KZR INiG System /8

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

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The KZR INiG System/8

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1. Introduction

Article 17(2) of Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Official Journal of the European Union No. L 140/16 of 9.06.2009), called RED [1], defines one of the sustainability criteria pertaining to the ability of biofuels/ bioliquids to limit greenhouse gas (GHG) emissions. According to that article, GHG emission savings achieved by the use of biofuels/bioliquids must amount to at least 35 % compared to their relevant fossil fuel comparator. Starting from 1.01.2018, this value will increase to 50%.
The GHG emission saving from the use of biofuels shall be at least 60 % for biofuels produced in installations starting operation after 5 October 2015. An installation shall be considered to be in operation if the physical production of biofuels has taken place.

Annex V Part C of the RED provides the following equation [1] for the calculation of the saving mentioned above:

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

where:
E_B – total emission from the biofuel or bioliquid (including emissions from carbon stock change caused by land-use change that has occurred since 1 January 2008), and
E_F – total emissions from the fossil fuel comparator.

E_F is the newest available actual average GHG emission value of the fossil part of gasoline and diesel oil formulations for the area of the European Union, reported under Directive 98/70/EC (FQD). If the latest data are not available, a value of **83,8 gCO_{2eq}/MJ** is used, and for bioliquids used for energy production, in calculations of emission savings, the value of fossil fuel comparator (E_F) amounts to **91 gCO_{2eq}/MJ**. For bioliquids used for heat generation, their emission savings level shall be compared with the fossil fuel comparator (E_F) equal to **77 gCO_{2eq}/MJ**. In the case of bioliquids used in cogeneration, their emission savings shall be compared with the fossil fuel comparator (E_F) of **85 gCO_{2eq}/MJ**.

Determination of E_B value is an important issue. RED[1] specifies the method of determination of this value, leaving the possibility of determination of actual emission values or use of default values listed in the RED to the manufacturer. However, the default value may be used under certain conditions which will be discussed below. The methodology of determining the actual values is provided in Annex V to the RED[1]and in Communications 2010/C 160/01 and 160/02, and EC Decision 2010/335/EU. The KZR INiG methodology is consistent with the RED methodology. **All emissions, including land use change emissions (e_l), are taken into account.**

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 /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 /10/ Guidelines for auditor and conduct of audit

PrEN 16214-1 *Sustainably produced biomass for energy applications – Principles, criteria, indicators and verifies for biofuels and bioliquids – Part 1: Terminology.*

PrEN 16214-4 *Sustainably produced biomass for energy applications – Principles, criteria, indicators and verifies for biofuels and bioliquids – Part 4: Calculation methods of the greenhouse gas emission balance using a life cycle analysis.*

PrEN 16214-5 *Sustainably produced biomass for energy applications – Principles, criteria, indicators and verifies for biofuels and bioliquids – Part 5: Guidance towards definition of residue and waste via positive list.*

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

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, according to the RED

Given the requirements of the methodology and necessity of its implementation, the method of calculation of greenhouse gas emissions in the lifecycle of biofuels is described sufficiently in the RED and communications supplementing it[2,3,7]. This is why it has become a starting point for dedicated system solutions. Detailed rules for the calculation of greenhouse gas emissions, applied in a particular certification system, must adhere to the RED methodology. Therefore, extracts from the RED, concerning this issue, are cited below.

Article 19.1 of the RED "***Calculation of the greenhouse gas impact of biofuels and bioliquids***" 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 and where the e_1 value for those biofuels or bioliquids calculated in accordance with point 7 of part C of Annex V 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; or
c) by using a value calculated as the sum of the factors of the equation 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, for all other factors.

Re a)

The default values for biofuels and the disaggregated default values for cultivation may be used when their raw materials were

- cultivated outside the European Community or cultivated in the Community
- waste or residues other than agricultural, aquaculture and fisheries residues.

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

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

Default values/disaggregated default values can be applied only if the process technology and feedstock used for the production of the biofuel match their description and scope. 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. 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[4].

Further default values can be used only if no land use change has occurred. Otherwise, the related emissions must be added.

Re b)

Actual values of GHG emissions resulting from the production of biofuels may be used in every case.

Re c)

The RED 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.

The KZR INiG System for the cultivation stage allows use of typical values of GHG emissions designated for areas classified as level 2 in the Nomenclature of Territorial Units for Statistics (NUTS), designated in accordance with Article 19 of Directive 2009/28 / EC. The System allows the use of typical values of GHG emissions for areas in countries outside the EU included in reports approved by the European Commission. Member States or competent authorities of third countries may submit to the Commission reports including data on typical emissions from cultivation of feedstock[a]. As set out in Commission Communication 2010/C 160/02, the values from the "NUTS 2" reports, which were submitted to the Commission by the Member States as requested in Article 19(2) Renewable Energy Directive, can be used in the KZR INiG System. 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[4]. 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 for the time being 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 biofuel[4].

Actual values of emissions from cultivation can only be determined at the origin of the chain of custody[4].

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[4].

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[4].

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

[a] Article 19(3) Directive (2009/28/EC)

adequately taken into account, it must be clearly documented that default values have had to be used[4].

Within the KZR INiG System, it is recommended that, for the cultivation, storage, transport and distribution stages, default values be used (if corresponding conditions are met); and actual values for the biomass processing and biofuel/bioliquid manufacturing stages. If a given stage is implemented by more than one operator (e.g. the processing stage of pressing oil and transesterification), all entities performing the stage are required to use the same type of GHG emissions, default or actual.

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

4.2. Calculation of actual values of greenhouse gas emissions in the life cycle of biofuels 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, the economic operator has the option of providing the actual value of emissions in terms of units of mass or energy of the fuel. 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.

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.

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), or obtained from external sources (e.g. emission indicators for raw materials or energy purchased from an external supplier). The data generated within the plant (basic data) shall be stored in properly organized datasets, enabling reviews and verification in a simple way.

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 should 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

Data concerning artificial fertilizers and chemicals used in agriculture:
- EFMA: http://www.efma.org.

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].

