

# ISCC 205

# GREENHOUSE GAS EMISSIONS

Version 3.0



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## Content

1	Introduction .....	4
2	Scope and Normative References.....	5
3	Options for the provision of GHG information .....	5
	3.1 Use of default values.....	5
	3.2 Use of actual values.....	8
4	Requirements for individual GHG emission calculations.....	10
	4.1 Data gathering.....	11
	4.2 Supply chain elements .....	12
	4.3 Calculation methodology .....	13
	4.3.1 Emissions from the extraction or cultivation of raw materials ( $e_{ec}$ ).....	13
	4.3.2 Emissions from carbon stock changes caused by land-use change ( $e_l$ ) ....	16
	4.3.3 Emission saving from soil carbon accumulation via improved agricultural management ( $e_{sca}$ ) .....	18
	4.3.4 Emissions from transport and distribution ( $e_{td}$ ) .....	19
	4.3.5 Emissions from processing ( $e_p$ ).....	20
	4.3.6 Emission savings from excess electricity ( $e_{ee}$ ).....	23
	4.3.7 Emission savings from carbon capture and replacement ( $e_{cct}$ ) and carbon capture and geological storage ( $e_{ccs}$ ).....	24
	4.3.8 Working with incoming emission values and allocation of emissions to main- and co-products.....	26
	4.3.9 Further requirements for the producers of final biofuels and bioliquids .....	29
5	Switching between different options of GHG information.....	31
6	Documentation and verification requirements.....	34
	Annex I List of emission factors and lower heating values (LHVs) .....	37

## 1 Introduction

The intention of the document “Greenhouse Gas Emissions” is to explain the options of stating greenhouse gas (GHG) emissions along the supply chain and to provide the methodology, rules and guidelines for calculating and verifying GHG emissions and emission reductions.

*Intention,  
Applicability.  
Legal  
background*

The ISCC requirements regarding GHG emissions apply to all relevant supply chain elements from raw material production to the distribution of the final product, including cultivation, all processing steps, and transport and distribution of intermediates and final products.

Following the requirements of the Renewable Energy Directive 2009/28/EC amended through Directive (EU) 2015/1513 (RED) and Fuel Quality Directive 2009/30/EC amended through Directive (EU) 2015/1513 (FQD)<sup>1</sup>, ISCC requires a minimum level of GHG savings for final biofuels. In the case of installations that were in operation on or before 5 October 2015, biofuels and bioliquids shall achieve GHG savings of at least 35% until December 2017 and at least 50% from 1 January 2018. The GHG emission savings from the use of biofuels and bioliquids shall be at least 60% for biofuels and bioliquids produced in installations starting operation after 5 October 2015.

The following emissions are covered:

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

*GHG calculation  
formula*

where

- E* total emissions from the use of the fuel,
- e<sub>ec</sub>* emissions from the extraction or cultivation of raw materials,
- e<sub>l</sub>* annualised emissions from carbon stock changes caused by land-use change,
- e<sub>p</sub>* emissions from processing,
- e<sub>td</sub>* emissions from transport and distribution,
- e<sub>u</sub>* emissions from the fuel in use,
- e<sub>sca</sub>* emission saving from soil carbon accumulation via improved agricultural management,
- e<sub>ccs</sub>* emission saving from carbon capture and geological storage,
- e<sub>ccr</sub>* emission saving from carbon capture and replacement, and
- e<sub>ee</sub>* emission saving from excess electricity from cogeneration.

Emissions from the manufacture of machinery and equipment shall not be taken into account. The carbon dioxide fixation during raw material cultivation is not considered in the calculation formula. To balance this, the

<sup>1</sup> In the following referred to as RED and FQD

emissions from the final degradation or combustion of the bio-based products ( $e_u$ ) are not taken into account.

## 2 Scope and Normative References

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

*Relevant supply chain elements*

- a) Raw material production (extraction or cultivation)
- b) Processing units (companies, that process raw materials/input materials and thereby change relevant physical or chemical properties)
- c) Transport and distribution

The requirements for the GHG calculation throughout the supply chain, and verification requirements for auditors are explained in this document.

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

## 3 Options for the provision of GHG information

The RED<sup>2</sup> allows economic operators to calculate actual GHG emission values, to use default values or to use a combination of disaggregated default values and calculated actual values.

Within ISCC there are different options for GHG information provision:

- 3.1. Use of total default values OR  
Use of disaggregated default values (which allow a combination of default values and actual values);
- 3.2. Use of actual values (individually calculated values).

### 3.1 Use of default values

Total default values as well as disaggregated default values are provided by the RED in Annex V. These default values reflect standardised biofuel supply chains and processes, and are conservative. The RED contains total default values for different types of biofuels as well as disaggregated default values for cultivation ( $e_{ec}$ ), processing ( $e_p$ ) and transport and distribution ( $e_{td}$ ). Default values listed in Annex V can be applied only if the process technology and raw material used for the production of the biofuel match the respective scope of the default value. Certified economic operators can only use (disaggregated) default values if the following criteria are met:

*Source of default values*

<sup>2</sup> Annex V of RED

*Restrictions for  
the use of  
default values*

- > The total default value for GHG emission savings laid down in part A or B of Annex V of the RED can only be used if it reflects the production pathway, and where  $e_i$  (emissions from land use change) calculated according to chapter 4.3.2 of this document for those biofuels or bioliquids are equal to or less than zero.
- > The total default value can only be used, if the minimum GHG emission savings can be reached (installations that were in operation on or before 5 October 2015: 35% until 31 December 2017 and 50% from 1 January 2018; respectively 60% for biofuel and bioliquid installations in which production started after 5 October 2015). E.g. the total default value for soy biodiesel cannot be used, as the default GHG emission saving only accounts 31%
- > The input material/raw material and process of the certified economic operator fits the total or disaggregated default value in question, e.g.:
  - > The default value for “palm oil biodiesel (process with methane capture at oil mill)” can only be applied if the application of the methane capture method at the palm oil mill 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 kg of methane per ton of CPO;
  - > Corn producers outside the European community cannot apply the default value for “corn ethanol, Community produced”;
  - > If an ethanol plant uses lignite as a process fuel in a conventional boiler, then none of the (disaggregated) default values can be used, as they only give values for the process fuels natural gas in a CHP plant or a conventional boiler or lignite in a CHP plant.
- > Within the EU: Within the European Community, the total default value or the disaggregated default values for cultivation can always be used independent from the fact if the NUTS2 requirements are fulfilled.

If the *total default value* is applied, certified economic operators up to the final processing unit state “Use of total default value” on their Sustainability Declarations. No further information is required. The final processing unit of the biofuel/bioliquid can then state the total default value of its specific supply chain in g CO<sub>2</sub>eq per MJ of biofuel and the GHG emission savings in % on its Sustainability Declaration. The respective values are provided in the RED. The information on GHG emissions can be reported as an aggregate. If relevant, both the process technology and the raw material used need to be specified. During the certification audit, the auditor needs to verify the

*Information  
provision for total  
default values*

suitability of the input material and process as well as the correct application of the total default value.

