]

For animal manure used as feedstock, a bonus of 45 gCO_2eq/MJ manure (– 54 $kgCO_2eq/t$ fresh matter) is added.

The requirements described in sections 2.1 to 2.5 above for the documentation and transfer of default are also to be followed for biomethane production.

2.8.2. Actual values

In the case of co-digestion of a mixture of different feedstocks in a biogas plant for the production of biogas or biomethane, the total GHG emissions of the biomass fuels resulting from a co-digestion of different substrates shall be calculated as a sum and considering on pro rata 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 as follows:

$$E = \sum_{1}^{n} S_n \cdot (e_{ec,n} + e_{td,feedstock,n} + e_{l,n} - e_{sca,n}) + e_p + e_{td,product} + e_u - e_{ccs} - e_{ccr}$$

Where,

E =total emissions from the production of the biogas or biomethane before energy conversion on a MJ basis
S_n = share of feedstock n, in a fraction of input to the digester.
$e_{ec,n}$ =emissions from the extraction or cultivation of feedstock n;
$e_{td,feedstock,n}$ =emissions from transport of feedstock n to the digester;
$e_{l,n}$ =annualised emissions from carbon stock changes caused by land-use change, for feedstock n;
e_{sca} =emission savings from improved agricultural management of feedstock n (*);
e_p =emissions from processing.
$e_{td,product}$ =emissions from transport and distribution of biogas and/or biomethane;
e_u =emissions from the fuel in use that is, greenhouse gases emitted during combustion.
e_{ccs} =emission savings from CO_2 capture and geological storage; and
e_{ccr} =emission savings from CO_2 capture and replacement.

*** Biomethane made from animal manure receives a bonus saving of 45 gCO_2eq/MJ manure (– 54 $kgCO_2eq/t$ fresh matter).**

The terms in the formula above are calculated as described in section 2.7.

Emissions of CO_2 from fuel in use, $\mathbf{e_u}$, shall be taken to be zero for biomass fuels.
Emissions of non-CO_2 greenhouse gases (CH_4 and N_2O) from the fuel in use shall be included in the $\mathbf{e_u}$ factor.

2.8.3. Leak detection

Both for gas losses and liquefaction, if an actual GHG value is used, the auditor shall verify the register of **leak detection** during the audit. Every year, leak detection is performed by a third party prior to the audit. The economic operator keeps a **register of leak detections**. In case of multiple detections in the same year, the most recent one is retained.

2.8.4. Clarification on gas grid losses and related to liquefaction

For liquefied NG or biomethane, in JEC Well-to-Tank report v5, there are available calculations for 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

For gas losses, the 2019 report which contains the calculations to obtain the default values in RED II contains an emission factor of 0.17 g CH4/MJ NG supplied. See: https://op.europa.eu/en/publication-detail/-/publication/7d6dd4ba-720a-11e9-9f05-01aa75ed71a1

2.9. Renewable transport fuels of non-biological origin

Renewable liquid and gaseous transport fuels of non-biological origin are important to increase the share of renewable energy in sectors that are expected to rely on liquid fuels in the long term. To ensure that renewable fuels of non-biological origin contribute to greenhouse gas reduction, the electricity used for fuel production **shall be** from a renewable source.

Current examples of renewable transport fuels of non-biological origin include hydrogen made from water and renewable electricity.

Electricity obtained from direct connection to an installation generating renewable electricity may be fully counted as renewable electricity where it is used for the production of renewable liquid and gaseous transport fuels of non-biological origin, provided that the installation:

a. comes into operation after, or at the same time as, the installation producing the renewable liquid and gaseous transport fuels of non-biological origin; and

b. is not connected to the grid or is connected to the grid but evidence can be provided that the electricity concerned has been supplied without taking electricity from the grid.

The electricity taken from the grid may be counted as fully renewable provided that:

- it is *produced exclusively* from renewable sources and
- the *renewable properties and other appropriate criteria* have been demonstrated,
- ensuring that the *renewable properties of that electricity are claimed only once and only in one end-use sector*.

Verification of renewable electricity will be detailed when the European Commission has published a methodology to be applied where electricity is taken from the grid rather than generated in situ.

The emissions savings **shall** be calculated according to (COM DA referred to in Article 28(5)) of European Union Directive 2018/2001(RED II). Greenhouse gas emissions intensity **shall be** reported for each consignment of fuel.

The greenhouse gas emissions savings from using renewable liquid and gaseous transport fuels of non-biological origin shall be at least 70 %.

2.10. Recycled carbon fuels

The methodology for GHG emissions savings from recycled carbon fuels will be provided when information has been published by the European Commission.

3. Definitions

'Agricultural, aquaculture, fisheries and forestry residues' means residues that are directly generated by agriculture, aquaculture, fisheries and forestry and that do not include residues from related industries or processing.