4.2.2. Applicable units

In accordance with the requirements of the RED, 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.

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

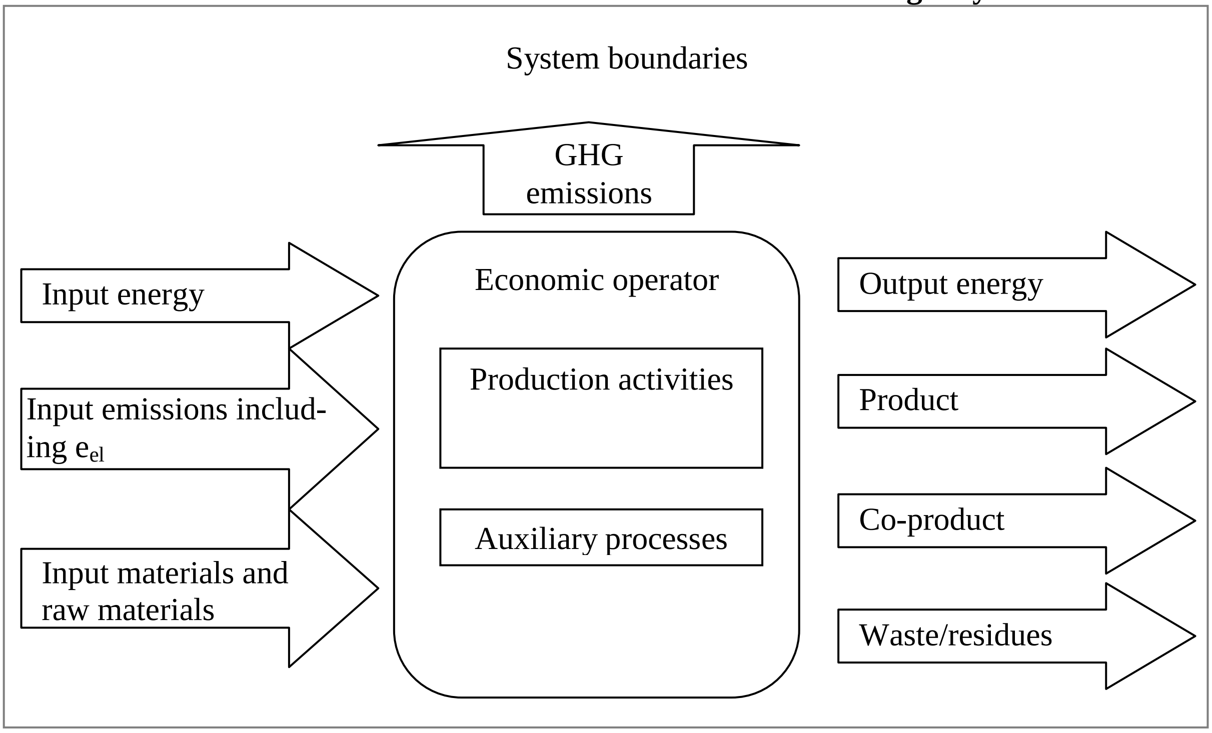
$$e_{ec}feedstock_a\left[\frac{gCO_2eq}{kg_{dry}}\right]=\frac{e_{ec}feedstock_a\left[\frac{gCO_2eq}{kg_{moist}}\right]}{(1-moisture\ content)} \qquad [2]$$

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].

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

Actual value of GHG emissions in a biofuel's life cycle is calculated using the following equation [3]:

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee} \qquad [3]$$

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 carbon capture and geological storage;*
e_{ccr} = *emission saving from carbon capture and replacement; and*
e_{ee} = *emission saving from excess electricity from cogeneration.*

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

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 (set by economic operator, maximum 12 months) in connection with using a particular energy source, the following equation is used:

$$C_x = \epsilon_x * F_{ex} \qquad [4]$$

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 3 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 exemption 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.

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

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. 3) 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 using engine fuels for agricultural machinery and other vehicles, from the collection of raw materials, from waste/residues and leakages, and from the production of chemicals or products used in extraction or cultivation. Sequestration of CO_2 in the cultivation of raw materials shall be excluded. Estimates of emissions from cultivation may be derived from the use of averages calculated for smaller geographical areas than those used in the calculation of the default values, as an alternative to using actual values[1]. In the case of lack of default values, actual values shall be used. 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 [3].

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

$$e_{ec} = e_{seed} + e_{chem} + e_{irr} + e_{field} + e_{burn} + e_{mm} \quad [5]$$

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_{burn} = GHG emissions caused by pre and post-harvest burning,
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.

GHG emissions from the production and transport of fertilisers and agrochemicals
These are calculated according to the following formula:

$$e_{chem} = Q_{chem} * F_{chem} \quad [6]$$

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

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 four different components:

$$e_{field} = e_{f-N2O\ direct} + e_{f-N20\ indirect} + e_{liming+ureain} + e_{CH4,flood} \quad [7]$$

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;

$e_{liming+ureain}$ = emissions of CO_2 from urea and lime application, expressed in mass of CO_2eq per unit of land area

$e_{CH4flood}$ = emissions of CH4 from flooded cultures, expressed in 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[b]. All three IPCC tiers could be used by economic operators. Tier 3, which relies on detailed measurement and/or modelling, seems more relevant for the calculation of ‘regional’ cultivation values than for the calculation of actual values.

Pre and post-harvest burning

These are emissions caused by burning of vegetation, dead organic matter or crop residues and may result in emissions of CH_4 and N_2O from incomplete combustion. CO_2 emissions from burning biomass material are considered to be zero.

Emissions from fuel use in agricultural and forest machinery are calculated according to the equation [8]:

$$Fl_{mm} = Q_{mmf} * F_f \quad [8]$$

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).

[b] 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).

For the purposes of reporting, these values may be also expressed in relation to the net amount of biomass produced, using the following equation [9]:

$$F_{mm} = \frac{Fl_{mm}}{Y_{bp}} \qquad [9]$$

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.

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. 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 10 June 2010.

