KZR INiG System/8

Guidelines for the determination of the lifecycle per unit values of GHG emissions for biofuels, biomass fuels and bioliquids

by The Oil and Gas Institute - National Research Institute

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1. Introduction

The use and production of biofuels, bioliquids and biomass fuels should lead to reductions in greenhouse gas emissions compared to fossil fuels.

Rules described in this document are to ensure that operators deliver accurate data on GHG emissions of biofuels, bioliquids and biomass fuels.

Member States will verify whether these emissions fulfil the requirements of the Renewable Energy Directive recast.

As defined in the RED II directive and in the document System KZR INiG/1 biofuel, bioliquids and biomass fuels are obliged to meet GHG reduction threshold (saving).

Greenhouse gas emissions savings from biofuel are calculated according to following equation [1]:

$$SAVING = (E_F - E_B)/E_F \qquad [1]$$

where:

E_B – *total emission from the biofuel*

E_F – *total emissions from the fossil fuel comparator for transport.*

Greenhouse gas emissions savings from heat and cooling, and electricity being generated from bioliquids are calculated according to following equation:

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

where:

$EC_{B(h\&c,el)}$ =*total emissions from the heat or electricity; and*

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

Greenhouse gas emissions savings from biomass fuels used as transport fuels are calculated according to following equation:

$$SAVING = (EF(t) - EB)/EF(t) \qquad [2]$$

where

E_B =*total emissions from biomass fuels used as transport fuels; and*

$E_{F(t)}$ =total emissions from the fossil fuel comparator for transport.

Greenhouse gas emissions savings from heat and cooling, and electricity being generated from biomass fuels are calculated according to following equation:

$$SAVING = (EC_{F(h\&c,el)} – EC_{B(h\&c,el)})/EC_{F\ (h\&c,el)}, \qquad [3]$$

where

$EC_{B(h\&c,el)}$ =total emissions from the heat or electricity,

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

For biofuels, the fossil fuel comparator $E_{F(t)}$ shall be **94 g CO_{2eq}/MJ**.

For bioliquids used for the production of electricity, the fossil fuel comparator $EC_{F(e)}$ shall be **183 g CO_{2eq}/MJ**.

For bioliquids used for the production of useful heat, as well as for the production of heating and/or cooling, the fossil fuel comparator $EC_{F(h\&c)}$ shall be **80 g CO_2eq/MJ**.

For biomass fuels used for the production of electricity, the fossil fuel comparator $EC_{F(el)}$ shall be **183 g CO_{2eq}/MJ** electricity or **212 g CO_{2eq}/MJ** electricity for the outermost regions.

For biomass fuels used for the production of useful heat, as well as for the production of heating and/or cooling, the fossil fuel comparator $E_{CF(h)}$ shall be **80 g CO_{2eq}/MJ** heat.

For biomass fuels used for the production of useful heat, in which a direct physical substitution of coal can be demonstrated, the fossil fuel comparator $EC_{F(h)}$ shall be **124 g CO2eq/MJ** heat.

For biomass fuels used as transport fuels, the fossil fuel comparator $E_{F(t)}$ shall be **94 g CO_{2eq}/MJ**.

By 31 December 2021, the Commission shall adopt delegated acts in accordance with Article 35 to supplement this Directive by specifying the methodology to determine the share of biofuel, and biogas for transport, resulting from biomass being processed with fossil fuels in a common process, and by specifying the methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels, which shall ensure that credit for avoided emissions is not given for

CO_2 the capture of which has already received an emission credit under other provisions of law. These methodologies will be implemented into the KZR INiG with immediate effect.

2. Normative references

The normative references, covering all aspects of the KZR INiG System, are the following linked documents, which should be read in conjunction.

KZR INiG System /1/ Description of INiG System of Sustainability Criteria – general rules

KZR INiG System /2/ Definitions

KZR INiG System /3/ Reference with national legislation

KZR INiG System /4/ Land use for raw materials production – lands with high carbon stock

KZR INiG System /5/ Land use for raw materials production – biodiversity

KZR INiG System /6/ Land use for raw materials production – agricultural and environmental requirements and standards

KZR INiG System /7/ Guidance for proper functioning of mass balance system

KZR INiG System /8/ Guidelines for the determination of the life cycle per unit values of GHG emissions for biofuels, biomass fuels and bioliquids

KZR INiG System /9/ Requirements for certification bodies

KZR INiG System /10/ Guidelines for auditor and conduct of audit

KZR INiG System /11/ Forest biomass

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

Directive 98/70/EC of The European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC.

3. Definitions

KZR INiG System/2/Definitions

4. Guidelines for the determination of greenhouse gases emissions in the life cycle of biofuels

4.1. Conditions for use of default and actual values

Detailed rules for the calculation of greenhouse gas emissions, applied in a particular certification system, must adhere to the RED II methodology. Therefore, extracts from the RED II, concerning this issue, are cited below.

Article 31 of the RED II "***Calculation of the greenhouse gas impact of biofuels, bioliquids and biomass fuels***" provides the following methods of calculation of greenhouse gas emissions in the biofuel life cycle:

a) where a default value for greenhouse gas emission saving for the production pathway is laid down in part A or B of Annex V for biofuels and bioliquids and in Part A of Annex VI for biomass fuels where the e_1 value for those biofuels or bioliquids calculated in accordance with point 7 of part C of Annex V and for those biomass fuels calculated in accordance with point 7 of Part B of Annex VI is equal to or less than zero, by using that default value;

b) by using an actual value calculated in accordance with the methodology laid down in part C of Annex V for biofuels and bioliquids and in Part B of Annex VI for biomass fuels;

c) by using a value calculated as the sum of the factors of the formulas referred to in point 1 of Part C of Annex V, where disaggregated default values in Part D or E of Annex V may be used for some factors, and actual values, calculated in accordance with the methodology laid down in Part C of Annex V, are used for all other factors;

d) by using a value calculated as the sum of the factors of the formulas referred to in point 1 of Part B of Annex VI, where disaggregated default values in Part C of Annex VI may be used for some factors, and actual values, calculated in accordance with the methodology laid down in Part B of Annex VI, are used for all other factors.

Re a)

Default values/disaggregated default values can be applied only if the process technology and feedstock used for the production of the fuels match their description and scope and in the case of biomass fuels also the transport distance. In most cases, it can easily be checked which default value should be applied because many specify only the feedstock used for the production of the biofuel. Others depend also on the energy carrier used for processing, transport distance. Two pathways require additionally the use of processes with methane capture at the oil mill. These default values can be applied by economic operators only when the approved methane capture methods and auditing requirements are described in detail in the scheme documents. Methane capture methods can only be approved when their application ensures that the methane is captured in an efficient manner similar to what has been assumed in the calculation of the default values. For the calculation of the default values, it was assumed that methane emissions are reduced so that without allocating emissions to palm oil mill effluent (POME), plants emit less than 5.46 kgs of methane per tonne of CPO.

Where biomethane is used as compressed biomethane as a transport fuel, a value of 4.6 g CO_2 eq/MJ biomethane needs to be added to the default values.

It is important to note that there are no default emissions values for the component 'land-use changes' (e_l in formula 2 section 4.2.4). If disaggregated default values are used for the cultivation stage, GHG emissions from land-use changes must be added to them.

For biofuels, bioliquid and biomass fuels not falling under the points mentioned above, the actual value for cultivation shall be used.

Please note, that there is no longer any NUTS II restriction on the use of default values.

Both default values and disaggregated default values for all production pathways are listed in Annex 1 to this document.

Re b)

Actual values of GHG emissions resulting from the production of biofuels, bioliquids and biomass fuels may be used in every case.

Re c) and d)

The RED II allows also the use of the sum of disaggregated default values and calculated actual values. Given the complex character of the methodology, adopting this solution may be the most convenient by KZR INiG participants.

Member States may submit to the Commission reports including information on the typical greenhouse gas emissions from the cultivation of agricultural raw materials of the areas on their territory classified as level 2 in the nomenclature of territorial units for statistics (NUTS) or as a more disaggregated NUTS level in accordance with Regulation (EC) No 1059/2003 of the European Parliament and of the Council. In the case of territories outside the Union, reports equivalent to those referred above and drawn up by competent bodies may be submitted to the Commission. The calculation of these values has been scrutinised by the Commission services and thus the KZR INiG may allow operators to apply these values as an alternative to actual values, provided these are available in the unit g CO_2eq/dry-ton of feedstock on the Commission website. The calculation of alternative averages for areas and crops which are covered by the NUTS 2 reports should under normal condition not be deemed appropriate, as the appropriate averages have already been calculated by the national authorities.

It is also possible to calculate average GHG values for a certain region, provided that this takes place on a more fine-grained level. Use of such values should be restricted to farm groups only.

In this context, it is important to note that the values included in the NUTS 2 reports do not represent disaggregated default values. Therefore, they can only be used as input for the calculation of actual values but not to report emissions from cultivation in the unit CO_{2eq}/MJ of fuel.

It is necessary to communicate whether the calculation of actual values remains an option.

Therefore, whenever information that is relevant for the calculation of actual emissions is not adequately taken into account, it must be clearly documented that default values have had to be used.

In every case, annualized emissions from carbon stock changes caused by land-use change that has occurred since January 2008, are taken into account.

Gas losses must be included in the scope of the GHG emissions savings calculation. A standard industry factor can be applied for this purpose.

4.2. Calculation of actual values of greenhouse gas emissions in the life cycle of biofuels, biomass fuels and bioliquids

In cases when the above conditions for usage of default values/ disaggregated default values are not met, or when the actual emission generated during a given process is lower than the one cited in the RED II, the economic operator has the option of providing the actual value of emissions in terms of units of mass or energy of the biomass/processed biomass. All the calculations are carried out based on the dry weight of the raw material / product.