'Agricultural biomass' means biomass produced from agriculture.

'Actual value' means the greenhouse gas emissions savings for some or all of the steps of a specific biofuel, bioliquid or biomass fuel production process, calculated in accordance with the methodology laid down in Part C of Annex V or Part B of Annex VI of European Union Directive 2018/2001 (RED II).

'Advanced biofuels' means biofuels that are produced from the feedstock listed in Part A of Annex IX of European Union Directive 2018/2001(RED II).

'Biofuels' means liquid fuel for transport produced from biomass.

'Bioliquids' means liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass.

'Biogas' means gaseous fuels produced from biomass;

'Biomass' means the biodegradable fraction of products, waste and residues of biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin.

'Biomass fuels' means gaseous and solid fuels produced from biomass.

'Biowaste' means biowaste as defined in point (4) of Article 3 of Directive 2008/98/EC.

'Default value' means a value derived from a typical value by the application of pre-determined factors and that may, in the circumstances specified in European Union Directive 2018/2001(RED II), be used in place of an actual value.

'Economic operator' means a producer of raw material, a collector of waste and residues, an operator of installations processing raw material into final fuels or intermediate products, an operator of installations producing energy (electricity, heating or cooling) or any other operator, including of storage facilities or traders that are in physical possession of raw material or fuels, provided that they process the information on the sustainability and greenhouse gas emissions saving characteristics of those raw materials or fuels;

'Forest biomass' means biomass produced from forestry.

'Forest regeneration' means the re-establishment of a forest stand by natural or artificial means following the removal of the previous stand by felling or as a result of natural causes, including fire or storm.

'Fuel supplier' means an entity supplying fuel to the market that is responsible for passing the fuel through an excise duty point or, in the case of electricity or where no excise is due or where duly justified, any other relevant entity designated by a Member State.

'Residue' means a substance that is not the end product(s) that a production process directly seeks to produce; it is not a primary aim of the production process, and the process has not been deliberately modified to produce it;

'Low indirect land-use change-risk biofuels, bioliquids and biomass fuels' means biofuels, bioliquids and biomass fuels, the feedstock of which was produced within schemes which avoid displacement effects of food and feed-crop-based biofuels, bioliquids and biomass fuels through improved agricultural practices as well as through the cultivation of crops on areas which were previously not used for cultivation of crops, and which were produced in accordance with the sustainability criteria for biofuels, bioliquids and biomass fuels laid down in Article 29 of European Union Directive 2018/2001(RED II).

'Intermediate crops for energy purposes (CIVE)' means crops, such as catch crops and cover crops, grown before or after main crops, provided that the use of such intermediate crops does not trigger demand for additional land. For example, Food and feed crops not reaching their maturity and cultivated before or after the main crop can be considered intermediate crops. This Definition is pending clarified guidelines or approval from the EU Commission.

"Mix of raw material for further processing" means the physical mixing of raw material **at the fuel production plant** for the sole purpose of producing biofuels, bioliquids, or biomass fuels.

'Recycled carbon fuels' means liquid and gaseous fuels that are produced from a liquid or solid waste streams of non-renewable origin which are not suitable for material recovery following Article 4 of Directive 2008/98/EC, or from waste processing gas and exhaust gas of non-renewable origin which are produced as an unavoidable and unintentional consequence of the production process in industrial installations.

'Renewable liquid and gaseous transport fuels of non-biological origin' means liquid or gaseous fuels which are used in the transport sector other than biofuels or biogas, the energy content of which is derived from renewable sources other than biomass.

'Severely degraded land' means land that, for a significant period of time, has either been significantly salinated or presented low organic matter content significantly and has been severely eroded.

'Sourcing area' means the geographically defined area from which the forest biomass feedstock is sourced, from which reliable and independent information is available and where conditions are sufficiently homogeneous to evaluate the risk of the sustainability and legality characteristics of the forest biomass.

'Sustainability and greenhouse gas emissions saving characteristics' means the set of information describing a consignment of raw material or fuel that is required for demonstrating compliance of that consignment with the sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels or the greenhouse gas emission savings requirements applicable for renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels;

'Typical value' means an estimate of the greenhouse gas emissions and greenhouse gas emissions savings for a particular biofuel, bioliquid or biomass fuel production pathway, which is representative of the Union consumption.

4. Annex A – "e_{ec}" Calculation

To calculate the emissions from the extraction or cultivation of raw materials Part C, point 5 of Annex V and Part B, point 5 of Annex VI to Directive (EU) 2018/2001 state that the calculation shall include the sum of all 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.