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 [10]:

$$e_l = (CS_R - CS_A) \times 3.664 \times 1/20 \times 1/P - e_B \qquad [10]$$

[c]

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 (megajoules)). "Cropland"*[d] *and "perennial cropland"*[e] *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*

[c] 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

[d] Cropland as defined by IPCC.

[e] 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.

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) falls into one of the following categories:
   (i) severely degraded land, including such land that was formerly in agricultural use;
   (ii) heavily contaminated land.

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 (ii) is reduced.

The definition of "degraded land" is not yet available from the EC. Until such time that the definition of degraded land is finalized, it is not possible to allocate the 29gCO2/MJ biofuel bonus for degraded land (e_B).

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

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

Such land shall include land that is subject to Commission decision in accordance with the fourth subparagraph of Article 18(4) of the RED.

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:

$$CS_{A/R} = (SOC + C_{VEG}) \qquad [11]$$

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:

$SOC = SOC_{ST} \times F_{LU} \times F_{MG} \times F_I$ [12]

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}

Improved agricultural management' could include practices such as:
— shifting to reduced or zero-tillage;
— improved crop rotations and/or cover crops, including crop residue management;
— improved fertiliser or manure management;
— use of soil improver (e.g. compost).

NOTE
Only measures taken after January 2008 are eligible.

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:

$$E_{sca} = (CS_R - CS_A) \times 3.664 \times 1/Y \times 1/P - e_B \qquad [13]$$

where:

CS_R = *see formula [11];*
CS_A = *see formula [11];*
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_2eq/dry tonne.

4.2.4.2 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.

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 [4].

Calculation of the GHG emission savings of FAME
Biodiesel derived by transesterification 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 esterification 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.

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

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. Emissions generated at this stage shall be calculated according to equation [14]:

$$F_t = \sum \left(F_f i \cdot Qs_t i\right) D_t \qquad [14]$$

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.*

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 the following depot and filling station emissions (for all biofuels):

- 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)

In the KZR INiG certification system, **disaggregated default values for the transport stage** are recommended for the calculation of GHG emissions.

4.2.4.4. 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.

4.2.4.5. 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. The emissions saving is expressed in gCO_2eq/MJ.

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 2009/28/EC 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 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 [15]:

$$CO_{2cap} = \frac{CO_{2ori} \cdot \eta_{cap}}{1 - F_{cap} \cdot \eta_{cap}}$$

[15]

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:

$$CO_{2av} = CO_{2ori} - \left(CO_{2pr} - CO_{2cap}\right) = CO_{2ori} - CO_{2cap} \cdot \frac{1-\eta_{cap}}{\eta_{cap}} \quad [16]$$

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:

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

[17]

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_2eq 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_2eq per mass of CO_2 transported;
F_{st} - is the GHG emission factor for CO_2 storage, in mass of CO_2eq per mass of CO_2 stored.

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

$$CCR = \frac{CO_{aav}}{Q_{bf} \cdot LHV_{bf}} \qquad [18]$$

$$CCS = \frac{CO_{aav}}{Q_{bf} \cdot LHV_{bf}} \qquad [19]$$

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.

4.2.4.6. Emission savings from excess electricity from cogeneration, e_{ee},

Emission savings from excess electricity from cogeneration shall be taken into account. This refers to the excess electricity produced by fuel production systems that use cogeneration, except where the fuel used for cogeneration is a co-product other than an agricultural crop residue. The emission saving is expressed in gCO_2eq/MJ.

The general allocation rule in point 17 of Annex V of the RED does not apply for electricity from CHP when the CHP runs on:
(i) fossil fuels;

(ii) bioenergy;

where this is not a co-product from the same process; or
(iii) agricultural crop residues, even if they are a co-product from the same process.

Instead, the rule of calculation of emission savings from excess electricity applies as follows[3]:

- Where the CHP supplies heat not only to the biofuel/bioliquid process but also for other purposes, the size of the CHP should be notionally reduced, for the calculation, to the size that is necessary to supply only the heat required for the biofuel/bioliquid process. The primary electricity output of the CHP should be notionally reduced in proportion.

- To the amount of electricity that remains after this notional adjustment and after covering any actual internal electricity needs, a greenhouse gas credit should be assigned that should be subtracted from the processing emissions.
- The amount of this benefit is equal to the life cycle emissions attributable to the production of an equal amount of electricity from the same type of fuel in a power plant.

If the whole amount of heat produced by a CHP unit is consumed for biofuels production, GHG emissions calculations shall be based on the total fuel consumption of the CHP plant. In cases where a CHP is also supplying other external consumers, fuel consumption shall be distributed proportionally according to the heat consumption of the individual consumers.
If the ratio of electricity to heat consumed by the biofuels production plant is higher than that for electricity produced by CHP, it is assumed that the additional amount of electricity required comes from the local grid.

If the aforementioned ratio is lower, it may be assumed that the volume of energy production by CHP is that required for biofuel production. The electricity surplus is allocated to biofuels according to the following equation [20]:

$$P_s = P_{CHP} * \frac{H_b}{H_{CHP}} - P_b \qquad [20]$$

where:
P_s - *electricity surplus allocated to biofuel facility;expressed in energy unit*
P_{CHP} - *total electricity production in CHP plant; expressed in energy unit*
P_b - *amount of electricity consumed by biofuel production facility; expressed in energy unit*
H_b - *amount of heat consumed by biofuel production facility; expressed in energy unit*
H_{CHP} - *total amount of heat generated by the CHP, expressed in energy unit.*

The GHG emission savings associated with the excess electricity shall be taken to be equal to the amount of GHG that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit.

For the calculations, harmonized reference values of efficiency for distributed electricity production shall be used, as provided in Annex I to Decision of European Commission of 21 December 2006 setting harmonized reference values of efficiency for separated electricity production and heat according to Directive 2004/8/EC of European Parliament and of the Council (200/74/EC)[8]. Coefficients of GHG emission characterizing fuel used in a CHP plant shall be based on a credible external source (e.g. national statistical data, BioGrace, GEMIS, etc).