In accordance with the KZR INIG System guidelines, determination of actual values shall be carried out based on credible data, in a clear and transparent way, easy to verify

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

GHG emissions from fuels, E, shall be expressed in terms of grams of CO_2 equivalent per MJ of fuel, gCO_2eq/MJ

The calculations shall be carried out for a defined time period set by the economic producer. This defined time period cannot be longer than one year.

Economic operators can only make actual GHG values claims after the capability to conduct actual value calculations has been verified by an auditor during an audit.

4.2.1. Credibility of data sources

Numerical data constituting a base for determination of values of GHG emissions per unit of mass or energy usually originate from many sources; for instance they can be operator-generated (such as size of production or quantity of energy used for production) – data called primary data, or obtained from external sources (e.g. emission factors for raw materials or energy purchased from an external supplier) – data called secondary data. The data generated within the plant (basic data) shall be stored in properly organized datasets, enabling reviews and verification in a simple way. Data used to calculation covering mass and energy balance (primary data) are always actual values originating from an installation, from production process.

In cases when data are gathered from external sources (secondary data), particular care shall be taken to maintain their transparency and to properly document their origin. Literature data, collected for particular needs, shall originate from commonly available sources, be well documented and transparent.

For the purpose of actual GHG emission calculations, whenever available, the standard calculation values published on the Commission website shall be applied. In case alternative values are chosen this must be duly justified and flagged up in the documentation of the calculations in order to facilitate the verification by auditors.

Below is a recommended list of sources of literature data

- Ecoinvent: http://www.ecoinvent.org

- Biograce: http://www.biograce.net

- GEMIS: http://www.oeko.de

Data concerning land use:

- IPCC Good practice guidance: http://www.ipcc-nggip.iges.or.jp

Whenever an item is covered by the list, the use of alternative values must be duly justified. In case alternative values are chosen, this must be highlighted in the documentation of the calculations, in order to facilitate verification by auditors.

4.2.2. Applicable units

In accordance with the requirements of the RED II, the only unit approved for the determination of intensity of GHG emissions is gCO_{2eq}/MJ of energy contained in the biofuel. Actual values for GHG emissions for raw material and intermediate product shall be expressed in gCO_2eq/dry-ton. Only two kinds of units are acceptable: gCO_{2eq}/MJ for biofuel and gCO_2eq/dry-ton for raw material and intermediate product.

Greenhouse gas emissions from biomass fuels shall be expressed as follows:

(a) greenhouse gas emissions from biomass fuels, E, shall be expressed in terms of grams of CO_2 equivalent per MJ of biomass fuel, g CO_2eq/MJ;

(b) greenhouse gas emissions from heating or electricity, produced from biomass fuels, EC, shall be expressed in terms of grams of CO_2 equivalent per MJ of final energy commodity (heat or electricity), g CO_2eq/MJ.

To receive information on emissions per dry-ton of feedstock, the following formula has to be applied:

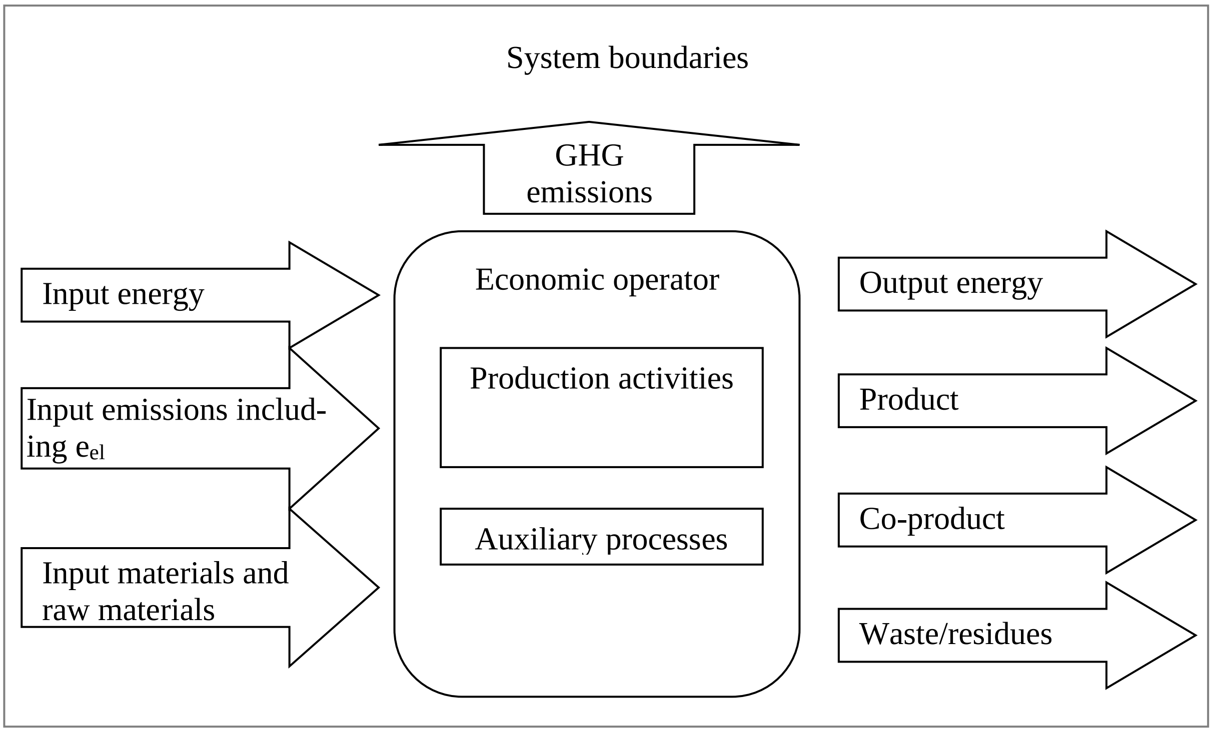
$$e_{ec}feedstock_a \left[\frac{gCO_2eq}{kg_{dry}}\right] = \frac{e_{ec}feedstock_a \left[\frac{gCO_2eq}{kg_{moist}}\right]}{(1 - moisture\ content)} \tag{4}$$

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

4.2.3. System boundaries, completeness of the data

The boundaries of the system of GHG emissions calculation in a given production plant (at a particular stage of a biofuel's life cycle) shall converge with those determined for development of a mass balance system (in accordance with the guidelines of the document *System KZR INiG/7/ Guidance for proper functioning of mass balance system*). The Figure below shows the boundaries of the calculation system schematically.

Fig.1 System boundaries



It is necessary to define all streams of raw materials, other materials and energies entering and exiting the system. The economic operator carrying out the calculations is responsible for both minuteness of detail and scope of inclusion of the production activity within the system boundaries. The significance of the input data in the general GHG balance, and completeness and quality of the values collected from other sources, are the guidelines. **Any emissions from land use change (e_l) that has occurred since 1st January 2008 are taken into account.**

In the performance of some technological processes, small quantities of raw materials and reagents are utilized (e.g. antifoam agents, corrosion inhibitors, water treatment chemicals). Influence of these streams in GHG emission results is slight, and may be omitted if adjusted with a verifier. In such cases, the rule recommended for the evaluation of the magnitude of influence of component data on the result stipulates that if this value does not influence the value of the biofuel's ability to limit greenhouse gases emission saving rounded to one percentage point, the given factor may be disregarded.

4.2.4. Actual value calculation

If at any point of the chain of custody emissions have occurred and are not recorded, so that the calculation of an actual value is no longer feasible for operators downstream in the chain of custody, this must be clearly indicated in the delivery notes.

4.2.4.1. Biofuels and bioliquids

Greenhouse gas emissions **from the production and use of biofuels** and bioliquids shall be calculated as: [4]:

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} \qquad [5]$$

where:

E = *total emissions from the use of the fuel;*

e_{ec} = *emissions from the extraction or cultivation of raw materials;*

e_l = *annualized emissions from carbon stock changes caused by land-use change;*

e_p = *emissions from processing;*

e_{td} = *emissions from transport and distribution;*

e_u = *emissions from the fuel in use;*

e_{sca} = *emission saving from soil carbon accumulation via improved agricultural management;*

e_{ccs} = *emission saving from CO_2 capture and geological storage; and*

e_{ccr} = *emission saving from CO_2 capture and replacement;*

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

(i) For energy installations delivering only heat:

$$EC_h = \frac{E}{\eta_h} \qquad [6]$$

(ii) For energy installations delivering only electricity:

$$\boldsymbol{EC_{el} = \frac{E}{\eta_{el}}}$$

[7]

Where

$EC_{h,el}$ =Total greenhouse gas emissions from the final energy commodity

E =Total greenhouse gas emissions of the bioliquid before end-conversion.

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

η_{h} = The heat efficiency, defined as the annual useful heat output divided by the annual bioliquid input based on its energy content

(iii) For the electricity or mechanical energy coming from energy installations delivering useful heat together with electricity and/or mechanical energy:

$$EC_{el} = \left(\frac{C_{el}\cdot\eta_{el}}{C_{el}\cdot\eta_{el}+C_h\cdot\eta_h}\right) \qquad [8]$$

(iv) For the useful heat coming from energy installations delivering heat together with electricity and/or mechanical energy:

$$EC_h = \frac{E}{\eta_h}\left(\frac{C_h\cdot\eta_h}{C_{el}\cdot\eta_{el}+C_h\cdot\eta_h}\right) \qquad [9]$$

Where:

$E_{Ch,el}$ =Total greenhouse gas emissions from the final energy commodity.

E =Total greenhouse gas emissions of the bioliquid before end-conversion.