The capture of CO_2 in the cultivation of raw materials shall be excluded. 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 European Directive (EU) 2018/2001 or the information on the disaggregated default values for cultivation emissions included in this Annex, as an alternative to using actual values. In the absence of relevant information in those reports, averages can be calculated based on local farming practices, for instance on data of a group of farms, as an alternative to using actual value

4.1. Emissions from the extraction or cultivation process itself

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

(i) the provision of the fuels for farm machinery used;
(ii) the production of seeding material for crop cultivation;
(iii) the production of fertilisers and pesticides;
(iv) fertiliser acidification and liming application; and
(v) soil emissions from crop cultivation

4.1.1. Fuel use for farm machinery

The GHG emissions from crop cultivation (**field preparation, seeding, fertiliser and pesticide application, harvesting, collection**) shall include all emissions from the use of fuels (such as diesel oil, gasoline, heavy fuel oil, biofuels or other fuels) in farm machinery.

The amount of fuel use in farm machinery shall be duly documented.

Appropriate emission factors of the fuels must be used in accordance with **Annex IX** of Implementing Regulation (EU) 2022/996.

Where biofuels are used, the default GHG emissions set out in Directive (EU) 2018/2001 must be used.

4.1.2. Chemical fertilisers and pesticides

The emissions from the use of chemical fertilisers and pesticides[25] for the cultivation of raw materials shall include all related emissions from the manufacture of chemical fertilisers and pesticides.

The amount of the chemical fertilisers and pesticides, depending on the crop, local conditions and farming practices, shall be duly documented.

Appropriate emission factors, including upstream emissions, must be used to account for the emissions from the production of chemical fertilisers and pesticides pursuant to Annex IX.

If the economic operator knows the factory producing the fertiliser and it falls under the EU Emissions Trading System (**ETS**), then the economic operator can use the production emissions declared under ETS, adding the upstream emissions for natural gas etc.

Transport of the fertilisers shall also be included, using the emissions from transport modes listed in Annex IX. If the economic operator does not know the factory supplying the fertiliser, it should use the standard values provided for **in Annex IX**.

4.1.3. Seeding material

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.

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** must be used. For other seeds, literature values from the following hierarchy must 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

[25] 'Pesticides' means all plant protection products, including herbicides, insecticides, fungicides, etc.

4.1.4. Emissions from neutralisation of fertiliser acidification

The emissions from the neutralisation of fertiliser acidification and application of aglime shall account for the CO_2 emissions

- from neutralisation of acidity from nitrogen fertilisers, or
- from aglime reactions in the soil.

4.1.4.1. Emissions from neutralisation of fertiliser acidification

The emissions resulting from acidification caused by nitrogen fertiliser use **in the field shall be accounted for in the emission calculation**, based on the amount of nitrogen fertilisers used. For:

- **nitrate fertilisers**, the emissions from the neutralisation of nitrogen fertilisers in the soil shall be 0,783 kg CO_2/kg N;
- **urea fertilisers**, the neutralisation emissions shall be 0,806 kg CO_2/kg N.

4.1.4.2. Soil emissions from liming (aglime)

The real amount of aglime used shall be duly documented. 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/kg CaCO3 equivalent aglime).

2. If soil pH is greater or equal to 6,4, an emission factor of 0,98/12,44 = 0,079 kg CO_2/(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 1.4.1 if the fertilizer acidification was neutralized by the applied lime. In such a case, the fertilizer neutralization emissions (in 4.1.4.1) may be subtracted from the calculated liming emissions to avoid that its emissions are counted twice.

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 4.1.4.1.

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 CO_2 emissions shall be calculated using points 1 and 2 of this section above. However, the subtraction specified in point 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.

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

The calculation of N2O emissions from managed soils shall follow the IPCC methodology.

The use of disaggregated cropspecific emission factors for different environmental conditions (corresponding to Tier 2 of the IPCC methodology) shall be used to calculate the N2O emissions resulting from crop cultivation.

Specific emission factors for different environmental conditions, soil conditions and different crops should be taken into account.

Economic operators could use validated models to calculate those emission factors provided that the models take these aspects into account.

In line with the IPCC guidelines[26], both direct and indirect N2O emissions shall be taken into account.