Energy needed for a given process may be generated by using part of the raw material or by streams obtained during raw material processing (e.g. residues). As these streams are of biological origin, CO_2 emission generated during their combustion shall be taken to be zero. Nevertheless, GHG emissions in the form of methane or N_2O shall be taken into account in the calculations.

When a part of the raw material is used as an energy fuel, GHG emissions from the production and transport of the total amount of the raw material shall be taken into account in the calculations.

In the case of excess heat production (without cogeneration) and export of this heat to an external consumer (beyond the boundaries of the calculation system), part of the fuel used for production of this heat is not considered an input stream for the calculation.
The net value of GHG emissions accompanying the consumption and sale of energy is calculated according to the following equation [21]:

$$C_n = C_{if} + C_{ih} + C_{ieg} + C_{int} - C_{ex} \qquad [21]$$

where:

C_{if} - *emission from externally supplied fuel; expressed in mass units* CO_{2eq}

C_{ih} - *emission from externally supplied heat; expressed in mass units* CO_{2eq}

C_{ieg} - *emission from electricity supplied from the grid; expressed in mass units* CO_{2eq}

C_{int} - *emission from combustion of own raw material or internal streams; expressed in mass units* CO_{2eq}

C_{ex} - *emission connected with exported electricity produced in the CHP unit. expressed in mass units* CO_{2eq}

Savings of GHG emissions connected with electricity surplus are considered equal to the amount of GHG that would be emitted if the same amount of electricity as in a co-generation unit had been produced in a power plant using the same fuel.

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. 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:

$$C_i = C_t * Q_i * \frac{LHV_i}{\sum(Q_i * LHV_i)} \qquad [22]$$

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. However, the latter could give a result that is an adequate approximation in many cases, notably in relation to nearly-dry products.

Co-products
If, in producing biofuel/bioliquid for which emissions are calculated, one or more co-products are produced simultaneously, GHG emissions are distributed between the biofuel (or its intermediate product) and the co-products in proportion to their energy contents (defined according to the lower heating value for co-products other than electricity). 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, emissions to be allocated are: $\boldsymbol{e_{ec}}$ + $\boldsymbol{e_l}$ + those parts of $\boldsymbol{e_p}$, $\boldsymbol{e_{td}}$ and $\boldsymbol{e_{ee}}$ that occur before the phase of production in which co-product forms, and also during this phase. If, in relation to these co-products, any emissions have been allocated to earlier production phases in the life cycle, only the part of the emissions allocated to intermediate fuel products in the last production phase is taken into account, not the whole emissions.

For biofuels and bioliquids, all co-products are taken into account in calculations, including electricity omitted in e_{ee} (with the exclusion of agriculture crop residue, including straw, bagasse, husk, cobs and nutshells). In the calculations, for co-products with negative energy value, it is assumed that they have zero energy value.

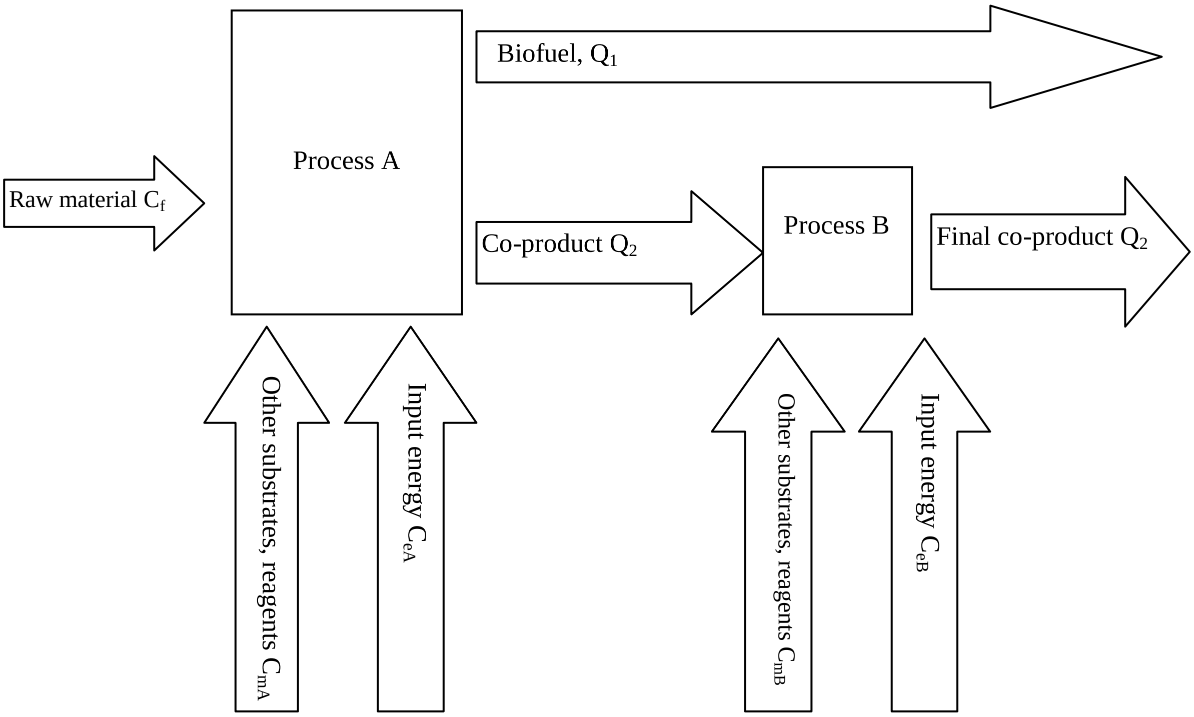
Wastes from processing, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined), shall be considered to have zero life-cycle GHG emissions up to the stage of collection of those materials.