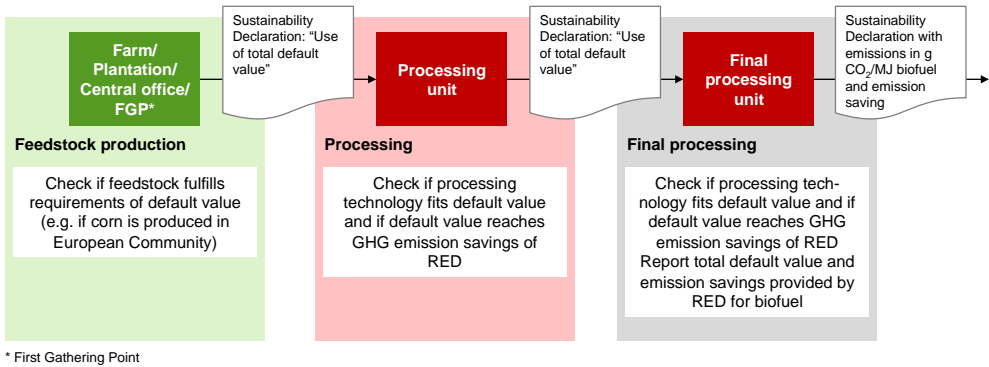


Figure 1: Application of total default values

If an economic operator in the supply chain cannot use the total default value, e.g. because one of the criteria referred to in the above figure is not fulfilled, he can switch to individual calculation or disaggregated default values. Further information on switching between different options of GHG information is provided in chapter 5 “Switching between different options of GHG information”.

While the total default values are always applied to a final biofuel or bioliquid, the *disaggregated default values* are for certain elements in the supply chain (cultivation ( $e_{ec}$ ), processing ( $e_p$ ) and transport and distribution ( $e_{td}$ )). In sections D and E of Annex V of the RED different disaggregated default values for biofuels and bioliquids are provided. Using these values provides the possibility to combine default values with actual values from individual GHG calculations (e.g. to use the disaggregated default value for the incoming raw material and do an individual GHG calculation for own processing emissions, or an individual calculation for processing and the use of the disaggregated default value for transport & distribution). For applying disaggregated default values, the same conditions apply as for total default values (please see above points).

*Use of disaggregated default values*

When using disaggregated default values for one or more elements in the calculation methodology, certified economic operators up to the final processing unit have to state “Use of disaggregated default value” on their Sustainability Declarations. The below figure shows an example of using the disaggregated default value for transport and distribution ( $e_{td}$ ) while an individual calculation is carried out for cultivation ( $e_{ec}$ ) and processing ( $e_p$ ).

*Information provision for disaggregated default values*

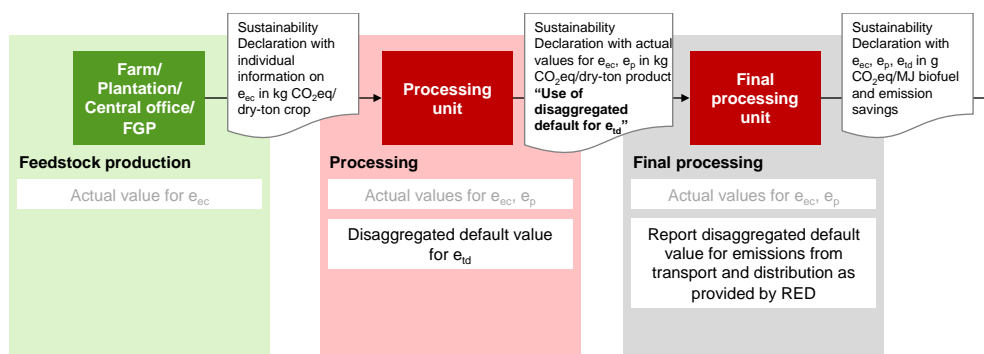


Figure 2: Application of disaggregated default value for  $e_{td}$

### 3.2 Use of actual values

Individually calculated GHG values or “actual values” are calculated based on ISCC’s calculation methodology (see following chapters for calculation methodology) and that of RED (according to the methodology laid down in part C of Annex V). Individual calculations of emissions must always be conducted at the point in the chain of custody where they originate (e.g. emissions from cultivation can only be determined at the farm/plantation, the central office or the first gathering point (FGP) of a group if all data is provided by the farms/plantations). For the calculation of “actual values” all relevant inputs of an economic operator must be considered. Whenever information which is relevant for the calculation of actual emissions is not adequately taken into account, default values must be used.

*Individual calculation of GHG emissions*

Certified economic operators, who do an individual GHG calculation, must state the calculated GHG values for their product in kg CO<sub>2</sub>eq per ton of product on the Sustainability Declarations. For raw materials and interim products information on GHG emissions has to be provided in the unit kg CO<sub>2</sub>eq/dry-ton feedstock or kg CO<sub>2</sub>eq/dry-ton intermediary product, respectively. The RED requests that information on actual GHG emission values has to be provided for all relevant elements of the GHG emission calculation formula. A separate reporting of  $e_{ec}$ ,  $e_l$ ,  $e_p$ ,  $e_{td}$ ,  $e_{sca}$ ,  $e_{ccs}$ ,  $e_{ccr}$  and  $e_{ee}$  is thus necessary if relevant. Relevant refers in this context to elements for which reporting is obligatory (e.g.  $e_l$  in case of land use change), all elements for which actual values should be used instead of disaggregated default values and all elements related to emission savings (if applicable). The below figure shows an example for an individual calculation including the elements cultivation ( $e_{ec}$ ), land use change ( $e_l$ ), processing ( $e_p$ ), transport and distribution ( $e_{td}$ ) and excess electricity ( $e_{ee}$ ). Further information on how to deal with incoming GHG values and how to do individual calculations in the different supply chain steps are provided in chapter 4 “Requirements for individual GHG emission calculations”.

*Information provision for actual values*



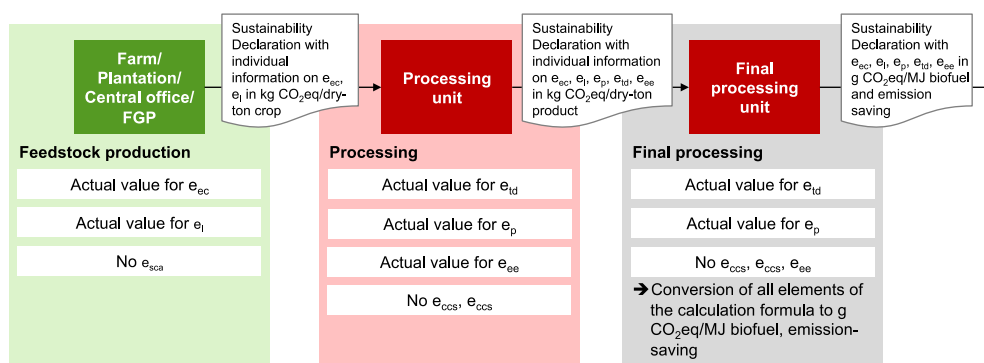


Figure 3: Application of actual values

If the actual values for processing or transport shall be used, all processing and transport steps have to conduct an individual calculation. It is possible to switch from actual values to disaggregated or total default values in a later state of the supply chain, if all relevant information, as referred to under chapter 3.1 “Use of default values”, are known at this stage. Further information on switching between different options of GHG information is provided in chapter 5.

*Restrictions for actual values*

For agricultural production, Member States or competent authorities of third countries may have submitted to the Commission reports including data on *typical emissions from cultivation of feedstock*. As laid 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. The calculation of these values has been scrutinised by the Commission services and thus under ISCC it is allowed to operators to apply these values as an alternative to actual values provided these are available in the unit kg CO<sub>2</sub>eq/dry-ton of feedstock on the Commission web site. It is possible to use either the respective GHG value for the specific NUTS2 region (or the region in the third country) from which the raw material originates or to use the highest emission value from the Member State's NUTS2 report (or the third countries report) for specific raw material coming from that country (as long as product identity is preserved and crop-specific typical emission values exist for all regions of the country). Companies (farmers or FGPs/ Central offices) using the typical emission values for cultivation must provide the specific value in kg CO<sub>2</sub>eq per dry-ton of raw material on their Sustainability Declarations as available on the Commission website.