The GNOC tool shall be used, which is based on the formulas below, following the naming conventions in the IPCC (2006) guidelines:

Ntotal – N = N2Odirect – N 2O+ N2Oindirect – N

Where:

- For mineral soils: NDirect – N = [(FSN 2O+ F1ij] ON) • EF+ [FCR • EF1]
- For organic soils: N2ODirect – N = [(F + F1] ON) • EF+ [FF1] CR • E+ [(F2CG, Temp] OS,CG,Temp • EF+ [FCROS,CG,Trop • E2CG,Trop]
- For both mineral and organic soils: N2ODirect – N = [((FGASF) SN • Frac+ (FGASM) • EF4] ON • Erac+ [(F+F+ FCR) • FracLeach-(H) • EF5

4.1.5.1. <u>Crop residue N input</u>

It must be calculated for:

(a) **sugar beet, sugar cane** according to IPCC (2006) Vol. 4 Chapter 11 Eq. 11.6, not considering below-ground residues and with the addition of N input from vignasse and filter cake in the case of sugar cane;

FBurnt • Cf) • [RAG • NAG • (1 – FracRemove)] CR = Yield • DRY • (1-Frac+ FVF)

[26] *IPCC (2006), Vol. 4, Chapter 11: N2O emissions from managed soils, and CO2 emissions from lime and urea application*

(b) **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, pursuant to Annex IX;

(c) for all other crops according to IPCC (2006) Vol. 4 Chapter 11 Eq. 11.7a 11.11, 11.12, as

FBurnt • Cf) • AGDM • NAG • (1-FracRemove) CR = (1-Frac+ (AG+ Yield • DRY) • RBG-BIO • NBG

Where:

- N2Ototal – N = direct and indirect annual N2O–N emissions produced from managed soils; kg N2O–N ha-1 a-1
- N2Odirect – N = annual direct N2O–N emissions produced from managed soils; kg N2O–N ha-1 a-1
- N2Oindirect – N = annual indirect N2O–N emissions (that is to say, the annual amount of N2O–N produced from atmospheric deposition of N volatilised from managed soils and annual amount of N2O–N produced from leaching and run-off of N additions to managed soils in regions where leaching/run-off occurs); kg N2O–N ha-1 a-1
- FSN = annual synthetic nitrogen fertiliser input; kg N ha-1 a-1
- FON = annual animal manure N applied as fertiliser; kg N ha-1 a-1
- FCR = annual amount of N in crop residues (above ground and below ground); kg N ha-1 a-1
- FOS,CG,Temp = annual area of managed/drained organic soils under cropland in temperate climate; ha-1 a-1
- FOS,CG,Trop = annual area of managed/drained organic soils under cropland in tropical climate; ha-1
- FracGASF = 0,10 (kg N NH3–N + NOx–N) (kg N applied)-1. Volatilisation from synthetic fertiliser
- FracGASM = 0,20 (kg N NH3–N + NOx–N) (kg N applied)-1. Volatilisation from all organic nitrogen fertilisers applied
- FracLeach-(H) = 0,30 kg N (kg N additions) -1. N losses by leaching/run-off for regions where leaching/run-off occurs
- EF1ij = Crop and site-specific emission factors for N2O emissions from synthetic fertiliser and organic N application to mineral soils (kg N2O–N (kg N input)-1);
- EF1 = 0,01 [kg N2O–N (kg N input) -1]
- EF2CG,Temp = 8 kg N ha-1 a-1 for temperate organic crop and grassland soils
- EF2CG,Trop = 16 kg N ha-1 a-1 for tropical organic crop and grassland soils

- EF4 = 0,01 [kg N2O–N (kg N NH3–N + NOx–N volatilised) -1] L 168/36 EN Official Journal of the European Union 27.6.2022
- EF5 = 0,0075 [kg N2O–N (kg N leaching/run-off) -1]
- Yield = annual fresh yield of the crop (kg ha-1)
- DRY = dry matter fraction of harvested product [kg d.m. (kg fresh weight)-1] (see Table 1)
- FracBurnt = Fraction of crop area burnt annually [ha (ha)-1]
- Cf = Combustion factor [dimensionless] (see Table 1)
- RAG = Ratio of above-ground residues, dry matter to harvested dry matter yield, for the crop [kg d.m. (kg d. m.)-1] (see Table 3)
- NAG = N content of above-ground residues [kg N (kg d.m.)-1] (see Table 1)
- FracRemove = Fraction of above-ground residues removed from field [kg d.m. (kg AGDM)-1]
- FVF = Annual amount of N in sugar cane vignasse and filter cake returned to the field [kg N ha-1], calculated as Yield * 0,000508.
- AG = Above-ground residue dry matter [kg d.m. ha-1]

4.1.5.2. Crop and site-specific emission factors for N2O emissions from synthetic and organic N application

N2O 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 (2006) statistical model (hereinafter referred to as 'the S&B model'):

$$E = exp\left(-1{,}516 + \sum ev\right)$$

Where:

- E = N2O emission (in kg N2O-N ha-1 a-1)
- ev = effect value for different drivers (see Table 2)
- The EF1ij for the biofuel crop i at location j is calculated (S&B model) as:

$$EF1_{ij} = (E_{fert,ij} - E_{unfert,ij}) / N_{appl,ij}$$

The IPCC (2006) factor (EF1) for direct N2O emissions from fertiliser input based on a global mean shall be replaced by the crop- and site-specific EF1ij for direct emissions from mineral fertiliser and manure N input, based on the crop- and site-specific EF1ij, applying the S&B model.