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

η_h =The heat efficiency, defined as the annual useful heat output divided by the annual fuel input based on its energy content.

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

C_h =Carnot efficiency (fraction of exergy in the useful heat).

The Carnot efficiency, Ch, for useful heat at different temperatures is defined as:

$$C_h = \frac{T_h - T_o}{T_h} \quad \textbf{[10]}$$

Where

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 exported 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 the purposes of that calculation, the following definitions apply: (a) ‘cogeneration’ means the simultaneous generation in one process of thermal energy and electricity and/or mechanical energy; (b) ‘useful heat’ means heat generated to satisfy an economical justifiable demand for heat, for heating and cooling purposes; (c) ‘economically justifiable demand’ means the demand that does not exceed the needs for heat or cooling and which would otherwise be satisfied at market conditions.

Greenhouse gas emissions from biofuels and bioliquids shall be expressed as follows:

(a) greenhouse gas emissions from biofuels, E, shall be expressed in terms of grams of CO_2 equivalent per MJ of fuel, g CO_2eq/MJ.

(b) greenhouse gas emissions from bioliquids, EC, in terms of grams of CO_2 equivalent per MJ of final energy commodity (heat or electricity), g CO_2eq/MJ.

When heating and cooling are co-generated with electricity, emissions shall be allocated between heat and electricity, irrespective if the heat is used for actual heating purposes or for cooling[a].

The efficiency is calculated for each unit separately.

The greenhouse gases taken into account for the purposes of calculation of actual value of GHG emission shall be CO_2, N_2O and CH_4. For the purposes of calculating CO_2 equivalence, those gases shall be valued as follows

CO_2: 1

N_2O: 298

CH_4: 25

4.2.4.2. Biomass fuels

Greenhouse gas emissions from the production and use of biomass fuels, shall be calculated as follows: (a) Greenhouse gas emissions from the production and use of biomass fuels before conversion into electricity, heating and cooling, shall be calculated as:

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

Where

E =total emissions from the production of the fuel before energy conversion;

e_{ec} =emissions from the extraction or cultivation of raw materials;

e_l =annualised emissions from carbon stock changes caused by land-use change;

e_p =emissions from processing;

e_{td} =emissions from transport and distribution;

e_u =emissions from the fuel in use;

e_{sca} =emission savings from soil carbon accumulation via improved agricultural management;

e_{ccs} =emission savings from CO_2 capture and geological storage;

e_{ccr} =emission savings from CO_2 capture and replacement.

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

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

In the case of **co-digestion** of different substrates in a biogas plant for the production of biogas or biomethane, **the default values** of greenhouse gas emissions shall be calculated as:

$$E = \sum_l^n S_n \cdot E_n \qquad [12]$$

Where:

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

S_n =Share of feedstock n in energy content

E_n =Emission in g CO_2/MJ for pathway *n* as provided in Part D of Annex VI of the RED II (see also tables Chapter 2 of Annex 1 to the document System KZR INiG/8)[b]

$$S_n = \frac{P_n \cdot W_n}{\sum_1^n S_n \cdot W_n} \qquad [13]$$

Where

P_n =energy yield [MJ] per kilogram of wet input of feedstock *n* [c]

W_n =weighting factor of substrate *n* defined as:

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

Where

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

[b] For animal manure used as substrate, a bonus of 45 g CO_2eq/MJ manure (– 54 kg CO_2eq/t fresh matter) is added for improved agricultural and manure management.
[c] 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 [$MJ_{biogas}/kg_{\text{wet biowaste @ 76 \% moisture}}$]

AM_n =Average annual moisture of substrate $_n$ [kg water/kg fresh matter]

SM_n =Standard moisture for substrate *n* [d].

In the case of **co-digestion** of *n* substrates in a biogas plant for the production of electricity or biomethane, actual greenhouse gas emissions of biogas and biomethane are calculated as follows:

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

[15]

Where

E =total emissions from the production of the biogas or biomethane before energy conversion;
S_n =Share of feedstock *n*, in fraction of input to the digester;

eec,*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];

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;

e_{ccr} =emission savings from CO_2 capture and replacement.

[d] 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]
[e] For e_{sca} a bonus of 45 g CO_2eq/MJ manure shall be attributed for improved agricultural and manure management in the case animal manure is used as a substrate for the production of biogas and biomethane

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

For energy installations delivering only heat:

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

[16]

For energy installations delivering only electricity:

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

[17]

where:

$E_{Ch,el}$ =Total greenhouse gas emissions from the final energy commodity.

E =Total greenhouse gas emissions of the fuel before end-conversion.

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

η_h =The heat efficiency, defined as the annual useful heat output divided by the annual fuel input, based on its energy content.

For the electricity or mechanical energy coming from energy installations delivering useful heat together with electricity and/or mechanical energy:

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

[18]

For the useful heat coming from energy installations delivering heat together with electricity and/or mechanical energy:

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

[19]

where

$E_{Ch,el}$ =Total greenhouse gas emissions from the final energy commodity.

E =Total greenhouse gas emissions of the fuel before end-conversion.

H_{el} =The electrical efficiency, defined as the annual electricity produced divided by the annual energy input, based on its energy content.

H_h =The heat efficiency, defined as the annual useful heat output divided by the annual energy input, based on its energy content.

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

C_h =Carnot efficiency (fraction of exergy in the useful heat).

The Carnot efficiency, C_h, for useful heat at different temperatures is defined as:

$$C_h = \frac{T_h - T_0}{T_h}$$

[20]

where

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 exported 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 the purposes of that calculation, the following definitions apply:

'cogeneration' shall mean the simultaneous generation in one process of thermal energy and electricity and/or mechanical energy;

'useful heat' shall mean heat generated to satisfy an economical justifiable demand for heat, for heating or cooling purposes;

'economically justifiable demand' shall mean the demand that does not exceed the needs for heat or cooling and which would otherwise be satisfied at market conditions.

4.2.4.3. Overall guidelines referring biofuels, bioliquid and biomass fuels

GHG emissions from energy consumption

At each of the biofuels, bioliquids and production stages, GHG emission is generated in connection with the consumption of energy, both bought and generated by the plant. The energy externally supplied may be in the form of:

- fuel (coal, petroleum oil products, diesel oil, gasoline, natural gas, biomass (also biofuel feedstock, bioliquids));
- electricity from a local energy grid or other supplier;
- heat (commonly as steam) from the nearest available source.

In the case of the calculation of GHG emissions generated in a defined inventory period () in connection with using a particular energy source, the following equation is used:

$$C_x = \epsilon_x * F_{ex} \qquad [21]$$

where:

C_x = *quantity of GHG gases (CO_{2eq}) expressed in mass units, resulting from energy consumption in a given period;*

ε_x = *quantity of energy used in a given period. If this value is not provided directly, and only the amount of fuel used is known, lower heating values shall be used for calculation of this value. Expressed in MJ*

F_{ex} = *GHG emission factor for fuel, taking into account its production and final consumption (expressed as CO_{2eq}/energy unit). For the calculations, it shall be assumed that complete combustion of the fuel occurred. For the purpose of actual GHG emissions calculations, whenever available, the standard calculation values published on the Commission websites should always be applied.*

In Poland, in the case of fossil fuels, indicators developed by the National Center for Emission Balancing and Management (KOBiZE) may be used, applied for accounting in trading CO_2 emissions quotas[6]. In cases when biofuels/bioliquids are used as energy fuel, F_{ex} shall be defined according to the methodology provided in this document.

Formula 20 must be used at each stage of biofuel/bioliquid production.

GHG emissions generated for heat production shall be calculated considering fuels and equipment used for the production; this value shall be provided by the supplier.

When calculating GHG emissions generated by the consumption of electricity not produced in the fuel production plant, the GHG emissions intensity of the production and distribution of that electricity shall be assumed to be equal to the **average emissions intensity of the production and distribution of electricity in a defined region**. In the case of the EU, the most logical choice is the whole EU. In the case of third countries, where grids are often less linked-up across borders, the national average is the appropriate choice. By way of derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid. These rules also apply in case of GHG calculation at farming stage.

4.2.4.4. Emissions from the extraction or cultivation of raw materials, e_{ec}, e_l

Actual values of emissions from cultivation can only be determined at the origin of the chain of custody.

Regulations of this paragraph refer to biofuels, bioliquids, biomass fuels.

Economic operators shall declare the method and source used for determining actual values (e.g. average values based on representative yields, fertilizer input, N_2O emissions and changes in carbon stock).

For agricultural management (e_{ec} and e_l, see formula No. 5 and No 11) it is permitted to use either measured or aggregate values. When using aggregate values:

- Aggregate GHG values may be calculated for farmers operating as a group in a certain region, and on condition that this takes place in more detail than that of NUTS2 or equivalent;
- The calculation of aggregate values for cultivation shall follow the methodology for e_{ec} described in this section;
- Input data should primarily be based on official statistical data from government bodies if available and of good quality. If unavailable, statistical data published by independent bodies may be used. As a third option, the numbers may be based on scientifically peer-reviewed work, on condition that data used lie within the commonly accepted data range when available;

- The data used shall be based on the most recently available information from the above-mentioned sources. The data should be kept updated, unless there is no significant variability of the data over time;
- For fertilizer use, the typical type and quantity of fertilizer used for the crop in the region concerned shall be used;
- If a measured value (as opposed to an aggregated value) for yields is used for the calculation, it is a requirement that a measured value is also used for fertilizer input, and vice versa.