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}*:

$$C_{tA} = C_f + C_{mA} + C_{eA} \quad [23]$$

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

$$C_{tB} = C_{mB} + C_{eB} \quad [24]$$

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

$$C_1 = C_{tA} * Q_1 * LHV_1 / (Q_1 * LHV_1 + Q_2 * LHV_2) \quad [25]$$

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

$$C_2 = C_{tA} * Q_2 * LHV_2 / (Q_1 * LHV_1 + Q_2 * LHV_2) \quad [26]$$

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

Where

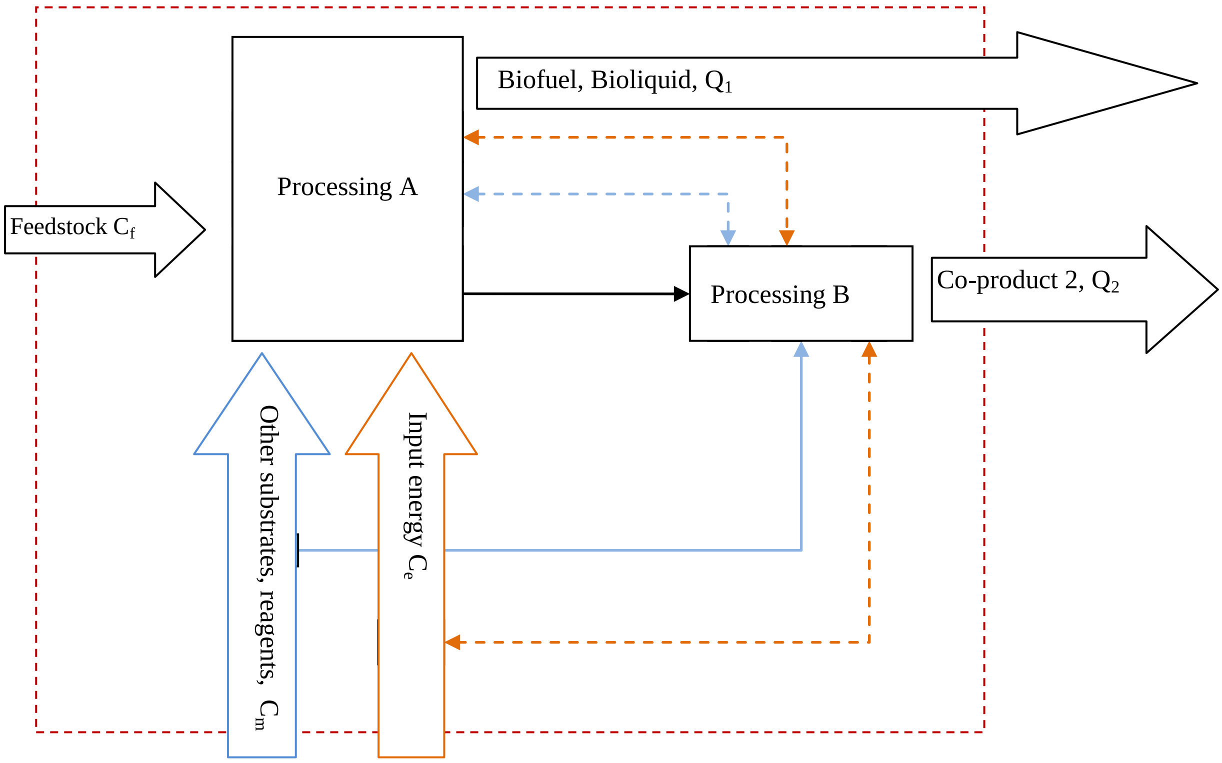
$C_{tA/B}$ = *the* total GHG emissions from Process A/B (including emissions allocated to input energy), *expressed in mass units CO_{2eq}*

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}
$C_{1\ or2}$ = 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 raw (non-refined) glycerol, 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, processing 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/ Land-use for biomass production – lands with high carbon stock* *KZR INiG/ System 5/ Land-use for biomass production – biodiversity* *KZR INiG System /8/ Guidelines for determination of lifecycle per unit values of GHG emissions for biofuels, bioliquids*, p.4.2	kg CO_{2eq}/t of biomass (dry tonne)	Economic operator
Biomass production	Emissions from usage of fertilizers and plant pesticides Emission from usage of agricultural machinery	*KZR INiG System /8/Guidelines for determination of lifecycle per unit values of GHG emissions for biofuels, bioliquids*, 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/ Guidelines for determination of lifecycle per unit values of GHG emissions for biofuels, bioliquids*, 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/ Guidelines for determination of lifecycle per unit values of GHG emissions for biofuels, bioliquids*, 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/ Guidelines for determination of lifecycle per unit values of GHG emissions for biofuels, bioliquids*, 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 manufacturing	Emissions introduced with reagents Emissions from processes and activities	*System KZR INiG/8/ Guidelines for determination of lifecycle per unit values of GHG emissions for biofuels, bioliquids*, p.4.2, p.4.3, p.4.4	g CO_{2eq}/MJ of energy contained in the biofuel	Biofuel/ bioliquid manufacturer

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:

$$e_{ec} intermediate\ product_a \left[\frac{gCO_2eq}{kg_{dry}}\right] = e_{ec}\ feedstock_a \left[\frac{gCO_2eq}{kg_{dry}}\right] * Feedstock\ factor_a * Allocation\ factor\ intermediate\ product_a \quad [27]$$

where

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

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

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:

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

[28]

Where

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

$$Biofuel\ feedstock\ factor_a = [Ratio\ of\ MJ\ feedstock\ required\ to\ make\ 1\ MJ\ biofuel]$$

Similarly, also the values for e_{p}, e_{td}, e_{l} and e_{ee} 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[f] 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
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 and bioliquids manufacturers may indicate the default greenhouse gas emission savings for the indicated biofuels production pathways, shown in Table 3[1]. Default values are based on the RED, in force since April 23rd, 2009

[f] 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 2009/28/EC, Annex V, part C, point 18.