*Use of NUTS2 GHG values*

For cultivation outside the European Community (where no typical emission values for cultivation of feedstocks exist), 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. The methodology for calculating average GHG values can be the same as described in the chapter 4 “Requirements for individual GHG emission calculations”. The data should be updated over time, unless there is no significant variability of the data over time. For agrochemicals use, the typical type and quantity of agrochemical product used for the raw material

*Use of average GHG values*

in the region concerned may be utilised. Emissions from the production of agrochemicals should either be based on measured values or on technical specifications of the production facility. When the range of emissions values for a group<sup>3</sup> of agrochemicals production facilities to which the facility concerned belongs is available, the most conservative emission number (highest) of that group shall be used. When a measured value for yields is used (as opposed to an aggregated value) for the calculations, it is required to also use a measured value for agrochemicals input and vice versa.

Other options than the ones described are not accepted under the RED/FQD. All deliveries, also from other recognised voluntary certification schemes, must comply with these requirements. Otherwise they cannot be accepted.

*Other  
recognized  
certification  
schemes*

## 4 Requirements for individual GHG emission calculations

The following chapters describe how an individual calculation shall be conducted in the different steps of the supply chain. Chapter 4.1 describes the general requirements for data gathering and type of data to be used in an individual calculation. Chapter 4.2 defines the relevant supply chain elements for an individual GHG calculation. In chapter 4.3 the calculation methodologies for the following elements are introduced in detail:

*Individual  
calculation*

- 4.3.1 Emissions from the extraction or cultivation of raw materials ( $e_{ec}$ )
- 4.3.2 Emissions from carbon stock changes caused by land-use change ( $e_l$ )
- 4.3.3 Emission saving from soil carbon accumulation via improved agricultural management ( $e_{sca}$ )
- 4.3.4 Emissions from transport and distribution ( $e_{td}$ )
- 4.3.5 Emissions from processing ( $e_p$ )
- 4.3.6 Emission savings from excess electricity ( $e_{ee}$ )
- 4.3.7 Emission savings from carbon capture and replacement ( $e_{ccr}$ ) and carbon capture and geological storage ( $e_{ccs}$ )
- 4.3.8 Adjusting incoming emission values and allocation of emissions to main products and co-products
- 4.3.9 Requirements for the final processing unit in the supply chain

<sup>3</sup> It refers to for example a situation where an economic operator knows that a certain company in a certain country produced the fertiliser. That company has a number of fertiliser production facilities in that country for which the range of processing emissions are known; an economic operator can claim the most conservative number of emissions from those group of fertiliser production facilities.

## 4.1 Data gathering

The GHG calculation methodology for individual calculations differentiates between the different elements in the supply chains, i.e. between agricultural producers (cultivation) and processing units. The calculation formula consists of data gathered on-site and data gathered from databases and literature:

On-site data gathering is relevant for actual input data, e.g. electricity or heat consumption, chemicals or fertilisers and for output data like wastewater production. Data measured and gathered on-site must be documented and provided to the auditor for the verification. This can include field record systems, production reports, production information systems, delivery notes, weighbridge protocols, contracts, invoices and others. The calculation period should cover a full twelve-month period. It must be as up to date as possible. As an alternative, it must cover the previous calendar or financial year. The respective period for data gathering and thus for the calculation of GHG emissions must be transparently displayed in the calculation. If, at the initial certification audit, no actual data is available (i.e. at the beginning of the production), the use of “design data” is possible when conducting the Individual calculation. Six months after the date of certificate issuance, certified economic operators must prove to their Certification Bodies that the values based on design data are appropriate. In case of deviations, new actual GHG values must be calculated, verified and used. After one year, the company has to switch from design data to actual data. This change is subject to the general recertification audit.

*On-site data gathering for individual calculation*

If an input has little or no effect for the emission element of the calculation formula, it can be excluded from the emission calculation. Inputs with little or no effect are those that have an impact on overall emissions of the respective calculation formula element (e.g. cultivation  $e_{ec}$ ) that is lower than 0.5%.

Published data includes the emission factors (EF), with which the respective input data are multiplied, and lower heating values. Preferably they shall be gathered from official sources, like the RED or Annex I “List of emission factors and lower heating values (LHVs)” of this document. Alternative values might be used but must be duly justified and flagged in the documentation of the calculations in order to facilitate the verification by auditors. They can be based on Ecoinvent or Biograce or individually calculated or measured (e.g. LHV could be measured through laboratory analyses) as long as the methodology used complies with the methodology set in the RED and is verifiable during the audit or the supplier of the EF/LHV is ISCC certified. If not available, other scientifically peer-reviewed literature or official statistical data from government bodies can be used. All data gathered from databases or literature shall be based on the most recent available sources and shall be updated over time. The source and the date of data collection shall be documented. Emission factors chosen or calculated shall also reflect the specific situation and set up. E.g. if a

*Data sources for EF and LHVs*

process-specific input was produced in Europe then the emission factor for this input shall also reflect the European situation.

## 4.2 Supply chain elements

An individual GHG emission calculation is not performed for the whole supply chain but only within the system boundary of a certified economic operator (supply chain element). The following figure shows the responsible supply chain elements for calculating the individual elements of the calculation formula.

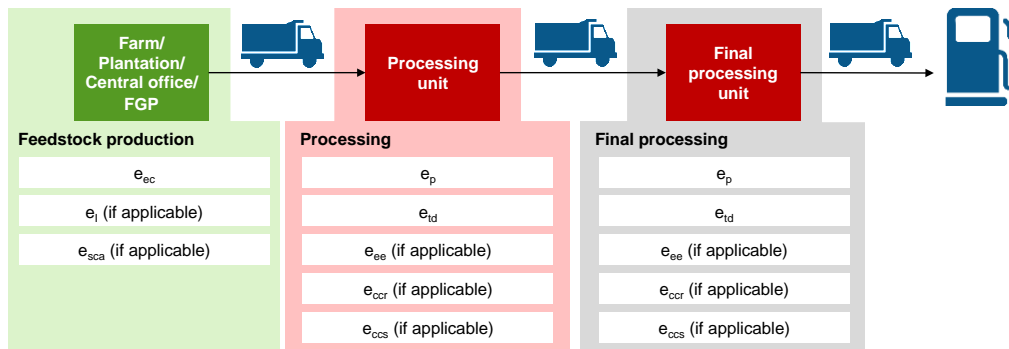


Figure 4: Relevant supply chain elements for an individual calculation of the different elements of the calculation formula

Actual values of emissions from the extraction or cultivation of raw materials  $e_{ec}$  can only be determined at the origin of the chain of custody. Farmers and agricultural producers or FGPs/ groups' central offices (on behalf of the farmers belonging to the group) can do an individual GHG emission calculation for  $e_{ec}$ . If, additionally, land use change ( $e_l$ ) happened or improved agricultural management ( $e_{sca}$ ) is applied, these emissions also need to be calculated at this step. In case farmers or plantations belong to a group, they can either do an individual GHG emission calculation for each farmer or one GHG emission calculation for the whole group. As highlighted in the EC Communication 2010/C160/01, group certification for the purpose of calculating GHG emissions is acceptable if the units have similar production systems and products.<sup>4</sup> All requirements of ISCC Document 206 "Group Certification" shall be fulfilled. The data basis for an individual calculation of a group is based on a sample of relevant individual input data. Data is gathered from the square root of all farms/plantations belonging to a group. The data gathering samples must take into account the different crops cultivated, regional specifics and the size of the individual farms. Sampling for the purpose of Individual calculations must also be risk-based. The highest GHG emission value can be used for the whole group. An average of different GHG emission values is not possible.