Emissions from the extraction or cultivation of raw materials, e_{ec}, shall include emissions from the extraction or cultivation process itself; from the collection, drying and storage of raw materials; from waste and leakages; and from the production of chemicals or products used in extraction or cultivation. Capture of CO_2 in the cultivation of raw materials shall be excluded. Estimates of emissions from agriculture biomass cultivation may be derived from the use of regional averages for cultivation emissions included in the reports referred to in Article 31(4) of RED II or the information on the disaggregated default values for cultivation emissions, as an alternative to using actual values. In the absence of relevant information in those reports it is allowed to calculate averages based on local farming practises based for instance on data of a group of farms, as an alternative to using actual values.

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

Calculation of actual values shall be carried out based on credible and documented data. Also, the calculation method shall be documented in a clear and evident way. Input data for the calculations shall include, firstly: seeds, biomass yield per area unit, biomass parameters (e.g. moisture content), type of fuel and fuel consumption during cultivation and extraction, quantities and types of fertilizers, plant pesticides, herbicides or other chemicals used, quantities of co-products and other data, depending on specificity of a given production pathway.

The inputs/variables that affect emissions from cultivation will typically include seeds, fuel, fertiliser, pesticide, yield, and N_2O emissions from the field. The short carbon cycle uptake of carbon dioxide in the plants is not taken into account here.

GHG emissions from biomass production are calculated according to the following formula:

$$e_{ec} = e_{seed} + e_{chem} + e_{irr} + e_{filed} + e_{mm} \qquad [22]$$

where:

e_{seed} = GHG emissions from seeding material,

e_{chem} = GHG emissions from production and transport of fertilisers and agrochemicals,

e_{irr} = GHG emissions from crop irrigation,

e_{fuield} = emissions (methane and mostly nitrous oxide) occurring during the cultivation cycle as a result of land management,

e_{mm} = GHG emissions from agricultural, forestry machinery and other mobile or stationary machinery,

e_{ec} is expressed *as* CO_{2eq} *per dry mass.*

GHG emissions from seeding material

include those incurred during production, storage and transport of seeds. Where seeding material is obtained from its own production, the amount of biomass retained as seeding material shall be subtracted from the total biomass production to calculate the net biomass production. It is required to use factors provided by EC[f]

GHG emissions from the production and transport of fertilisers and agrochemicals

These are calculated according to the following formula:

$$e_{chem} = Q_{chem} * F_{chem} \qquad [23]$$

where

Q_{chem} = quantity of fertiliser or agro-chemical applied per unit of land area, usually expressed in mass,

F_{chem} = GHG intensity (emission factor) of fertiliser or agro-chemical production and transport, expressed in mass of CO2eq per unit of fertiliser or agro-chemical (usually mass).

GHG emissions from crop irrigation

[f] https://ec.europa.eu/energy/topics/renewable-energy/biofuels/voluntary-schemes_en?redir=1

These are emissions caused by using machinery for pumping, storage and spreading of water. The related GHG emissions shall be calculated as e_{mm}.

GHG field emissions (*e_{fuield}*)

These are emissions (methane and mostly nitrous oxide) occurring during the cultivation cycle as a result of land management. These emissions consist of two different components:

$$e_{field} = e_{f\_N2O\ direct} + e_{f\_N2Oindirect} \quad [24]$$

where

$e_{f\text{-}N2O}$ direct = direct emissions expressed as mass of CO_2eq per unit of land area;

$e_{f\text{-}N2O}$ indirect = indirect emissions expressed as mass of CO_2eq per unit of land area;

An appropriate way to take into account N_2O emissions from soils is the IPCC methodology, including what are described there as both 'direct' and 'indirect' N_2O emissions[g]. All three IPCC tiers could be used by economic operators. Tier 3, which relies on detailed measurement and/or modeling, seems more relevant for the calculation of 'regional' cultivation values than for the calculation of actual values.

KZR INiG recommends following tools to calculate field emission: Biograce (www.biograce.net), GNOC (https://gnoc.jrc.ec.europa.eu/).

Emissions from fuel use in agricultural and forest machinery are calculated according to the equation:

$$Fl_{mm} = Q_{mmf} * F_f \quad [25]$$

where:

Fl_{mm} = emissions from use of agricultural and forest vehicles, expressed as CO_{2eq} per unit area per year;

Q_{mmf} = fuel consumption of agricultural and forest machinery, expressed in units of mass, volume or energy per unit area per year;

F_t = GHG emission factor from fuel production and consumption, expressed as CO_{2eq} per fuel unit (energy).

For the purposes of reporting, these values may be also expressed in relation to the net amount of biomass produced, using the following equation:

$$F_{mm} = \frac{Fl_{mm}}{Y_{bp}} \qquad [26]$$

where:

F_{mm} = emission from use of agricultural machinery for biomass production, expressed as CO_{2eq} per unit of net biomass produced;

Y_{bp} = net biomass yield, expressed as quantity of biomass (in units of mass or volume), net of any losses or retained seeding material, per unit of land area per year.

In order to determine GHG emissions from the use of chemicals used in agriculture, it is necessary to know their GHG emission factors, and the quantity used in relation to their net biomass yield. This emission includes also emission generated due to transport of raw material to the first gathering point.

Annual emissions from carbon stock changes caused by land-use change, e_l

The methodology for calculating annual emissions from carbon stock changes specified by the KZR INiG is consistent with the European Commission guidelines. Commission Decision 2010/335/EU (5), which provides for guidelines for the calculation of land carbon stocks and is in accordance with Regulations (EU) No 525/2013 and (EU) 2018/841, shall serve as the basis for the calculation of land carbon stocks. Any updates to the methodology will be implemented by KZR INiG without delay.

Annual emissions from carbon stock changes caused by land-use change, e_l shall be calculated by dividing total emissions equally over 20 years.

For the calculation of those emissions the following rule shall be applied:

$$e_l = (CS_R - CS_A) \times 3.664 \times 1/20 \times 1/P - e_B \qquad [27]$$

[h]

[h] Coefficient obtained by dividing molar mass of CO_2 (44.010 g/mol) by molar mass of carbon (12.011 g/mol); amounts to 3.664

where:

e_l *is annualised GHG emissions from carbon stock change due to land-use change (measured as mass (grams) of CO_2-equivalent per unit of biofuel energy (mega joules)). "Cropland"*[i] *and "perennial cropland"*[j] *shall be regarded as one land use;*

CS_R *= the carbon stock per unit area associated with the reference land use (measured as mass (tonnes) of carbon per unit area, including both soil and vegetation). 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;*

CS_A *= the carbon stock per unit area associated with the actual land use (measured as mass (tonnes) of carbon per unit area, including both soil and vegetation). In 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;*

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

e_B *= a bonus of 29 gCO_{2eq}/MJ biofuel or bioliquid if biomass is obtained from restored degraded land under the conditions provided below.*

The bonus of 29 gCO_{2eq}/MJ shall be attributed if evidence is provided that the land:

a) was not in use for agriculture or any other activity in January 2008; and
b) 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 10 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 the erosion phenomena for land falling under (i) are ensured and that soil contamination for land falling under (b) is reduced.

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

The categories referred to in point (b) are defined as follows:

[i] Cropland as defined by IPCC.
[j] Perennial crops are defined as multi-annual crops, the stem of which is usually not annually harvested, e.g. short rotation coppice and oil palm.

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

b) 'severely contaminated land' means land that is unfit for the cultivation of food and feed due to soil contamination.

The methodology of annual emission from carbon stock changes specified by the KZR INiG is consistent with the European Commission guidelines. The European Commission developed guidelines for calculating land carbon stock for the purposes of Annex V of the RED, published in the Commission Decision of 10th June 2010[7].

For the calculation of $CS_{R/A}$ the following formula is used:

$$CS_{A/R} = (SOC + C_{VEG}) \qquad [28]$$

where:

$CS_{A/R}$ = carbon stock per unit of surface area associated with land use (t C /ha)

SOC = soil organic carbon (t C /ha)

C_{VEG} = vegetation carbon stock above and below ground (t C /ha)

Calculation of *SOC*

In accordance with Commission Decision 2010/335/EU, for mineral soils organic carbon in the soil is calculated using the following formula:

$$SOC = SOC_{ST} \times F_{LU} \times F_{MG} \times F_{I} \qquad [29]$$

where:

SOC - soil organic carbon (t C /ha);

SOC_{ST} -is standard soil organic carbon in the 0 to 30 cm topsoil layer (t C/ha);

F_{LU} - land use factor, reflecting the difference between quantity of soil organic carbon in connection with land use forms, and standard soil organic carbon;

F_{MG} - land management factor, reflecting the difference between quantity of soil organic carbon in connection with basic principle management practice, and standard soil organic carbon;

F_{I} - input factor reflecting the difference in soil organic carbon associated with different levels of carbon input to soil compared to the standard soil organic carbon;

The values of SOC_{ST} and F_{LU}, F_{MG}, and F_i used are those provided respectively in Table 1 and Tables 2, 4, 5, and 7 of Commission Decision 2010/335/EU.

Calculation of C_{VEG}

Above- and below-ground vegetation carbon stock (C_{VEG}) may be calculated by two methods:

(1) application of the formula provided under point 5 of Commission Decision 2010/335/EU; or

(2) application of corresponding standard values, provided in Tables 9-18 of Commission Decision 2010/335/EU.

Further details concerning the land use change calculation can be found in the example published by the European Commission at https://ec.europa.eu/energy/sites/ener/files/2010_bsc_example_land_carbon_calculation.pdf.

Emission saving from soil carbon accumulation via improved agricultural management e_{sca}

For the purposes of the calculation referred to formula [5], greenhouse gas emissions savings from improved agriculture management, e_{sca}, such as 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), shall be taken into account only if solid and verifiable evidence is provided that the soil carbon has increased or that it is reasonable to expect to have increased over the period in which the raw materials concerned were cultivated while taking into account the emissions where such practices lead to increased fertiliser and herbicide use[k].