Where:

- Efert,ij = N2O emission (in kg N2O-N ha-1 a-1) based on S&B, where the fertiliser input is the actual N application rate (mineral fertiliser and manure) to the crop i at location j
- Eunfert,ij = N2O emission of the crop i at location j (in kg N2O-N ha-1 a-1) based on S&B. The N application rate is set to 0, all the other parameters are kept the same.
- Nappl,ij = N input from mineral fertiliser and manure (in kg N ha-1 a-1) to the crop i at location j

Table 1

Crop-specific parameters to calculate N input from crop residues ([3])

Crop	Calculation method	DRY	LHV	N_{AG}	slope	intercept	R_{BG_BIO}	N_{BG}	Cf	R_{AG}	Fixed amount of N in crop residues (kg N ha^{-1})	Data sources*
Barley	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.865	17	0.007	0.98	0.59	0.22	0.014	0.8			1, 2
Cassava	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.302	16.15	0.019	0.1	1.06	0.2	0.014	0.8			1, 2
Coconuts	Fixed N from crop residues	0.94	32.07								44	1, 3
Cotton	No inform. 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	0.61	0.22	0.007	0.8			1, 2
Oil palm fruit	Fixed N from crop residues	0.66	24								159	1, 4
Rapeseed	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.91	26.976	0.011	1.5	0	0.19	0.017	0.8			1, 5
Rye	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.86	17.1	0.005	1.09	0.88	0.22	0.011	0.8			1, 6
Safflower seed	No inform.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	1.33	0.22	0.006	0.8			1, 7
Soybeans	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.87	23	0.008	0.93	1.35	0.19	0.087	0.8			1, 8
Sugar beets	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.6	0.25	16.3	0.004					0.8	0.5		1, 9
Sugar cane	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.6	0.275	19.6	0.004					0.8	0.43		1, 10
Sunflower seed	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.9	26.4	0.007	2.1	0	0.22	0.007	0.8			1, 11
Triticale	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.86	16.9	0.006	1.09	0.88	0.22	0.009	0.8			1, 2
Wheat	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.84	17	0.006	1.51	0.52	0.24	0.009	0.9			1, 2

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

Table 2

Constant and effect values for calculating N_2O emissions from agricultural fields based on the S&B model

Constant value	-1.516	
Parameter	**Parameter class or unit**	**Effect value (ev)**
Fertilizer input		0.0038 * N application rate in kg N ha^{-1} a^{-1}
Soil organic C content	<1 %	0
	1-3 %	0.0526
	>3 %	0.6334
pH	<5.5	0
	5.5-7.3	-0.0693
	>7.3	-0.4836
Soil texture	Coarse	0
	Medium	-0.1528
	Fine	0.4312
Climate	Subtropical climate	0.6117
	Temperate continental climate	0
	Temperate oceanic climate	0.0226
	Tropical climate	-0.3022
Vegetation	Cereals	0
	Grass	-0.3502
	Legume	0.3783
	None	0.5870
	Other	0.4420
	Wetland rice	-0.8850
Length of experiment	1 yr	1.9910

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

Emissions from the collection, drying and storage of raw materials include **all emissions related to fuel use** in the:

- collection,
- drying and storage of

raw materials.

Emissions from collection

Emissions from the collection of raw materials include all the emissions resulting from:

- **the collection** of raw materials and
- **their transport to storage**.

The emissions are calculated using appropriate emission factors for the type of fuel used (diesel oil, gasoline, heavy fuel oil, biofuels or other fuels).

Biomass drying

The cultivation emissions shall include emissions

- **from drying before storage** as well as
- **from storage and handling of biomass feedstock**.

Data on energy use for drying before storage shall include actual data on the drying process used to comply with the requirements of storage, depending on the biomass type, particle size, moisture content, weather conditions, etc.

Appropriate emission factors, including upstream emissions, shall be used 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**.

4.3. Accounting for Emissions for Electricity used in Farmin Operations

When accounting for the consumption of electricity not produced within the fuel production plant, the GHG 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, which can be at a NUTS2[27] region or a national level.
In case national electric emission coefficients are used, the values from Annex IX shall be used.