If the certified economic operator is a processing unit (processing raw materials and thereby changing relevant physical or chemical properties), the emissions from processing ( $e_p$ ) may be calculated. Actual values of

*System boundaries*

*Individual calculation for cultivation*

*Individual calculation for processing units*

<sup>4</sup> For details on group auditing see ISCC 206 "Group Certification"

emissions from processing can only be determined if emissions of all processing steps are recorded and transmitted through the chain of custody. During this step further emission savings such as carbon capture and geological storage ( $e_{ccs}$ ), carbon capture and replacement ( $e_{ccr}$ ) or excess electricity from cogeneration ( $e_{ee}$ ) are calculated if applicable.

Actual values of emissions from transport and distribution emissions ( $e_{td}$ ) can only be determined if emissions of all transport steps are recorded and transmitted through the chain of custody. Any recipient of physical material has to determine the upstream transport emissions ( $e_{td}$ ) and has to transmit these values to the recipient of the material. The final processing unit additionally has to determine the downstream transport and distribution to the final market (the filling station).

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 Sustainability Declarations.

*Individual calculation for transport*

### 4.3 Calculation methodology

#### 4.3.1 Emissions from the extraction or cultivation of raw materials ( $e_{ec}$ )

Emissions from the extraction or cultivation of raw materials apply to all agricultural raw materials, such as rapeseed/ canola, palm, soybean, wheat, corn/maize or sugarcane. If wastes or residues are used as a raw material of a process, the GHG emissions of extraction or cultivation of the raw material is considered to be zero and emissions at the point of origin of the waste or residue are zero.

*Applicability of  $e_{ec}$*

GHG emission calculation shall always refer to a single raw material, for which the different input values are gathered. The actual GHG value for a raw material must be provided to the recipient of the raw material in the unit kg CO<sub>2</sub>eq/dry-ton raw material.

*Information transfer*

##### 4.3.1.1 Data basis

###### On-site data gathering

The following data for the calculation of GHG emissions from cultivation must be gathered on-site. They will form the basis for the calculation of GHG emissions. All input values must be gathered for the same reference area and time period. In the below example the time period of 1 year (yr) and the reference area of 1 hectare (ha) are used.

*Relevant input data for cultivation*

- > Amount of seeds in kg seeds per ha and yr
- > Amount of plant protection products (PPP) in kg active ingredient per ha and year (e.g. kg glyphosate/(ha\*yr))

- > Amount of synthetic fertilisers: phosphorus ( $P_2O_5$ )-, potassium ( $K_2O$ )-, lime ( $CaO$ )- and nitrogen (N)- fertiliser in kg nutrient per ha and year (e.g. kg nitrogen/(ha\*yr))
- > Amount of organic nitrogen (N)- fertilisers in kg N/(ha\*yr)
- > Amount of crop residues in kg N/(ha\*yr)
- > Diesel consumption, electricity consumption and other energy consumption (for any work related to the cultivation and drying of biomass)
- > Yield of the raw material in ton/(ha\*yr) moist and moisture content to determine yield of dry matter. If moisture content or yield of dry matter are not known, emissions can be calculated based on moist yield and adapted by applying a moisture factor (see 4.3.1.2). Therefore the moisture content should be measured after delivery to the first gathering point or be based on the maximum value allowed by the delivery contract with the first gathering point

In the case that further, emission-relevant input is used during cultivation, the relevant amounts per ha and time period must be documented and included in the calculation.

#### Published data

The following data for the calculation of GHG emissions are normally gathered from literature or other officially recognised or certified sources:

*Relevant  
emission factors*

- > Emission factors (EF) for seed in kg  $CO_2eq/kg$  seed
- > Emission factors for plant protection products in kg  $CO_2eq/kg$  active ingredient
- > Emission factors for synthetic fertilisers reflecting the emissions of production, extracting and processing of the fertilisers in kg  $CO_2eq/kg$  nutrient (to be applied for  $P_2O_5$ -,  $K_2O$ -,  $CaO$ - and synthetic N-fertiliser)
- > Emission factor for field emissions of all Nitrogen-fertilisers including synthetic and organic N-fertiliser and crop residues in kg  $CO_2eq/kg$  N ( $EF_{field}$ )
- > Emission factors for diesel, electricity or other energy source in kg  $CO_2eq$  per unit energy used

#### 4.3.1.2 Calculation formula for extraction or cultivation of raw materials

The GHG emission (EM) formula for extraction or cultivation of raw materials  $e_{ec}$  includes all emissions from the extraction, processing and production of relevant inputs during field-preparation, cultivation, harvest and post-treatment (e.g. drying of raw material):

*Sum of  
emissions from  
cultivation or  
extraction*

$$e_{ec} \left[ \frac{kg \text{ CO}_2eq}{ton} \right] = \frac{(EM_{fertiliser} + EM_{N_2O} + EM_{inputs} + EM_{diesel} + EM_{electricity}) \left[ \frac{kg \text{ CO}_2eq}{ha * yr} \right]}{yield \text{ raw material} \left[ \frac{ton}{ha * yr} \right]}$$

The sum of GHG emissions from fertilisers, plant protection products, seeds, diesel and electricity (EM, here in kg CO<sub>2</sub>eq per ha and year) is divided by the yield of raw material in ton per ha and year in order to receive the specific GHG emission per ton of raw material.

*Division by yield*

The yield shall refer to the dry matter content. Therefore, either the emissions are divided by the amount of dry raw material or they are calculated by applying a moisture factor:

*Emission per dry matter*

$$e_{ec \text{ feedstock}} \left[ \frac{kg \text{ CO}_2eq}{ton_{dry}} \right] = \frac{e_{ec \text{ feedstock}} \left[ \frac{kg \text{ CO}_2eq}{ton_{moist}} \right]}{(1 - \text{moisture content})}$$

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

The emissions of the different inputs (EM) are calculated by multiplying the input data with the respective emission factors. Care must be taken that units of on-site gathered data and data used from recognised sources are the same.

*Emission of individual inputs (EM)*

$$EM_{diesel} = \text{diesel consumption} \left[ \frac{l}{ha * yr} \right] * EF_{diesel} \left[ \frac{kg \text{ CO}_2eq}{l} \right]$$

For calculating EM<sub>diesel</sub> the diesel consumption of all activities during field-preparation, cultivation, harvest or further processing of the raw material must be determined and multiplied with the emission factor (EF) for diesel.

*EM<sub>diesel</sub>*

$$EM_{electricity} = \text{electricity consumption} \left[ \frac{kWh}{ha * yr} \right] * EF_{electricity} \left[ \frac{kg \text{ CO}_2eq}{kWh} \right]$$

If electricity is consumed from the grid, the emission factor of the regional electricity mix (EF<sub>electricity</sub>) shall be used. In the case of the EU the most logical choice is the whole EU. If electricity from renewable energies is directly consumed (i.e. not supplied from the grid), an adapted EF for the type of renewable electricity might be used.