NOTE

Only measures taken after January 2008 are eligible.

[k] Measurements of soil carbon can constitute such evidence, e.g. by a first measurement in advance of the cultivation and subsequent ones at regular intervals several years apart. In such a case, before the second measurement is available, increase in soil carbon would be estimated on the basis of representative experiments or soil models. From the second measurement onwards, the measurements would constitute the basis for determining the existence of an increase in soil carbon and its magnitude

Emission savings from such improvements can be taken into account if evidence is provided that the soil has carbon increased, or solid and verifiable evidence is provided that it can reasonably be expected to have increased, over the period in which the raw materials concerned were cultivated.

E_{sca} is calculated according to the following formula:

$$E_{sca} = (CS_R - CS_A) \times 3.664 \times 1/Y \times 1/P \qquad [30]$$

where:

CS_R *= see formula [27];*

CS_A *= see formula [27];*

Y *= the period (in years) of cultivation of the crops concerned*

P *= the productivity of the crop (measured as biofuel or bioliquid energy per unit area per year in relation to dry product ; and*

e_B *= a bonus of 29 gCO_{2eq}/MJ biofuel or bioliquid if biomass is obtained from restored degraded land under the conditions provided below.*

If applied, the e_{sca} value is transferred throughout the supply chain, expressed in kg $CO_{2}eq$/dry tonne.

4.2.4.5. Emissions from processing, e_p

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

The use of actual values for processing is only possible if information on the emissions of all processing steps was included at the appropriate processing step.

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

Where a biomass fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (‘co-products’), greenhouse gas emissions shall be divided between the fuel or its intermediate product and the co-products in proportion to their energy content (determined by lower heating value in the case of co-products other than electricity and heat). The greenhouse gas intensity of excess useful heat or excess electricity is the same as the greenhouse gas intensity of heat or electricity delivered to the biomass fuel production process and is determined from calculating the greenhouse gas intensity of all inputs and emissions, including the feedstock and CH_4 and N_2O emissions, to and from the cogeneration unit, boiler or other apparatus delivering heat or electricity to the biomass fuel production process. For the purposes of this calculations, 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 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 those purposes instead of the total of those emissions. In the case of biogas and biomethane, all co-products shall be taken into account for the purposes of that calculation. No emissions shall be allocated to wastes and residues. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purposes of the calculation. Wastes and residues, including tree tops and branches, straw, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined) and bagasse, shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials irrespectively of whether they are processed to interim products before being transformed into the final product. In the case of biomass fuels produced in refineries, other than the combination of processing plants with boilers or cogeneration units providing heat and/or electricity to the processing plant, the unit of analysis for the purposes of this calculation shall be the refinery. In the case of cogeneration of electricity and heat, the calculation is performed as described beneath:

Where a cogeneration unit – providing heat and/or electricity to a fuel production process for which emissions are being calculated – produces excess electricity and/or excess useful heat, the greenhouse gas emissions shall be divided between the electricity and the useful heat according to the temperature of the heat (which reflects the usefulness (utility) of the heat). The useful part of the heat is found by multiplying its energy content with the Carnot efficiency, C_h, calculated as follows:

$$C_h = \frac{T_h - T_0}{T_h}$$

[31]

Where:

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 exported 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 the purposes of that calculation, the actual efficiencies shall be used, defined as the annual mechanical energy, electricity and heat produced respectively divided by the annual energy input.

Definitions of “cogeneration”, “useful heat”, “economically justifiable demand” are placed in the document *KZR INiG System* /2 *Definitions.*

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

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

In the case of the **production stage**, given possible savings of GHG emissions and high traceability of production processes, and exact measurements of GHG intensity of both equipment and raw material, it is ultimately recommended to use actual values.

In order to standardize the applicable methodology, some common assumptions shall be made, intended for general use by all economic operators involved in biofuel and bioliquid generation and distribution. According to Communication[3 (see section 3.3.)] it would not seem necessary to include in the calculation inputs which will have little or no effect on the result, such as chemicals used in small amounts in processing. Values of GHG emission savings are rounded to the nearest percentage point.

Emissions from fuel use (heating fuels) at the processing stage are calculated according to equation [20].

Calculation of the GHG emission savings of FAME

Biodiesel derived by transestrification of fats with methanol (FAME) are regarded in the Renewable Energy Directive as being 100% of renewable origin. Similar to other inputs, the carbon footprint of the methanol used in the in estrification process needs to be taken into account in the calculation of the GHG emission intensity of the biofuel. This approach has been used in the calculation of the default values. In the case of conventional methanol in the original RED calculations, 0.0585 MJ of methanol was used per MJ of FAME produced, with an emissions factor of 99.57 g CO2eq per MJ of methanol. This factor is included along with those for other inputs in the list of standard values published on the Commission's website.

4.2.4.6. Emissions from transport and distribution, e_{td},

Economic operators will only be able to use actual values for transport if emissions of all relevant transport steps are taken into account. Therefore, in case no information on actual transport emissions is available at a stage where transport emissions should have occurred, the calculation of actual transport emissions cannot be considered as an option.

These shall include emissions from transport and storage of raw and semi-finished materials and from the storage and distribution of finished materials. This parameter also includes emissions from depots and filling stations. Emissions from on-farm transport and distribution allocated to crops cultivation or raw material extraction shall not be included; they shall instead be covered by 4.2.4.1. Calculation of transport stage starts from first gathering point (first warehouse when material is stored).

Emissions generated at this stage shall be calculated according to equation:

$$F_t = \sum \left(F_f i \cdot Qs_t i\right) D_t \quad [32]$$

where:

$F_f i$ - *emission factor for production and use of* i^{th} *fuel expressed as* CO_{2eq} *per fuel unit (energy);*

$Qs_t i$ - *consumption of* i^{th} *fuel per unit travelled and per unit of product transported (energy content). In the case when it is used, the value takes into account the fuel used for empty back-haul, excluding situations when given means of transport have been used for other purposes;*

D_t - *distance covered by given means of transport, expressed in unit travel.*

F_{td} value is divided by transported weight expressed in dry tone.

Note on emissions from filling stations and depots

Source: Additional background information on depot and filling station emissions provided by the European Commission to the EU voluntary schemes

The Communication 160/02 (see section 2.1) states that:

"Member States need to define which economic operators need to submit the information concerned. Most transport fuels are subject to excise duty, which is payable on release for consumption (9). The obvious choice is to place the responsibility for submitting information

on biofuels on the economic operator who pays the duty. At this point information with regard to the sustainability criteria along the entire fuel chain shall be available (10).”

With regard to footnote (10): *The one exception is the GHG emissions from distribution of the fuel (if needed for the calculation of an actual value). It would be appropriate to use a standard coefficient for this.*

Therefore it would be logical for an operator to use a standard coefficient for this, e.g. the BioGrace excel sheets show the typical/default values used for filling stations.

In addition, the emissions at the fuel depot need to be included. Emissions at the depot and filling station both relate to electricity usage. One important point to note is that for imported biofuels there may be several depots that need to be included in the calculation (e.g. import and export terminals).

The BioGrace includes depot and filling station emissions (for all biofuels). Please note that these numbers were used according to RED I Directive:

- Depot: 0.11 gCO2/MJ fuel (based on electricity usage of 0.00084 MJ/MJ fuel and the standard values for Electricity NG CCGT and Electricity EU mix LV)
- Filling station: 0.44 gCO2/MJ fuel (based on electricity usage of 0.0034 MJ/MJ fuel and the standard value for Electricity EU mix LV)

NOTE

Depot and filling station emissions will be updated using the latest EU electricity grid factor. After that, the KZR INiG will require System participant to use updated numbers immediately.

4.2.4.7. Emissions from the fuel in use, e_u,

These shall be taken to be zero for biofuels and bioliquids.

For the co-processed fuel, only the biogenic component is considered to be zero.

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.

4.2.4.8. Emission savings from carbon capture and geological storage e_{ccs}, Emission savings from carbon capture and replacement, e_{ccr}

Emission savings from carbon capture and geological storage that have not already been accounted for in e_p shall be limited to emissions avoided through the capture and sequestration 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.

Emission savings from carbon capture and geological storage e_{ccs} can only be taken into account if there is valid evidence that CO_2 was effectively captured and safely stored. If the CO_2 is directly stored it should be verified whether the storage is in good condition and that leakages are non-existent.

The KZR INiG System participant's documentation shall include at least the following information:

- The purpose for which the captured CO_2 is used;
- The origin of the CO_2 that is replaced;
- The origin of the CO_2 that is captured;
- Information on emissions due to capturing and processing of CO_2.

The above-mentioned information is subject to audit. Operators using the captured CO_2 should state how the CO_2 that is replaced was previously generated and declare, in writing, that due to the replacement, emissions of that quantity are avoided. The evidence must enable auditors to verify whether the requirements of Directive 2018/2001 are met, including whether emissions are actually avoided.

A good examples of a replacement which can be expected to avoid CO_2 emissions is the case where the CO_2 that is replaced was previously produced in a dedicated process aimed at CO_2 production.

Emission savings from carbon capture and replacement shall be related directly to the production of biofuel or bioliquid they are attributed to, and shall be limited to emissions avoided through the capture of CO_2 of which the carbon originates from biomass and which is used to replace fossil-derived CO_2 used in commercial products and services. The emission saving is expressed in gCO_2eq/MJ. Reducing GHG emissions is assigned only to biofuels, must relate to the production of biofuels from which GHG emissions comes from. If many biofuels comes from the same process, the reduction will be allocated equally to all biofuels. If the CO_2 is not captured continuously, it might be appropriate to deviate from this approach and to attribute different amounts of savings to biofuels 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 all of the CO_2 stemming from the production process is captured[4].