Table 3 - Default greenhouse gas emission savings for biofuels and bioliquids manufactured without net carbon dioxide emissions from land-use change

Production pathway	**Default greenhouse gases emission saving**
Sugar beet ethanol	52 %
Wheat ethanol (process fuel undefined)	16 %
Wheat ethanol (lignite as process fuel in CHP plant)	16 %
Wheat ethanol (natural gas as process fuel in conventional boiler)	34 %
Wheat ethanol (natural gas as process fuel in CHP plant)	47 %
wheat ethanol (straw as process fuel in CHP plant)	69 %
Corn (maize) ethanol Community produced (natural gas as process fuel in CHP plant)	49 %
Sugar cane ethanol	71 %
The part from renewable sources of ethyl-tert-butyl-ether (ETBE)	Equal to that of the ethanol production pathway used
The part from renewable sources of tert-amyl-ethyl-ether (TAEE)	Equal to that of the ethanol production pathway used
Rape seed biodiesel	38 %
Sunflower biodiesel	51 %
Soybean biodiesel	31 %
Palm oil biodiesel (process not specified)	19 %
Palm oil biodiesel (process with methane capture at oil mill)	56 %
Waste vegetable or animal (*) oil biodiesel	83 %
Hydrotreated vegetable oil from rape seed	47 %
Hydrotreated vegetable oil from sunflower	62 %
Hydrotreated vegetable oil from palm oil (process not specified)	26 %
Hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	65 %
Pure vegetable oil from rape seed	57 %
Biogas from municipal organic waste as compressed natural gas	73 %
Biogas from wet manure as compressed natural gas	81 %
Biogas from dry manure as compressed natural gas	82 %
(*) Not including animal oil produced from animal by-products classified as category 3 material in accordance with Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules on animal by-products not intended for human consumption.	

If the conditions defining usage of default values are met, economic operators in the supply chain may indicate the default values shown below (Table 4-7). Table 8-11 contains estimated disaggregated default values for future biofuel and bioliquid[1].

Table 4. Disaggregated default values for cultivation, 'e_{ec}', as defined in formula 2 section 4.2.4

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
sugar beet ethanol	12	12
wheat ethanol	23	23
corn (maize) ethanol, Community produced	20	20
sugar cane ethanol	14	14
the part from renewable sources of ETBE	Equal to that of the ethanol production pathway used	
the part from renewable sources of TAEE	Equal to that of the ethanol production pathway used	
rape seed biodiesel	29	29
sunflower biodiesel	18	18
soybean biodiesel	19	19
palm oil biodiesel	14	14
waste vegetable or animal (*) oil biodiesel	0	0
hydrotreated vegetable oil from rape seed	30	30
hydrotreated vegetable oil from sunflower	18	18
hydrotreated vegetable oil from palm oil	15	15
pure vegetable oil from rape seed	30	30
biogas from municipal organic waste as compressed natural gas	0	0
biogas from wet manure as compressed natural gas	0	0
biogas from dry manure as compressed natural gas	0	0
(*) Not including animal oil produced from animal by-products classified as category 3 material in accordance with Regulation (EC) No 1774/2002		

Table 5. Disaggregated default values for processing (including excess electricity), 'e_p – e_{ee}', as defined in formula 2 section 4.2.4

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
sugar beet ethanol	19	26
wheat ethanol (process fuel not specified)	32	45
wheat ethanol (lignite as process fuel in CHP plant)	32	45
wheat ethanol (natural gas as process fuel in conventional boiler)	21	30
wheat ethanol (natural gas as process fuel in CHP plant)	14	19
wheat ethanol (straw as process fuel in CHP plant)	1	1
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	15	21
sugar cane ethanol	1	1
the part from renewable sources of ETBE	Equal to that of the ethanol production pathway used	
the part from renewable sources of TAEE	Equal to that of the ethanol production pathway used	

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
rape seed biodiesel	16	22
sunflower biodiesel	16	22
soybean biodiesel	18	26
palm oil biodiesel (process not specified)	35	49
palm oil biodiesel (process with methane capture at oil mill)	13	18
waste vegetable or animal oil biodiesel	9	13
hydrotreated vegetable oil from rape seed	10	13
hydrotreated vegetable oil from sunflower	10	13
hydrotreated vegetable oil from palm oil (process not specified)	30	42
hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	7	9
pure vegetable oil from rape seed	4	5
biogas from municipal organic waste as compressed natural gas	14	20
biogas from wet manure as compressed natural gas	8	11
biogas from dry manure as compressed natural gas	8	11

Table 6. Disaggregated default values for the transport and distribution, ‘e_{td}’, as defined in formula 2 section 4.2.4

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
sugar beet ethanol	2	2
wheat ethanol	2	2
corn (maize) ethanol, Community produced	2	2
sugar cane ethanol	9	9
the part from renewable sources of ETBE	Equal to that of the ethanol production path-way used	
the part from renewable sources of TAEE	Equal to that of the ethanol production path-way used	
rape seed biodiesel	1	1
sunflower biodiesel	1	1
soybean biodiesel	13	13
palm oil biodiesel	5	5
waste vegetable or animal oil biodiesel	1	1
hydrotreated vegetable oil from rape seed	1	1
hydrotreated vegetable oil from sunflower	1	1
hydrotreated vegetable oil from palm oil	5	5
pure vegetable oil from rape seed	1	1
biogas from municipal organic waste as compressed natural gas	3	3
biogas from wet manure as compressed natural gas	5	5
biogas from dry manure as compressed natural gas	4	4

Table 7. Total for cultivation, processing, transport and distribution

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
sugar beet ethanol	33	40
wheat ethanol (process fuel not specified)	57	70
wheat ethanol (lignite as process fuel in CHP plant)	57	70
wheat ethanol (natural gas as process fuel in conventional boiler)	46	55
wheat ethanol (natural gas as process fuel in CHP plant)	39	44
wheat ethanol (straw as process fuel in CHP plant)	26	26
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	37	43
sugar cane ethanol	24	24
the part from renewable sources of ETBE	Equal to that of the ethanol production pathway used	
the part from renewable sources of TAEE	Equal to that of the ethanol production pathway used	
rape seed biodiesel	46	52
sunflower biodiesel	35	41
soybean biodiesel	50	58
palm oil biodiesel (process not specified)	54	68
palm oil biodiesel (process with methane capture at oil mill)	32	37
waste vegetable or animal oil biodiesel	10	14
hydrotreated vegetable oil from rape seed	41	44
hydrotreated vegetable oil from sunflower	29	32
hydrotreated vegetable oil from palm oil (process not specified)	50	62
hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	27	29
pure vegetable oil from rape seed	35	36
biogas from municipal organic waste as compressed natural gas	17	23
biogas from wet manure as compressed natural gas	13	16
biogas from dry manure as compressed natural gas	12	15