*EM<sub>electricity</sub>*

$$EM_{input} = \text{input} \left[ \frac{kg}{ha * yr} \right] * EF_{input} \left[ \frac{kg \text{ CO}_2eq}{kg} \right]$$

EM<sub>input</sub> refers to seed and plant protection products. One must always refer to kg active ingredient of the plant protection product.

*EM<sub>input</sub>*

$$EM_{fertiliser} = \text{fertiliser input} \left[ \frac{\text{kg nutrient}}{\text{ha} * \text{yr}} \right] * EF_{production} \left[ \frac{\text{kg CO}_2\text{eq}}{\text{kg nutrient}} \right]$$

The amount of fertilisers always refers to the main nutrient (e.g. nitrogen). For synthetic fertilisers other than nitrogen (e.g. P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, CaO) only the EF<sub>production</sub> is relevant and must be applied. For nitrogen fertilisers, the EF<sub>production</sub> applies only to synthetic nitrogen fertilisers. For synthetic as well as organic nitrogen fertilisers and crop residues being left on the field additionally N<sub>2</sub>O-field emissions must be calculated. To take into account N<sub>2</sub>O emissions from soils the IPCC methodology, including what are described as both “direct” and “indirect” N<sub>2</sub>O emissions of synthetic as well as organic nitrogen fertilisers and crop residues must be applied.<sup>5</sup> All three IPCC Tiers could be used by economic operators. For the calculation of the N<sub>2</sub>O-field emissions according to IPCC Tier 1 methodology the “Annotated example of a GHG calculation using the EU Renewable Energy Directive methodology” provides further practical guidance.<sup>6</sup>

*EM<sub>fertiliser</sub>*

After calculating the GHG emissions per dry-ton of product, the certified agricultural producers or FGPs/ Central offices (on behalf of the farmers belonging to the group) forward the GHG information for e<sub>ec</sub> in kg CO<sub>2</sub>eq/dry-ton raw material together with the agricultural raw material itself. An allocation of emissions to residues like straw is not possible.

*Information transfer of e<sub>ec</sub>*

#### 4.3.2 Emissions from carbon stock changes caused by land-use change (e<sub>l</sub>)

A land use change is any change in carbon stocks between the six IPCC-classified land categories forestland, grassland, cropland (including land for annual and perennial crops and fallow land<sup>7</sup>), wetland, settlements and other land. 'Cropland' and 'perennial cropland' (specified as palm and short rotation coppice) shall be regarded as one land use. GHG emissions from any land use change (e<sub>l</sub>) between these six land categories taking place after the cut-off date of 1 January 2008 and in compliance with ISCC sustainability principle 1 (see ISCC Document 202 “Sustainability Requirements”) must be taken into account. A change in cropland structure or of management activities, tillage practice or manure input practice is not considered land use change.

*Definition and reference year land use change*

The annualised emissions from carbon stock changes caused by land use change e<sub>l</sub> are calculated by averaging total emissions equally over 20 years based on the following formula:

*Formula for e<sub>l</sub>*

<sup>5</sup> 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](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf)

<sup>6</sup> [https://ec.europa.eu/energy/sites/ener/files/2010\\_bsc\\_example\\_ghg\\_calculation.pdf](https://ec.europa.eu/energy/sites/ener/files/2010_bsc_example_ghg_calculation.pdf)

<sup>7</sup> Land set at rest for one or several years before being cultivated again



$$e_i \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}} \right] = \frac{CS_R \left[ \frac{\text{kg C}}{\text{ha}} \right] - CS_A \left[ \frac{\text{kg C}}{\text{ha}} \right]}{\text{yield raw material} \left[ \frac{\text{ton}}{\text{ha} * \text{yr}} \right] * 20 [\text{yr}]} * 3.664$$

For calculating emissions in kg CO<sub>2</sub>eq/t of raw material, the carbon stock of the actual land use (CS<sub>A</sub>) is subtracted from the carbon stock of the reference land use (CS<sub>R</sub>). The result is divided by the yield of raw material (either refers to dry matter or emissions must be adapted by applying a moisture factor (see 2<sup>nd</sup> formula in 4.3.1.2)) and annualised over 20 years. In order to convert the carbon (C) to CO<sub>2</sub>eq-emissions, the conversion factor of 3.664 must be applied.

As the total carbon stock change is annualised over 20 years, the GHG emissions from land use change must be considered for a period of 20 years after the land use change took place. The reference land use (CS<sub>R</sub>) and the actual land (CS<sub>A</sub>) are defined by the mass of carbon in soil and vegetation per unit of land:

*e<sub>i</sub> must be considered for 20 years*

CS<sub>R</sub> (land carbon stock before conversion into agricultural land) is the carbon stock associated with the reference land per unit of land (measured as mass of carbon per unit of land including both soil and vegetation). The reference land use shall be the land use in January 2008 or 20 years before the crop was obtained, whichever was the latest.

CS<sub>R</sub>

CS<sub>A</sub> (carbon stock per unit of land after conversion into agricultural land) is the carbon stock per unit area associated with the actual land use (measured as mass of carbon per unit of land, including both soil and vegetation). In cases where the carbon stock accumulates over more than one year, the value attributed to CS<sub>A</sub> shall be the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever the earliest.

CS<sub>A</sub>

The carbon stock (CS) of land use i (reference or actual) takes into account the soil organic carbon as well as the carbon of the vegetation:

$$CS_i = (SOC + C_{veg}) * A$$

*Formula for CS*

A is referring to the converted area (is 1 if whole area is subject to conversion).

C<sub>veg</sub> is the above and below ground carbon stock of the vegetation. The vegetation value for cropland is zero.<sup>8</sup> The soil organic carbon (SOC) consists of four factors, which depend on climate, soil type, management practice and C-input practice: the standard soil organic carbon in the 0-30 cm topsoil layer (SOC<sub>ST</sub>), the land use factor (F<sub>LU</sub>), the management factor (F<sub>MG</sub>) and the input factor (F<sub>i</sub>):

*C<sub>veg</sub> is zero from cropland*

<sup>8</sup> EC Communication 2010/C160/02 from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels. Brussels.

*Formula for SOC*

$$SOC = (SOC_{ST} * F_{LU} * F_{MG} * F_i)$$

Further information and standard values on the four SOC factors can be found in the IPCC documents.<sup>9</sup>

Together with the batch of the respective agricultural raw material, the supplier forwards the actual GHG value for land use change  $e_i$  in kg CO<sub>2</sub>eq/dry-ton raw material to the recipient.

*Information transfer of  $e_i$*

#### 4.3.3 Emission saving from soil carbon accumulation via improved agricultural management ( $e_{sca}$ )

Improved agricultural management refers to practices that lead to an increase in soil carbon. According to the Communication from the European Commission (2010/C160/02), this can 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) .

*Recognised practices for  $e_{sca}$*

Emission savings from such improvements can be taken into account if evidence is provided that the above-mentioned practices were adopted after January 2008. Furthermore, it must be verified that they are implemented in best practice so that an increase in soil carbon can be expected over the period in which the raw materials concerned were cultivated. Measurement of soil carbon could also serve as additional evidence.