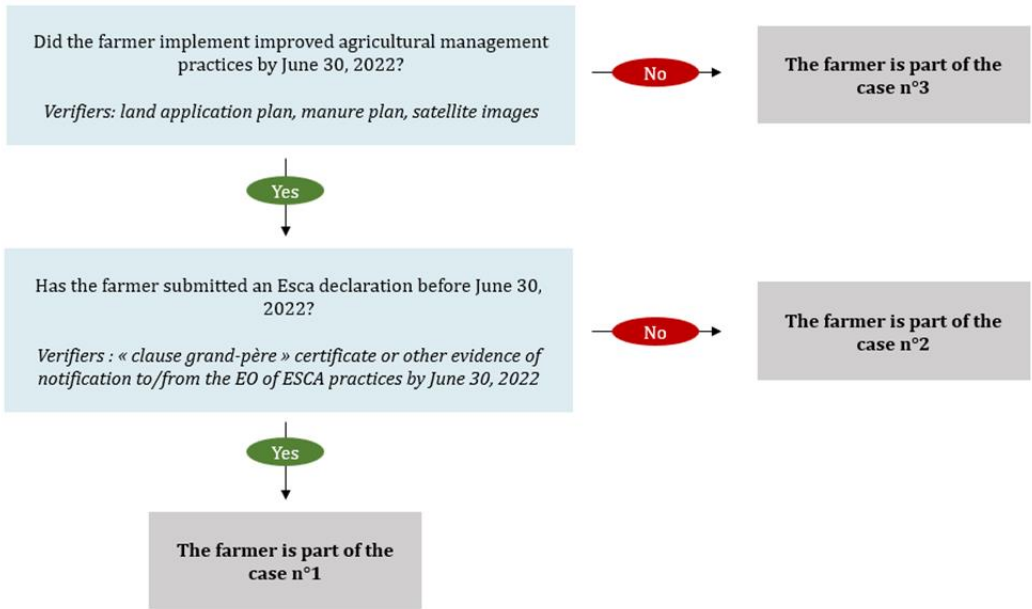
By way of derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant if it is not connected to the electricity grid and sufficient information are available to derive an emission factor.

[27] Nomenclature of territoral units for statistics

5. Annex B – "e_{sca}" Calculation

5.1. Decision tree

Decision tree for the economic operator to determine in which case the farmer is in respect to the Esca claims



5.2. Table of scenarios

		Date of commitment	Proof	Date of submission of Esca claims	CSR	CSA	Cap
Case n°1	**Farmers already engaged in eligible improved agricultural management practices and who have made Esca claims before June 30, 2022**	The date of commitment to the approach corresponds to the date of the 1st declaration of the Eec and Esca values of the farmer to the EO	Proof of commitment to the approach: presentation of the "clause grand-père" declaration or other evidence of notification to/from the EO of ESCA practices by June 30,2022.	The operator can submit an Esca declaration without a delay.	The CSR shall be measured as follows. Option 1 : Individual soil test realized before the esca practices. Option 2 : Measurement from a neighboring field if it exists. Option 3 : Use of reference in database proposed by 2BS. The first option shall be prioritized, if the measure does not exist the second or third option shall be used.	After the commitment date, the operator calculates a CSA based on the model (modeled CSA) for 5 years. At the 5th year after the commitment date, the operator must perform a first soil analysis (real CSA).	Producers committed before June 30, 2022 benefit from the esca cap of 45g CO2eq/MJ of biofuel or bioliquid for 5 years, i.e. until the date of the first real CSA. This esca cap is only valid for a CSA that takes place before June 30, 2027. Thereafter, the increase in carbon stock measured at the 5th year (actual CSA) will become a cap for the annual declarations to be submitted in the following 5 years.
Case n°2	**Farmers already engaged in eligible improved agricultural management practices but no Esca claims were made before June 30, 2022**	The commitment date corresponds to the date of the beginning of application of the good practices	Proof of implementation of improved farm management practices (up to 3 years prior to the commitment date): spreading book, manure plan, satellite images	A minimum of 3 years of continuous application of the improved management practice is required from the date of commitment, before the farmer or economic operator can submit a declaration	The CSR shall be measured as follows. Option 1 : Individual soil test realized before the esca practices. Option 2 : Measurement from a neighboring field if it exists. If there is no available data from such a neighbouring field, a first measurement shall be done immediately, at the moment of commitment. The first option shall be prioritized, if the measure does not exist the second option shall be used.	After the commitment date, the operator calculates a CSA based on the model (modeled CSA) for 5 years. At the 5th year after the commitment date, the operator must perform a first soil analysis (real CSA).	The maximum possible total value of annual claim for emission savings from soil carbon accumulation due to improved agricultural management (esca) is capped at 25 g CO2eq/MJ of biofuel or bioliquid for the entire period of application of the esca practices.
Case n°3	**Farmers starting to implement improved agricultural management practices after June 30, 2022**	The commitment date corresponds to the date of the beginning of the application of the good practices and thus to the date of the CSR measurement.	Proof of the implementation of good practices during the 3 years: spreading book, manure plan, satellite images	A minimum of 3 years of continuous application of the improved management practice is required from the date of commitment, before the farmer or economic operator can submit a declaration	CSR estimation will be based on soil analysis at the date of commitment.	Between the 3rd and the 5th year, the operator calculates a CSA based on the model (modeled CSA). At the 5th year after the commitment date, the operator must perform a first soil analysis (real CSA).	The maximum possible total value of annual claim for emission savings from soil carbon accumulation due to improved agricultural management (esca) is capped at 25 g CO2eq/MJ of biofuel or bioliquid for the entire period of application of the esca practices.