Both CCR and CCS processes require energy for capture, transport and, in the case of CCS, compression of CO_2, causing additional GHG emissions to the atmosphere (unless the energy used comes from renewable sources or from fuels not containing carbon). So the capture of CO_2 originating from biomass processing does not reduce the total GHG emission. In order to reduce CO_2 emission effectively, emissions generated during the capture and storage (replacement) processes shall also be stored, if possible In such a case, only the avoided CO_2 emission is considered and not the amounts actually stored in deep geological structures.

CO_2 captured is the sum of (A) CO_2 produced by the process without capture plus (B) the extra CO_2 generated by the capture process, multiplied by the efficiency factor of the capture process.

CO_2 captured shall be calculated according to equation:

$$CO_{2cap} = \frac{CO_{2ori} \cdot \eta_{cap}}{1 - F_{cap} \cdot \eta_{cap}} \qquad [33]$$

where:

CO_{2cap} - is the total mass of CO_2 captured, expressed in mass units CO_{2eq};

CO_{2ori} - is the mass of CO_2 produced by the process without capture, expressed in mass units CO_{2eq};

η_{cap} - is the efficiency of the capture process (CO_2 produced / CO_2 captured);

F_{cap} - is the GHG emission factor of the capture process, in mass of CO_2eq per mass of CO_2 captured. F_{cap} includes all kind of GHG emission originating from the capture (fuels, input materials, others).

This equation can be solved as long as F_{cap} x η_{cap} is less than 1 (i.e. as long as the capture process produces less CO_2 than it captures).

The total CO_2 produced (CO_2pr) equals CO_2 captured divided by the capture efficiency. The CO_2 avoided is:

$$CO_{2av} = CO_{2ori} - \left(CO_{2pr} - CO_{2cap}\right) = CO_{2ori} - CO_{2cap} \cdot \frac{1 - \eta_{cap}}{\eta_{cap}} \qquad [34]$$

where:

CO_{2av} *= net mass of* CO_2 *"avoided" i.e. not emitted, expressed in mass units* CO_{2eq}*;*

CO_{2cap} *= total mass of* CO_2 *captured, expressed in mass units* CO_{2eq}*;*

CO_{2ori} *= mass of* CO_2 *produced by the process without capture, expressed in mass units* CO_{2eq}*;*

η_{cap} *= efficiency of the capture process (*CO_2 *produced /* CO_2 *captured).*

CO_2 emissions from transport and storage operations are proportional to CO_{2cap} and are not usually captured, further reducing CO_{2av}.

The final equation reads:

$$CO_{2av} = CO_{2ori} - CO_{2cap} \cdot \left(\frac{1-\eta_{cap}}{\eta_{cap}} - F_{tr} - F_{st} \right)$$
$$= CO_{2ori} \left(\frac{1-\eta_{cap}}{1-F_{cap}.\eta_{cap}} \right) \cdot \left(\frac{1-\eta_{cap}}{\eta_{cap}} - F_{tr} - F_{st} \right) \quad [35]$$

where:

CO_{2av} *- is the net mass of* CO_2 *"avoided" i.e. not emitted, expressed in mass units* CO_{2eq}

CO_{2cap} *- is the total mass of* CO_2 *captured, expressed in mass units* CO_{2eq}*;*

CO_{2ori} *- is the mass of* CO_2 *produced by the process without capture, expressed in mass units* CO_{2eq}*;*

η_{cap} *- is the efficiency of the capture process (*CO_2 *produced /* CO_2 *captured);*

F_{cap} *- is the GHG emission factor of the capture process, in mass of* CO_2*eq per mass of* CO_2 *captured.* F_{cap} *includes all kind of GHG emission originating from the capture (fuels, input materials, others);*

F_{tr} *- is the GHG emission factor for* CO_2 *transport, in mass of* CO_2*eq per mass of* CO_2 *transported;*

F_{st} *- is the GHG emission factor for* CO_2 *storage, in mass of* CO_2*eq per mass of* CO_2 *stored.*

Next

CO_{2av} is referred to the amount of biofuel:

$$CCR = \frac{CO_{aav}}{Q_{bf} \cdot LHV_{bf}} \qquad [36]$$

$$CCS = \frac{CO_{aav}}{Q_{bf} \cdot LHV_{bf}} \qquad [37]$$

where:

CO_{2av} - *is the net mass of CO_2 "avoided" i.e. not emitted, expressed in mass units CO_{2eq};*

Q_{bf} - *mass of biofuel, expressed in mass unit;*

LHV_{bf} - *lower heating value of biofuel, expressed as energy unit per mass unit.*

4.3. Biofuels/bioliquids partially originating from renewable sources

Biofuels and bioliquids also include types that only partly consist of substances originating from renewable sources, e.g. ethyl-tert-butyl ether (ETBE). For some of them, Annex III to the RED defines the proportions in which the fuel may be considered a fuel originating from renewable sources, for the purposes stated in this Directive. In cases where a given type of fuel is not listed in Annex III, particularly if the biofuel is produced in a flexible production process (not always ensuring control over constant proportions of components from various sources in the individual supplies), a method analogous to that used to calculate electricity produced in plants powered with mixed fuel may be applied successfully. The method is such that the share of each energy source is calculated based on its energy content. Some specific technological aspects should be taken into account also. The proportions in which the fuel may be considered a fuel originating from renewable sources may be also determined based on reliable documents such as official governments documents issued by MS. For the purposes of meeting the sustainability criteria regarding GHG emission savings, **part of the fuels originating from renewable sources has to meet an appropriate threshold of GHG emission savings. For some biofuels, such as ETBE, tables 3-11 give default values (disaggregated default values).**

4.4. Allocation of GHG emissions to co-products and waste/residues

In the production process, co-products, waste and residues form besides the main product. Hence there is a need to define allocation rules, or allocation of GHG emission intensities, to the product groups mentioned above. Emission inventory for allocation shall also take into account all operations necessary for disposal or utilization, so that they leave the system without burdening with GHG emission. This is why the emissions value for the stage of collection of raw material-waste/residues is considered zero.

GHG emissions are allocated between the main product (biofuel, processed biomass, processed biomass for biofuels production) and co-products, based on the energy content of the individual streams, according to the equation:

$$C_i = C_t * Q_i * \frac{LHV_i}{\Sigma(Q_i * LHV_i)} \qquad [38]$$

where:

C_t = total GHG emissions incurred in the production process, up to separation of products, *expressed in mass units CO_{2eq}*

C_i = amount of C_t allocated to stream *i*, *expressed in mass units CO_{2eq}*

Q_i = amount of stream *i* produced, expressed in energy units

LHV_i = lower heating value of stream *I*, *expressed in energy units per mass unit*.

In applying this rule, the lower heating value used shall be that of the entire (co-)product, not just the dry fraction of it.

When heating and cooling are co-generated with electricity, emissions shall be allocated between heat and electricity, irrespective if the heat is used for actual heating purposes or for cooling.[1]

Co-products

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

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

ation unit, boiler or other apparatus delivering heat or electricity to the fuel production process. An example is the production of ethanol from corn, where through the use of wet grinding, such products as maize syrup, maize oil, maize gluten powder, and maize gluten fodder are obtained, as well as other food products such as vitamins and amino acids. These products may be used as feed for animals (e.g. DDGS – *Dried Distiller's Grains with Solubles*). Emissions are allocated to these products too. No GHG is allocated to waste/residue produced in the process.

In cases where co-products are taken into account in calculations, 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 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 those purposes instead of the total of those emissions.

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

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

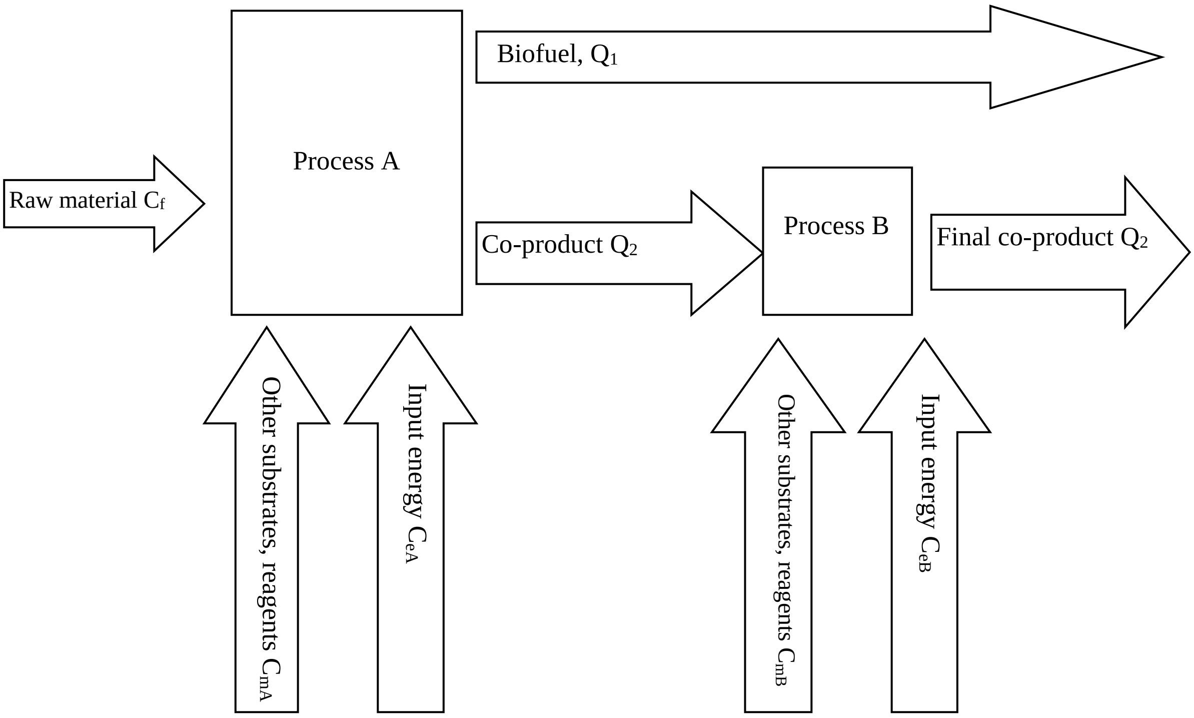
In the case of fuels produced in refineries, other than the combination of processing plants with boilers or cogeneration units providing heat and/or electricity to the processing plant, the unit of analysis for the purposes of the calculation of allocation, shall be the refinery.