Estimated disaggregated default values for future biofuels and bioliquids that were not on the market or were only on the market in negligible quantities in January 2008

Table 8. Disaggregated default values for cultivation: 'e_{ec}' as defined in formula 2 section 4.2.4

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
wheat straw ethanol	3	3
waste wood ethanol	1	1
farmed wood ethanol	6	6
waste wood Fischer-Tropsch diesel	1	1
farmed wood Fischer-Tropsch diesel	4	4
waste wood DME	1	1
farmed wood DME	5	5
waste wood methanol	1	1
farmed wood methanol	5	5
the part from renewable sources of MTBE	Equal to that of the methanol production pathway used	

Table 9. Disaggregated default values for processing (including excess electricity), '$e_p - e_{ee}$', as defined in formula 2 section 4.2.4

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
wheat straw ethanol	5	7
wood ethanol	12	17
wood Fischer-Tropsch diesel	0	0
wood DME	0	0
wood methanol	0	0
the part from renewable sources of MTBE	Equal to that of the methanol production pathway used	

Table 10. Disaggregated default values for transport and distribution, '*etd*', as defined in formula 2 section 4.2.4

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
wheat straw ethanol	2	2
waste wood ethanol	4	4
farmed wood ethanol	2	2
waste wood Fischer-Tropsch diesel	3	3
farmed wood Fischer-Tropsch diesel	2	2
waste wood DME	4	4
farmed wood DME	2	2
waste wood methanol	4	4
farmed wood methanol	2	2
the part from renewable sources of MTBE	Equal to that of the methanol production pathway used	

Table 11. Total for cultivation, processing, transport and distribution

Biofuel and bioliquid production pathway	Typical greenhouse gas emissions (gCO2eq/MJ)	Default greenhouse gas emissions (gCO2eq/MJ)
wheat straw ethanol	11	13
waste wood ethanol	17	22
farmed wood ethanol	20	25
waste wood Fischer-Tropsch diesel	4	4
farmed wood Fischer-Tropsch diesel	6	6
waste wood DME	5	5
farmed wood DME	7	7
waste wood methanol	5	5
farmed wood methanol	7	7
the part from renewable sources of MTBE	Equal to that of the methanol production pathway used	

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.

The values listed in table (3-11) are based on the RED. 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. Decision tree

Every economic operator in the supply chain is obliged to provide intensities of GHGemissions 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 12, System participants' options for forwarding GHG emissions are presented. Figures 3 and 4 show the decision tree for agriculture producers and intermediate/biofuel producers respectively.

Table 12. 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. • 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 valuemay 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.