5.3. Soil practices (tillage and inputs) in the calculation of e_{sca}

Practices	Definition
Full tillage	Deep soil tillage (reference practice)
Reduced tillage	Mixing and fragmentation of the soil. Practice considering the TCS (Simplified Cultural Techniques), the strip-till, the decompaction and the subsoiling. Exceptional tillage is allowed under certain conditions listed below: Climatic accidents, weeded plants in the rotation representing less than 30% of the total surface, phytosanitary problems.
No-till	Soil fragmentation only on the seeding line. Exceptional tillage is allowed under certain conditions listed below: Climatic accidents, weeded plants in the rotation representing less than 30% of the total surface, phytosanitary problems.
Organic fertilization	The operators must bring a significant contribution of organic matter (All the waste and organic by-products resulting from agricultural and human activities intended to be spread on the field. They can be of different origins) Non-exhaustive list of organic matter: - Animal: livestock effluents, composts, dried blood, ground horn - Vegetal: green waste, intra-parcel agroforestry, ashes - Human: sewage sludge - Industrial: sugar factory waste, starch factory, vegetables... - Digestates - Biochar - Manure fermentation - Compost
Intermediary crops	Seeding of cover/intermediate crops. Crop management practices should ensure minimum soil cover so that there is no bare ground during the most sensitive periods.
Mulching using crop residues	Agricultural technique consisting of covering the soil with an organic material (mulch), to preserve and improve the structure and fertility of the soil, and limit evaporation and erosion. Mulching can be done directly with the residues of the previous crop.
3-crop rotation	At least one 3-crop rotation, including legumes or green manure in the cropping system, considering the specific agronomic crop succession requirements of each crop and climatic conditions. A multi-species cover crop between cash crops counts as one crop.
Restitution of crop residues	The act of leaving all crop residues on the agricultural plot that can be returned or mulched on the surface

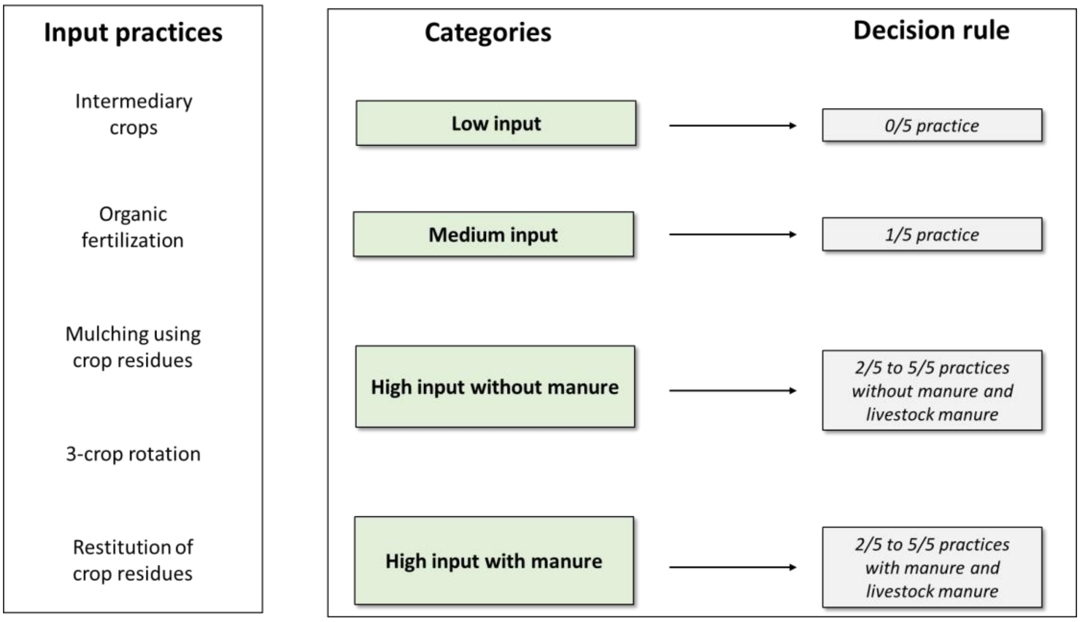
IPCC Categories (from IPCC 2019)