Allocation of emissions to the individual products shall be applied directly at this stage of the production process, during which biofuel, bioliquid (or intermediate product), or co-product (provided it is suitable for storage or commerce) are produced.

Allocation of GHG emissions to the individual products and co-products may be carried out at individual stages of the process in the plant, followed by further processing in the next stages of the production chain, for each of the products. However, if the product's or co-product's processing at later stages remains directly related (energy or material feedback loops) to any of the previous processing stages (e.g. turning back of the product stream in a given process), emissions allocations shall be attributed at the moment that each of the products reaches a point in which the next processing stages are no longer connected by material or energetic feedback loops to any earlier processing stages (GHG emissions are not allocated to the stream of product being turned back in the process).

Methodology of allocation of GHG emissions to the product and co-product, in cases where the latter undergoes further processing, is shown schematically in the Figure 2. Figure 3 shows the allocation between biofuels/bioliquids (or intermediates) and co-products with feedback loops.

Fig.2 Methodology of allocation of GHG emissions



Total GHG emissions from Process A (including emissions allocated to input energy), *expressed in mass units CO_{2eq}*:

$$C_{tA} = C_f+C_{mA}+C_{eA} \qquad [39]$$

Total GHG emissions from Process B (including emissions allocated to input energy), *expressed in mass units CO_{2eq}*:

$$C_{tB} = C_{mB}+C_{eB} \qquad [40]$$

GHG emissions allocated to Stream 1 (biofuel/bioliquid), *expressed in mass units CO_{2eq}*:

$$C_1=C_{tA}*Q_1*LHV_1/(Q_1*LHV_1+Q_2*LHV_2) \qquad [41]$$

GHG emissions allocated to Stream 2 (co-product), *expressed in mass units CO_{2eq}*:

$$C_2=C_{tA}*Q_2*LHV_2/(Q_1*LHV_1+Q_2*LHV_2) \qquad [42]$$

Total emissions allocated to the co-product stream: C_2+C_{tB}

Where

$C_{tA/B}$ = *the* total GHG emissions from Process A/B (including emissions allocated to input energy), *expressed in mass units CO_{2eq}*

C_f = *the emissions associated with feedstock, expressed in mass units CO_{2eq}*

$C_{mA/B}$ = *the emissions associated with other materials (Process A or B), expressed in mass units CO_{2eq}*

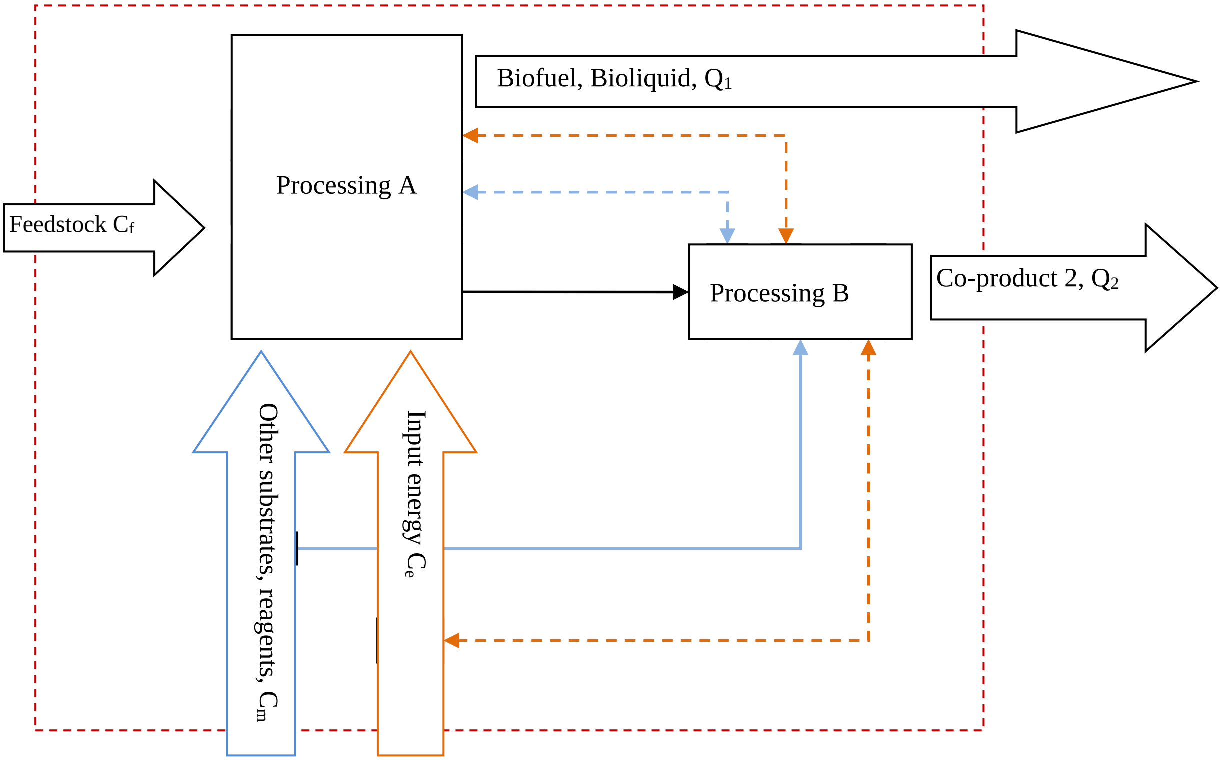
$C_{eA/B}$ = *the emissions associated with energy (A process or B), expressed in mass units CO_{2eq}*

$C_{1\ or 2}$ = GHG emissions allocated to Stream 1 or 2, *expressed in mass units CO_{2eq}*

$Q_{1/2}$ = *quantity of Product 1/2, expressed in mass units*

$LHV_{1/2/}$ = *lower heating value of Product 1/2, expressed as energy units per mass unit*

Figure 3 Allocation between biofuel/bioliquid (or intermediate) and co-products with feedback loops



Total GHG emissions associated with all inputs: $C_t = C_f + C_m + C_e$

GHG emissions allocation to Biofuel/Bioliquid: $C_1 = C_t *Q_1*LHV_1/(Q_1* LHV_1+Q_2* LHV_2)$

GHG emissions allocation to Co-product: $C_2 = C_t *Q_2*LHV_1/(Q_1* LHV_1+Q_2* LHV_2)$

Where

C_t = Total GHG emissions associated with all inputs, *expressed in mass units CO_{2eq};*

C_1 = GHG emissions allocation to Biofuel/Bioliquid, *expressed in mass units CO_{2eq};*

C_2 = GHG emissions allocation to Co-product, *expressed in mass units CO_{2eq};*

C_f = *emissions associated with feedstock, expressed in mass units CO_{2eq};*

C_m = *emissions associated with other materials, expressed in mass units CO_{2eq};*

C_e = *emissions associated with energy, expressed in mass units CO_{2eq};*

$Q_{1/2}$ = *quantity of Product 1/2, expressed in mass units;*

$LHV_{1/2/}$ = *lower heating value of Product 1/2, expressed as energy units per mass unit.*

Co-processing

The emission allocation procedure shall correspond with the character of the raw material. Some of GHG emission components (e.g. those due to reagents, chemicals, production, delivery and combustion of processed fuel) are not directly connected with a given raw material, while the component generated by fuels produced within the plant or associated with chemical reactions occurring in the biomass, may be allocated to the individual raw material streams.

Given that, in cases of the biological origin of the fuel, CO_2 emissions generated from combustion of the fuel are not taken into account, it shall be assumed that these emissions amount to zero. However, it is necessary to take into account emitted nitrogen oxides and methane, converted to CO_2 equivalent.

The quantity of co-processed biofuel is determined according to the *KZR INiG System/7 point 4*.

Waste and residues

Waste from processing, and agriculture crop residue, including straw, husks, cobs and nutshells, and residue formed in other processing operations, including crude glycerine (glycerine that is non-refined) , are considered to have zero life-cycle GHG emissions up to the process of collection of those materials. No emissions should be allocated to agricultural crop residues, residues or wastes, since they are considered to have zero emissions until the point of their collection. Similarly, when these materials are used as feedstock they start with zero emissions at the point of collection.

For the determination of the GHG emission savings value for a given biofuel, knowledge of the total GHG emissions generated in the life cycle of this product is necessary. Therefore, the intensity level of GHG emissions shall be determined at every stage by every economic operator handling biomass/processed biomass for energy purposes. Given the large diversification in operational activities of individual economic operators, there will be differences in: the scope of data, the operation taken into account, and the units in which the calculations will be carried out. Table 1 below gathers the most important elements pertaining to the calculations of GHG emissions at every stage.