Fig.3 Agricultural producer decision tree

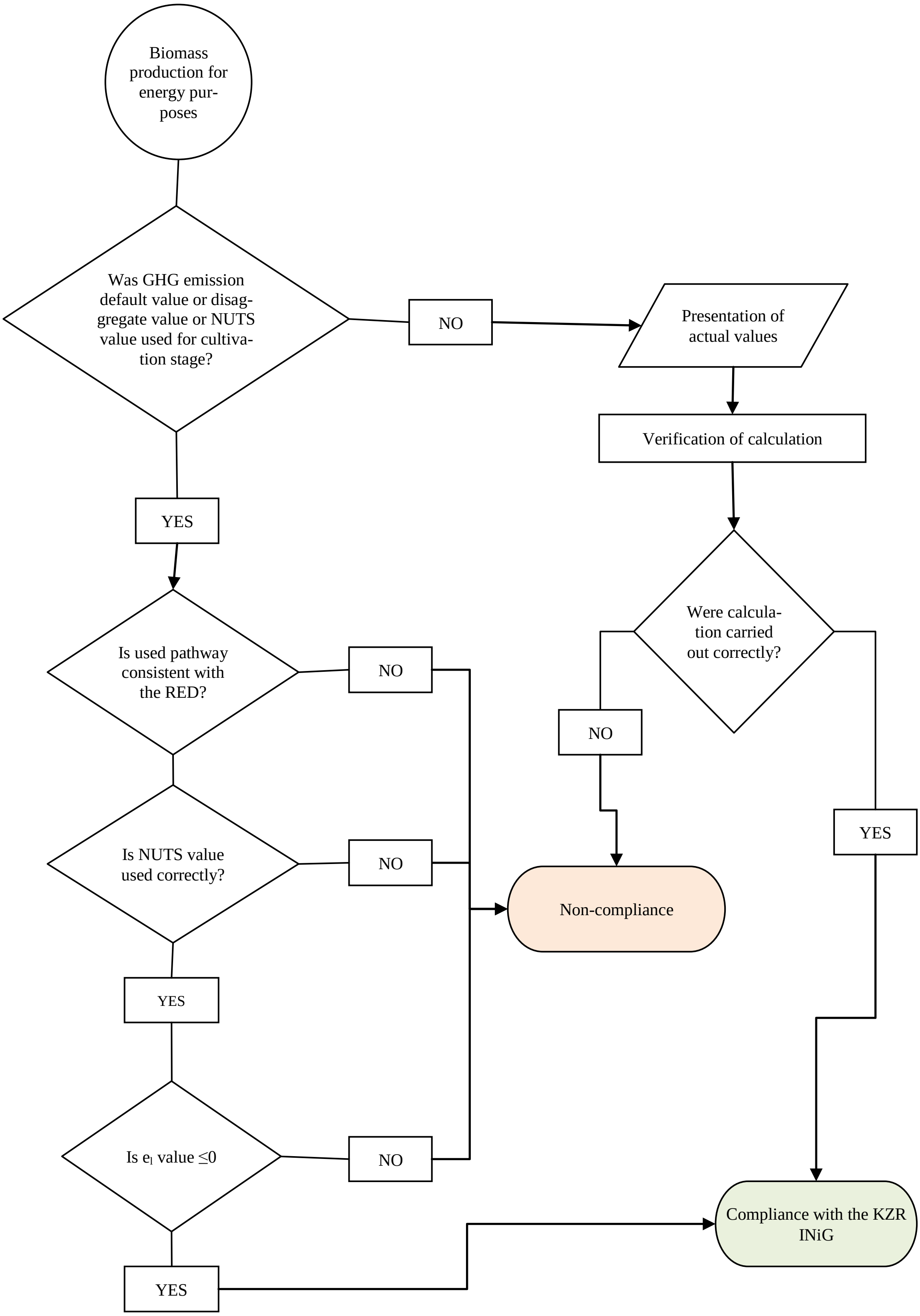
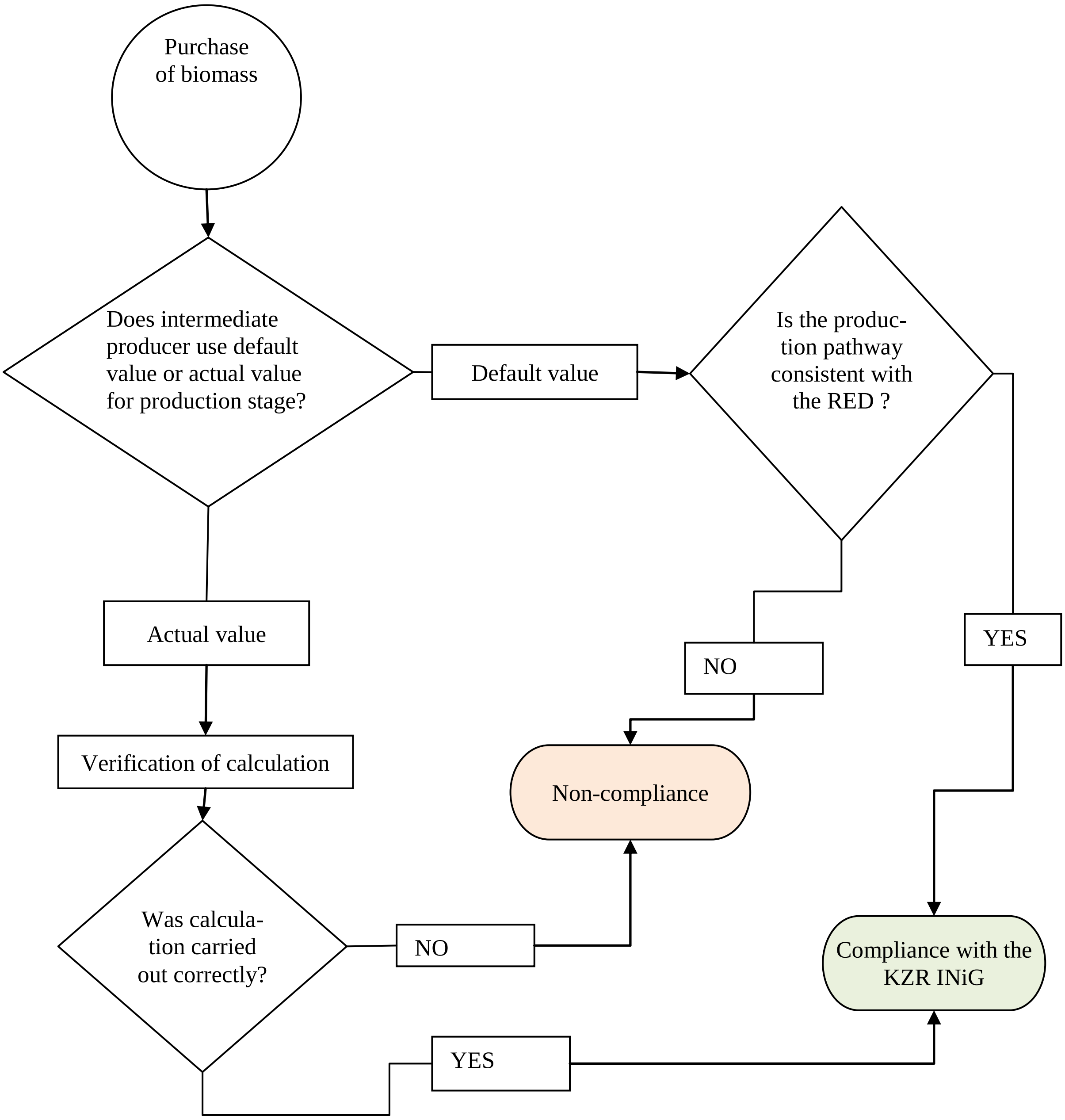


Fig. 4 Intermediate producer and biofuel/bioliquid producer decision tree



7. Checklist

The checklist with guidelines for auditors is published in document *KZR INiG System/10/ Guidelines to auditor and conduct of audit*.

8. References

1. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Official Journal of European Union No. L 140/16 of 9.06.2009).
2. Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme (Official Journal of European Union C 160/01 of 19.06.2010).
3. Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels (Official Journal of European Union C 160/02 of 19.06.2010).
4. Note on the conducting and verifying actual calculations of GHG emission savings. Brussels, BK/abd/ener.c.1(2015)4507918
5. FPrEN 16214-4 Sustainably produced biomass for energy applications – Principles, criteria, indicators and verifies for biofuels and bioliquids – Part 4:Calculation methods of the greenhouse gas emission balance using a life cycle analysis.
6. http://www.kobize.pl/index.php?mact=News,cntnt01,detail,0&cntnt01articleid=147& cntnt01origid=51&cntnt01returnid=116
7. Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (notified under document C(2010) 3751) O.J. L 151/19 of 17.06.2010.
8. Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels, Official Journal of European Union C160/08 of 19.06.2010.
9. Commission Decision of 21 December 2006 establishing harmonized efficiency reference values for separate production of electricity and heat in application of Directive 2004/8/EC of the European Parliament and of the Council.