Guidance on management and input for cropland and perennial crops

Management/ Input	Guidance
Full-tillage	Substantial soil disturbance with full inversion and/or frequent (within year) tillage operations. At planting time, little (e.g. < 30 %) of the surface is covered by residues.
Reduced tillage	Primary and/or secondary tillage but with reduced soil disturbance (usually shallow and without full soil inversion) and normally leaves surface with > 30 % coverage by residues at planting.
No till	Direct seeding without primary tillage, with only minimal soil disturbance in the seeding zone. Herbicides are typically used for weed control.
Low	Low residue return occurs when there is due to removal of residues (via collection or burning), frequent bare-fallowing, production of crops yielding low residues (e.g. vegetables, tobacco, cotton), no mineral fertilisation or nitrogen-fixing crops.
Medium	Representative for annual cropping with cereals where all crop residues are returned to the field. If residues are removed then supplemental organic matter (e.g. manure) is added. Also requires mineral fertilisation or nitrogen-fixing crop in rotation.
High with manure	Represents significantly higher carbon input over medium carbon input cropping systems due to an additional practice of regular addition of animal manure.
High without manure	Represents significantly greater crop residue inputs over medium carbon input cropping systems due to additional practices, such as production of high residue yielding crops, use of green manures, cover crops, improved vegetated fallows, irrigation, frequent use of perennial grasses in annual crop rotations, but without manure applied (see row above).

Correspondence table between agricultural practices and categories in IPCC 2019

Crops management	Techniques implemented	Exceptions
NO TILL	Soil fragmentation only on the seeding line.	*Exceptional tillage is allowed under certain conditions, for example : Climatic accidents, weeded plants in the rotation representing less than 30% of the farm, phytosanitary problems.* *Exceptional tillage makes it possible to remain engaged in "semi-direct" and "reduced tillage" practices but implies taking into account the carbon release associated with this change of practice (see calculator)*
REDUCED TILLAGE	Mixing and fragmentation of the soil. Practice taking into account the TCS (Simplified Cultural Techniques), the strip-till, the decompaction and the subsoiling.	
FULL TILLAGE	Any other technique that regularly uses tillage	



5.4. Soil analysis method from the Implementing Regulation (EU) 2022/996 Annex V

1. Representative sampling method:

(a) sampling shall be made for each plot or field;
(b) at least one grab sample of 15 well distributed sub-samples per every 5 hectares or per field, whichever is smaller (taking into account the heterogeneity of the plot's carbon content), shall be taken;
(c) smaller fields with same climatic conditions, soil type, reference farming practice, and e_{sca} practice can be grouped;
(d) sampling shall be done either in spring before soil cultivation and fertilisation or in autumn, a minimum of 2 months after harvest;
(e) direct measurements of soil carbon stock changes shall be taken for the first 30 cm of soil;
(f) the points of the initial sampling to measure the baseline of soil carbon stocks shall be used under identical field conditions (especially soil moisture);
(g) the sampling protocol shall be well documented.

2. Measurement of the soil carbon content:

(a) soil samples shall be dried, sieved, and if necessary grounded;
(b) if the combustion method is used, inorganic carbon shall be excluded.

3. Determination of dry bulk density:

(a) changes in bulk density over time shall be taken into account;
(b) bulk density should be measured using the tapping method, that is to say by mechanically tapping a cylinder into the soil, which greatly reduces any errors associated with bulk density measurement;
(c) if the tapping method is not possible, especially with sandy soils, a reliable method shall be used instead;
(d) samples should be oven-dried prior to weighing.

6. References

[1] EU Directive 2018/2001 - Annex V and Annex VI

[2] R Edwards, JF Larivé, JC Beziat. Well-to-wheels Analysis of future Automotive Fuels & powertrains in the European Context. WTT Appendix 1. Description of individual processes and detailed input data. 2011

[3] Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels. 2010/C 160/02.

[4] BIOIS for ADEME. Development of a methodological standard for performing life cycle analyses applied to first-generation biofuels in France 2008

[5] DECISION OF THE COMMISSION of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purposes of annex V of EU Directive 2009/28/CE modified by the Directive 2015/1513 [notified under document number C(2010) 3751] (2010/335/UE)

[6] Note on the conducting and verifying of actual calculations of GHG emission savings, complementing the communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (2010/C 160/01) and the communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels (2010/C 160/02)

[7] Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels (2010/C 160/02) Annex II. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:160:0008:0016:EN:PDF

[8] Note on the conducting and verifying of actual calculations of GHG emission savings https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001R(04)&from=EN

[9] COMMISSION IMPLEMENTING REGULATION on rules to verify sustainability and greenhouse gas emissions saving criteria and low indirect land-use change-risk criteria.