*Reference year for  $e_{sca}$*

For calculating the annualised GHG emission savings from carbon stock changes due to improved agricultural management  $e_{sca}$ , the formula as indicated in point 7, Annex V of the RED and as further specified in Annex II of the Communication from the Commission (2010/C160/02) shall be used:

$$e_{sca} \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}} \right] = \frac{CS_R \left[ \frac{\text{kg C}}{\text{ha}} \right] - CS_A \left[ \frac{\text{kg C}}{\text{ha}} \right]}{\text{yield raw material} \left[ \frac{\text{ton}}{\text{ha} * \text{yr}} \right] * \text{cultivation period raw material} [\text{yr}]} * 3.664$$

*Formula for  $e_{sca}$*

$CS_R$  and  $CS_A$  refer to the carbon stock of the reference land use (R) and the actual land use (A). They are calculated as shown in the chapter 4.3.2 “Land use change”. As an alternative to calculate SOC with standard values, it is also possible “to use other appropriate methods [...] to determine SOC. As far as such methods are not based on measurements, they shall take into

<sup>9</sup> IPCC Vol. 4, Chapter 11, See also Annex V and Commission Decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to RED (notified under document C(2010) 3751) (2010/335/EU).

account climate, soil type, land cover, land management and inputs”.<sup>10</sup> The result is divided by the yield of the raw material (either refers to dry matter or emissions must be adapted by applying a moisture factor (see 2<sup>nd</sup> formula in 4.3.1.2)) and annualised over the period of cultivation of the raw material.

Together with the batch of the respective agricultural raw material, the supplier forwards the actual GHG value for soil carbon accumulation via improved agricultural management  $e_{sca}$  in kg CO<sub>2</sub>eq/dry-ton raw material to the recipient.

*Information transfer of  $e_{sca}$*

#### 4.3.4 Emissions from transport and distribution ( $e_{td}$ )

##### 4.3.4.1 Data basis

###### On site data gathering

For the calculation of  $e_{td}$  the following information needs to be provided through on-site data gathering. All input values must be gathered for the same time.

*Relevant input data for transport*

- > Transport distance (d) loaded/ empty respectively (return transports that are not taking place empty do not need to be taken into account),
- > Mode of transport (e.g. diesel truck, 40t) and,
- > Amount of product transported.

###### Published data

The following impact factors must be drawn from the “ISCC list of emission factors” (see Annex 1 of this document) or from another recognised/certified source:

*Relevant published data*

- > Fuel consumption of the respective mode of transport per km when loaded  $K_{loaded}$  in l per km,
- > Fuel consumption of the respective mode of transport per km when empty  $K_{empty}$  in l per km,
- > Emission factor fuel ( $EF_{fuel}$ ) in kg CO<sub>2</sub>eq per l fuel,
- > As an alternative, an emission factor based on ton-km transported can also be used and multiplied with the transported amount and distance [kg CO<sub>2</sub>eq/t-km]. This EF especially becomes relevant for sea transport.

As an alternative to using fuel consumption data from literature, fuel consumption can also be measured by the logistics providers and provided to the economic operator, who is in charge for calculating emissions from transport. The reports of the logistics provider must be verified or the logistics provider must be certified.

<sup>10</sup> EC Communication 2010/C160/02

#### 4.3.4.2 Calculation formula for transport emissions

GHG emissions from upstream transport of the input material or downstream transport of the product  $e_{td}$  can be calculated based on the following formula:

$$e_{td} \left[ \frac{kg \ CO_2eq}{ton} \right] = \frac{T_{needed} * \left( d_{loaded}[km] * K_{loaded} \left[ \frac{l}{km} \right] + d_{empty}[km] * K_{empty} \left[ \frac{l}{km} \right] \right) * EF_{fuel} \left[ \frac{kg \ CO_2eq}{l} \right]}{amount \ transported \ input \ material \ [ton]}$$

*Formula for  $e_{td}$*

In order to find out how often a transport system was used for the transported amount,  $T_{needed}$  must be calculated. This value is calculated by dividing the amount of transported goods by the loading weight of the used transport system. E.g. if 100 tons of input material is transported by a 20 ton truck, 5 trucks ( $T_{needed} = 5$ ) would be needed to transport all input material. The sum of the fuel consumption of loaded transport and empty transport (if applicable) is multiplied with the transported needed and the emission factor of the fuel.

As an alternative, the methodology on ton-km may also be used:

*Alternative formula for  $e_{td}$*

$$e_{td} \left[ \frac{kg \ CO_2eq}{ton} \right] = \frac{(amount_{transported}[t] * distance_{transported}[km]) * EF_{transport \ type} \left[ \frac{kg \ CO_2eq}{tkm} \right]}{amount \ transported \ raw \ material \ [ton]}$$

The amount of transported material is multiplied with the total distance and an emission factor on ton-km for the transport type.

If upstream transport is calculated the GHG emissions are divided by the amount of the input material in order to receive GHG emissions in kg CO<sub>2</sub>eq/dry-ton input material. As the processing unit calculates upstream transport emissions in kg CO<sub>2</sub>eq/dry-ton input material but has to provide the GHG value for the product, it has to determine kg CO<sub>2</sub>eq/dry-ton of product by applying the feedstock factor. In chapter 4.3.8 "Working with incoming emission values and allocation of emissions to main- and co-products" the methodology for converting and allocating upstream emissions is described.

Together with the batch of the respective material, the supplier forwards the actual GHG value for transport and distribution  $e_{td}$  in kg CO<sub>2</sub>eq/dry-ton product to the recipient.

*Information transfer of  $e_{td}$*

### 4.3.5 Emissions from processing ( $e_p$ )

#### 4.3.5.1 Data basis

A processing unit can include one or more process steps (e.g. oil mill and refinery). The system boundaries of the individual calculation thereby always depend on the product, for which GHG emissions shall be calculated. If GHG emissions shall be calculated purely for the refined oil, oil mill and refinery can be treated as one process step. If also crude oil shall be sold

*System boundaries*

with a GHG emission value, oil mill and refinery must be split into two process steps.

The actual GHG value for an intermediate product must be provided to the recipient of the product in the unit kg CO<sub>2</sub>eq/dry-ton product.

For the calculation of GHG emissions from processing ( $e_p$ ) as a minimum, the following data shall be determined i.e. the respective quantities must be extracted from respective operating documents for the previous year and must be verified by the auditors.

### On-site data gathering

On site data always needs to be gathered for the whole process and not purely for biofuel-relevant processes. The following data for the calculation of GHG emissions must be gathered on-site. All input values must be gathered for the same time period.

*Relevant input  
data for  
processing*

- > Amount of main product and co-products in tons per year. Either refers to dry matter or emissions must be adapted by applying a moisture factor (see 2<sup>nd</sup> formula in 4.3.5.2)
- > Amount of process-specific inputs used (e.g. methanol, NaOH, HCl, H<sub>2</sub>SO<sub>4</sub>, hexane, citric acid, fuller's earth, alkali, process water, diesel or other fuel) in kg per year or litres per year
- > Electricity consumption in kWh/yr and source of electricity (e.g. grid),
- > Heat consumption in MJ/yr, fuel for heat production (e.g. natural gas) and type of heating system (e.g. boiler or combined heat and power system),
- > Amount of wastes (e.g. palm oil mill effluent (POME), wastewater) in kg/yr.

### Published data

The following data for the calculation of GHG emissions must be gathered from recognised/certified sources:

*Relevant  
published data*

- > Emission factors for process specific inputs in kg CO<sub>2</sub>eq/kg and fuels used in kg CO<sub>2</sub>eq/l,
- > Emission factors for electricity consumption based on the source of electricity in kg CO<sub>2</sub>eq/kWh,
- > Emission factors for heat consumption based on the fuel and the type of heating system in kg CO<sub>2</sub>eq/MJ.

#### 4.3.5.2 Calculation formula for processing emissions

Every processing unit in the supply chain must guarantee that all GHG emissions from processing, GHG emissions from wastes (wastewater) and from process-specific inputs are included in the emissions calculation.