Table 1 – Basic elements of GHG emissions calculation at different stages

Production stage	GHG emissions	Reference to system document	Unit	Subject
Land-use	Carbon stock change Soil degradation	*KZR INiG System /4/*, *KZR INiG/ System 5/* *KZR INiG System /8/* p.4.2	kg CO_{2eq}/t of biomass (dry tonne)	Farmer
Biomass production	Emissions from usage of fertilizers and plant pesticides Emission from usage of agricultural machinery Field emission	*KZR INiG System /8/* p.4.2, p.4.4	kg CO_{2eq}/t of biomass (dry tonne)	
Biomass purchase, brokerage	Emissions from biomass purification and storage processes	*System KZR INiG/8/* p.4.2, p.4.4	kg CO_2/t of biomass (dry tonne)	First gathering point, Broker
	Emissions from biomass transport	*System KZR INiG/8/* p.4.2	kg CO_2/t of biomass (dry tonne)	Broker
Biomass processing	Emissions introduced with reagents Emissions from processes and operations	*System KZR INiG/8/* p.4.2, p.4.4	kg CO_{2eq}/t of biomass (dry tonne) or g CO_{2eq}/MJ of energy contained in the biofuel	Intermediate producer
Biofuel/bioliquid production	Emissions introduced with reagents Emissions from processes and activities	*System KZR INiG/8/* p.4.2, p.4.3, p.4.4	g CO_{2eq}/MJ of energy contained in the biofuel	Biofuel/ bioliquid producer
Heat/Power plant	Emissions from the fuel in use.	*System KZR INiG/8/* 4.2.4.7.	gCO_2eq/MJ	Heat/Power plant

NOTE

Economic operators are only allowed to use actual values after the ability to conduct such a calculation according to the GHG emissions calculation methodology has been verified by an auditor.

4.5. Adjusting GHG emissions estimates throughout the chain of custody[4]

Whenever actual values are calculated at each step of the chain of custody, the additional emissions from transport and/or processing need to be added to e_p and/or e_{td}, respectively.

Whenever a processing step yields co-products, emissions need to be allocated, as set out in section 4.4.

More formally, the following formula should be applied to emissions from cultivation when processing intermediate products:

$$e_{ec} intermediate\ product_a \left[\frac{gCO_2eq}{kg_{dry}}\right] = e_{ec}\ feedstock_a \left[\frac{gCO_2eq}{kg_{dry}}\right] * Feedstock\ factor_a * Allocation\ factor\ intermediate\ product_a \qquad [43]$$

Where

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

$$Feedstock\ factor_a = [Ratio\ of\ kg\ dry\ feedstock\ required\ to\ make\ 1\ kg\ dry\ intermediate\ product] \qquad [44]$$

At the last processing step, the emission estimate needs to be converted into the unit CO_2eq/MJ of final biofuels, biomass fuels, bioliquids, (call as fuels).

For this transformation, the following formula should be applied to emissions from cultivation:

$$e_{ec} fuel_a \left[\frac{gCO_2eq}{MJ\ fuel}\right]_{ec} = \frac{e_{ec}\ feedstock_a \left[\frac{gCO_2eq}{kg_{dry}}\right]}{LHV_a \left[\frac{MJ\ feedstock}{kg\ dry\ feedstock}\right]} * fuel\ feedstock\ factor_a * Allocation\ factor\ fuel_a \qquad [45]$$

Where

$$Allocation\ factor\ fuel_a = \left[\frac{Energy\ in\ fuel}{Energy\ fuel + Energy\ in\ co-products}\right]$$

$$Fuel\ feedstock\ factor_a = [Ratio\ of\ MJ\ feedstock\ required\ to\ make\ 1\ MJ\ fuel] \qquad [46]$$

Similarly, also the values for e_p, e_{td}, and e_l need to be adjusted. In case of e_p, and e_{td}, the emissions from the relevant processing step must be added. For (e_{ccr}) and carbon capture and geological storage (e_{ccs}), dedicated rules apply.

For the purpose of this calculation feedstock factors based on plant data have to be applied. 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[m] need to be used as this approach was also applied for the calculation of the default values. The assumptions applied in the framework of the calculation of the default values are provided in table 2 for information (assuming that the biofuel is produced in one production step).

Table 2: Assumptions applied for the calculation of default values

Pathway	Crop	LHV: MJ/kg dry feedstock	MJ feedstock /MJ biofuel	Kg dry feedstock /MJ biofuel
Sugar beet ethanol	Sugar beet	16.3	1.840	0.1129
Wheat ethanol	Wheat	17.0	1.882	0.1107
Corn ethanol	Corn	18.5	1.958	0.1059
Sugar cane ethanol	Sugar cane	19.6	2.772	0.1414
FAME biodiesel from rapeseed	Rapeseed	26.4	1.729	0.0655
FAME biodiesel from sunflower	Sunflower seed	26.4	1.610	0.0610
FAME biodiesel from soybeans	Soybeans	23.5	3.078	0.1308
FAME from palm oil	FFB	24.0	2.018	0.0841
HVO from rapeseed	Rapeseed	26.4	1.705	0.0646
HVO from sunflower	Sunflower seed	26.4	1.588	0.0601

[m] 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 a negative energy content are treated at this point as having zero energy, and no allocation is made. See also 2018/2001 Annex VI, part B, point 18.

HVO from palm oil	FFB	24.0	1.992	0.0830
Pure vegetable oil from rapeseed	Rapeseed	26.4	1.718	0.0651

4.6. Usage of default values

If the conditions defining the usage of default values are met, biofuels, bioliquids, biomass fuels producers may indicate the default greenhouse gas emission savings or disaggregated default values for the indicated fuels production pathways, shown in the Annex 1 of *System KZR INiG/8*.

The values listed in the Annex 1 are based on the RED II. In the event of future EC changes in the default values or the GHG methodology, these changes will immediately be applied to the KZR INiG System. Any changes to the GHG methodology shall be notified to the Commission without delay.

5. Verified data collecting

In internal procedures of an economic operator participating in the KZR INiG Certification System, the method for the determination of greenhouse gas emission values for products shall be recorded. Particularly it shall be noted whether default or actual values are used (KZR INiG system permits both these possibilities).

In cases where default values are used, it is necessary to provide objective proof confirming that the necessary conditions are met.

In cases where actual values are used, the economic operator is obliged to collect identifying information on:

- boundaries of the calculation system;
- input data (raw materials, energy media);
- output data (products, energy media);
- internal processes together with their energy requirements;
- sources of primary data;
- sources of secondary data;
- method of calculations;
- wastes/residues, co-products.

All data shall be gathered in a clear, readable, transparent way, easy to verify.

6. Switching type of GHG emissions

Every economic operator in the supply chain is obliged to provide intensities of GHG emissions for their products. The intensity may be expressed using the calculated actual values or, if relevant conditions are met, using default values. Below, in Table 3, System participants' options for forwarding GHG emissions are presented.

Table 3. Possible options for forwarding GHG emission values

Supplier	Supplier's GHG emission type	Receiver	GHG emission type of the next step in a supply chain
FGP	Total default value	Intermediate producer	Only default values can be used. No possibility of switching to other emission type. A numerical value is not given.
	Disaggregated default value		• disaggregated default value for processing stage. A numeric value is not given. • disaggregated default value for cultivation stage and actual value for processing stage. Actual value is expressed in gCO_2eq/dry tonne. Notification is given that disaggregated value for cultivation stage was used. • The highest NUTS value for the country of origin of biomass. • total default value. A numerical value is not given. • either disaggregated default value or actual value for transport may be used.
	NUTS value expressed in gCO_2eq/dry tonne		• Actual value expressed in gCO_2eq/dry tonne. Notification is given that emission from cultivation is included as a NUTS value. • default value. A numerical

			value is not given. • disaggregated value for cultivation stage and actual value for processing stage. Actual value expressed in gCO_2eq/dry tonne. Notification is given that disaggregated value for cultivation stage was used. • disaggregated value for cultivation stage and disaggregated value for processing stage. • either disaggregated default value or actual value for transport may be used.
Intermediate producer	Total default value	Biofuel producer	• only default value may be used. No possibility to switch to other emission type. Default GHG emission saving is reported, as specified in the RED, expressed in %.
	Disaggregated default value for cultivation stage and actual value for processing stage.		• disaggregated default value for cultivation stage and actual value for processing stage. • disaggregated default value both for production stage and cultivation stage. • Default GHG emission saving is reported, as specified in the RED, expressed in %. • either disaggregated default value or actual value for transport may be used.

NOTE

Switching to another option, e.g. from actual to total default value, is possible if relevant requirements are met; these must always be checked.

Particular care is required when using values for transport stage.

7. Changes compared to the previous edition

Date	Section	Previous requirement	Current requirement
05/05/22	1	-	Added: The use and production of biofuels, bioliquids and biomass fuels should lead to reductions in greenhouse gas emissions compared to fossil fuels.
05/05/22	4.1.	Re a) [...] for the production of the biofuels, bioliquids and biomass fuels match their description and scope. [...]	Re a) [...] for the production of the fuels match their description and scope and in the case of biomass fuels also the transport distance. Added: [...]Where biomethane is used as compressed biomethane as a transport fuel, a value of 4.6 g CO_2 eq/MJ biomethane needs to be added to the default values.
05/05/22	4.2.4.1.	-	Added: [...] The efficiency is calculated for each unit separately. [...]
05/05/22	4.2.4.3.	By way of derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid.	By way of derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid. These rules also apply in case of GHG calculation at farming stage.

		[g] Cf. 2006 IPCC guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf).	Footnote removed
05/05/22	6.	-	In table 3, column 4 (GHG emission type of the next step in a supply chain) added point: • The highest NUTS value for the country of origin of biomass