Annual average figures can be used. The calculation must be based on the following formula:

$$e_p \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}} \right] = \frac{(EM_{\text{electricity}} + EM_{\text{heat}} + EM_{\text{inputs}} + EM_{\text{wastewater}}) \left[ \frac{\text{kg CO}_2\text{eq}}{\text{yr}} \right]}{\text{yield product} \left[ \frac{\text{ton}}{\text{yr}} \right]}$$

*Sum of  
emissions from  
processing*

For intermediate products the yield shall refer to the dry matter content. Therefore, either the emissions are divided by the amount of dry intermediate products or they are calculated by applying a moisture factor:

$$e_p \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}_{\text{dry}}} \right] = \frac{e_p \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}_{\text{moist}}} \right]}{(1 - \text{moisture content})}$$

The emissions of the different inputs (EM) must be calculated according to the formula below and divided by the yield of the main product. If more than one main product is produced, the calculation has to be repeated for each main product including the different yields of the different main products.

Formula components for calculating EM are:

$$EM_{\text{electricity}} = \text{electricity consumption} \left[ \frac{\text{kWh}}{\text{yr}} \right] * EF_{\text{regional electricity mix}} \left[ \frac{\text{kg CO}_2\text{eq}}{\text{kWh}} \right]$$

*Emissions of  
individual inputs  
(EM)*

If electricity is sourced externally from the grid, the emission factor for electricity from the regional electricity mix shall be used (average emission intensity for a defined region,  $EF_{\text{regional electricity mix}}$ ). In the case of the EU the most logical choice is the whole EU. If electricity from renewable energies is directly consumed (i.e. not supplied from the grid), an adapted EF for the type of renewable electricity might be used.

$EM_{\text{electricity}}$

For calculating the emissions from heat production, two different formulas can be used, based on the available units of the provided heat:

$EM_{\text{heat}}$

$$EM_{\text{heat}} = \text{fuel consumption} \left[ \frac{\text{kg or l}}{\text{yr}} \right] * EF_{\text{fuel}} \left[ \frac{\text{kg CO}_2\text{eq}}{\text{kg or l}} \right] \text{ or}$$

$$EM_{\text{heat}} = \text{heat produced from fuel} \left[ \frac{\text{MJ}}{\text{yr}} \right] * EF_{\text{fuel/heat system}} \left[ \frac{\text{kg CO}_2\text{eq}}{\text{MJ}} \right]$$

As the emission factors for heat production differ for the fuel and the heating system, both data must be documented. For calculating  $EM_{\text{heat}}$  the consumed heat or the fuel consumption for producing the heat for all activities during processing must be determined and multiplied with the respective emission factor (EF). If heat and electricity are consumed from a combined heat and power system (CHP), two emission factors exist for the produced heat and the produced electricity. One can either determine the total fuel consumed in the CHP and multiply that with the emission factor for the fuel or determine electricity and heat production and apply the different emission factors for heat and electricity.

$$EM_{inputs} = inputs\ consumption \left[ \frac{kg\ or\ l}{yr} \right] * EF_{inputs} \left[ \frac{kg\ CO_2eq}{kg\ or\ l} \right]$$

*EM<sub>inputs</sub>*

$EM_{inputs}$  refers to all consumed chemicals, other production goods, process water as well as diesel or other fuel used in the production process.

$$EM_{wastewater} = wastewater \left[ \frac{cbm}{yr} \right] * EF_{wastewater} \left[ \frac{kg\ CO_2eq}{cbm} \right]$$

*EM<sub>wastewater</sub>*

All wastewater production that is generated during the activities of processing must be documented and multiplied with the respective emission factor.

The total GHG emissions are calculated per unit mass of the main product (e.g. kg CO<sub>2</sub>eq-emissions per dry-ton of palm oil).

Emissions from processing need to be allocated to main products and co-products. The methodology for doing so is described in chapter 4.3.8 “Working with incoming emission values and allocation of emissions to main products and co-products”.

*Emissions allocation to different products*

#### 4.3.6 Emission savings from excess electricity ( $e_{ee}$ )

If electricity is produced in cogeneration (combined heat and power, CHP), excess electricity, which is fed into the grid, can be credited under certain conditions. These conditions are:

*Conditions for recognizing excess electricity*

- > The CHP plant is fed with a fuel or an agricultural crop residue, not with a co-product of the process. If co-products of the process are burned in the CHP plant, credits for excess electricity cannot be applied,
- > If the CHP plant is not only used for the process of biofuel production but also for other processes, its size and thus heat and electricity output must be notionally downgraded to the minimum necessary size to produce the heat used in the biofuel process. The produced electricity must be reduced in proportion to the heat reduction
- > In order to calculate excess electricity, the electricity consumed in the process unit is subtracted from the notionally reduced electricity produced in the CHP plant

#### On-site data gathering

For the calculation of  $e_{ee}$  the following data is collected on-site:

- > Steam consumption in MJ per year – Verification if steam produced in CHP plant completely delivers steam consumed in process or if a notional reduction was applied,

*Relevant input data for excess electricity*

- > Electricity production in kWh per year of CHP plant –reduced in proportion to steam production,
- > Electricity consumption of the process in kWh per year,
- > Excess electricity in kWh per year – Annual amount of electricity produced in an internal CHP plant (after notional reduction) but fed into an external grid,
- > Type of fuel for CHP plant – Type of fuel used within the CHP plant,
- > Amount of main product and co-products in tons per year.

### Published data

The credit for excess electricity equals the amount of GHG emissions from the production of an equal amount of electricity in a power plant using the same type of fuel as the CHP plant. For the calculation of  $e_{ee}$  the following data can be drawn from recognised/certified sources:

- > Emission factor $_{fuel}$  in kg CO<sub>2</sub>eq per kWh – Emission factor for the electricity production of the equivalent fossil fuel in a power plant

### Calculation formula for excess electricity

$$e_{ee} \left[ \frac{kg \text{ CO}_2eq}{ton} \right] = \frac{\text{excess electricity} \left[ \frac{kWh}{yr} \right] * EF_{fuel} \left[ \frac{kg \text{ CO}_2eq}{kWh} \right]}{\text{yield}_{product} \left[ \frac{ton}{yr} \right]}$$

*Formula for  
excess electricity*

The excess electricity must be multiplied with a typical emission factor of electricity production of the used fossil fuel in a power plant.

For intermediary products the dry yield of product is applied. Therefore, either the emissions are divided by the amount of dry intermediary product or they are calculated by applying a moisture factor (see 2<sup>nd</sup> formula in 4.3.5.2)

### 4.3.7 Emission savings from carbon capture and replacement ( $e_{ccr}$ ) and carbon capture and geological storage ( $e_{ccs}$ )

The RED sets out that emission savings from carbon capture and replacement,  $e_{ccr}$ , shall be limited to emissions avoided through the capture of CO<sub>2</sub> of which the carbon originates from biomass and which is used to replace fossil-derived CO<sub>2</sub> used in commercial products and services. Emission savings from carbon capture and geological storage ( $e_{ccs}$ ) that have not already been accounted for in  $e_p$ , shall be limited to emissions avoided through the capture and sequestration of emitted CO<sub>2</sub> directly related to the extraction, transport, processing and distribution of fuel.

*Conditions for  
recognised CCR  
and CCS*

For both elements, the emission saved must relate directly to the production of the biofuel or its intermediates they are attributed to. All biofuels/intermediates originating from the same process must be treated equally, i.e. an allocation of arbitrarily different amounts of savings to

*System  
boundaries and  
time frame*



biofuels obtained from the same process is not allowed. If the CO<sub>2</sub> is not captured continuously, it might be appropriate to deviate from this approach and to attribute different amounts of savings to biofuel obtained from the same process. However, in no case should a higher amount of savings be allocated to a given batch of biofuel than the average amount of CO<sub>2</sub> captured per MJ of biofuel in a hypothetical process where the entire CO<sub>2</sub> stemming from the production process is captured.

$e_{ccr}$  can only be taken into account if it can be proven that the CO<sub>2</sub> replaces fossil-derived CO<sub>2</sub> used in commercial products and services. Therefore, the recipient should provide information how the CO<sub>2</sub> that is replaced was generated previously and declare, in writing, that due to the replacement, emissions are avoided. It would be for the auditor to decide case by case whether the requirements of the RED are met including that emissions are actually avoided. It is not required to conduct audits on the premises of the recipient as the recipient of the CO<sub>2</sub> is not part of the chain of custody related to the biofuel production.

*“Replacement”*

$e_{ccs}$  can only be taken into account if there are valid evidences that CO<sub>2</sub> was effectively captured and safely stored. If the CO<sub>2</sub> is directly stored it should be verified whether the storage is in good condition, leakages are non-existent and the existing storage guarantees that the leakage does not exceed the current state of technology. If the CO<sub>2</sub> is sold for storage, one option to prove storage is to provide contracts and invoices of a professional recognised storage company.

*“Storage”*

The following formula shall be used to calculate  $e_{ccr}$  (in g CO<sub>2</sub>eq per MJ fuel):

*Formula for emissions from CCR*

$$e_{ccr} \left[ \frac{g \text{ CO}_2 \text{ eq}}{MJ} \right] = \frac{\left( \text{produced CO}_2 [\text{kg}] - \text{energy consumed [MWh]} * EF \left[ \frac{\text{kg CO}_2 \text{ eq}}{\text{MWh}} \right] - \text{input materials [kg]} * EF \left[ \frac{\text{kg CO}_2 \text{ eq}}{\text{kg}} \right] \right) * 1000}{\text{produced quantity of biofuel [t]} * 1000 * \text{lower heating value biofuel} \left[ \frac{MJ}{kg} \right]}$$

The following formula shall be used to calculate  $e_{ccs}$  (in g CO<sub>2</sub>eq per MJ fuel):

*Formula for emissions from CCS*

$$e_{ccs} \left[ \frac{g \text{ CO}_2 \text{ eq}}{MJ} \right] = \frac{\left( \text{produced CO}_2 [\text{kg}] - \text{energy consumed [MWh]} * EF \left[ \frac{\text{kg CO}_2 \text{ eq}}{\text{MWh}} \right] - \text{input materials [kg]} * EF \left[ \frac{\text{kg CO}_2 \text{ eq}}{\text{kg}} \right] \right) * 1000}{\text{produced quantity of biofuel [t]} * 1000 * \text{lower heating value biofuel} \left[ \frac{MJ}{kg} \right]}$$

### On-site data gathering

For the calculation of  $e_{ccr}$  and  $e_{ccs}$  the following information needs to be gathered on-site:

*Relevant input data for carbon capture*

- > Produced amount of biofuel

- > Quantity of biogenic CO<sub>2</sub> captured during the biofuel production process
- > Origin of the biogenic CO<sub>2</sub> (extraction, transport, processing and distribution of fuel)
- > Quantity of energy consumed for the capturing and the processing of CO<sub>2</sub> (e.g. compression and liquefaction)
- > Other input materials consumed in the process of CO<sub>2</sub> capture and processing

### Published data

The following information needs to be gathered from recognised/certified sources:

*Relevant published data*

- > GHG emission factors for all inputs and their sources (e.g. for input materials, energy consumption etc.)
- > Lower heating value of the main product in MJ per kg

### 4.3.8 Working with incoming emission values and allocation of emissions to main- and co-products

As referred to in chapter 3.1, “Use of default values” and 3.2, “Use of actual values” certified economic operators must state the calculated (or disaggregated default) GHG values for all elements of the calculation formula on the Sustainability Declaration of their product.

If an ISCC System User receives different GHG values, the aggregation of GHG values from incoming input materials is only possible if product identities and GHG values are the same. As an alternative to using single values for each incoming batch, the highest GHG value (of the least performing batch) can also be used for all incoming batches of the same kind of input material.

*Aggregation of different input values*

Incoming GHG emission values need to be adjusted from kg CO<sub>2</sub>eq per ton of input material to kg CO<sub>2</sub>eq per ton of product. In order to do so emissions of input materials are multiplied by a feedstock factor (FF). To some of the received actual GHG values, like processing emissions or transport emissions, own actual values need to be added at each step of the chain of custody. Whenever a processing step yields co-products, emissions need to be allocated by applying a so-called allocation factor AF. The following figure shows more details on how to proceed with different GHG values.

*Requirements for incoming and own GHG values*

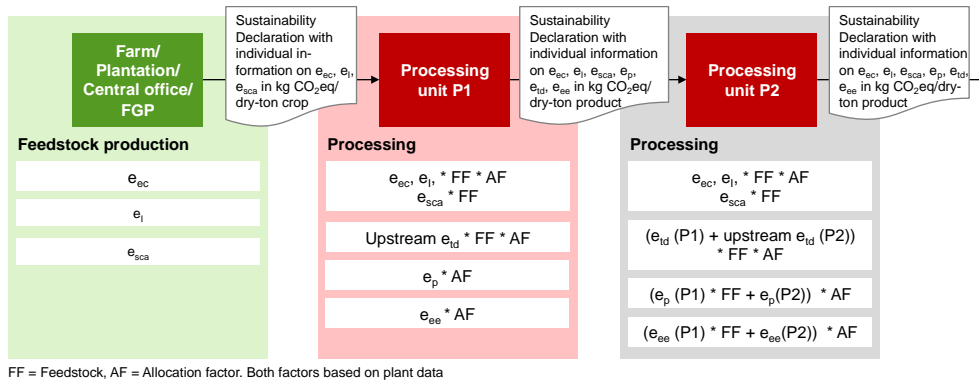


Figure 5: Procedure for the incoming actual GHG values

Emissions delivered with the incoming input material (in figure 5 e.g.  $e_{ec}$ ,  $e_{sca}$ ,  $e_l$ ,  $e_p$ ,  $e_{td}$  or  $e_{ee}$  delivered by P1 to P2) as well as the upstream transport emissions, which are given in kg CO<sub>2</sub>eq/ton input material, must be multiplied with the feedstock factor (FF) in order to calculate emissions in kg CO<sub>2</sub>eq per ton product.

Application of FF

#### 4.3.8.1 Intermediate products

For calculating FF the following formula must be applied when processing intermediate products:

*FF = Ratio of ton dry feedstock required to make 1 ton dry intermediate product*

FF is calculated by dividing the total amount of input materials by the total amount of the intermediate main-product. The following formula shows an example how the feedstock factor has to be applied (for the example of  $e_{ec}$  when processing intermediate product a)<sup>11</sup>:

$$e_{ec} \text{ interm. product}_a \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}_{dry}} \right] = e_{ec} \text{ feedstock}_a \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}_{dry}} \right] * \text{Feedstock factor}_a$$

After converting the GHG emissions of the incoming input material to GHG emissions of intermediate product, the additional emissions of the recipient need to be added to the emissions accordingly. In figure 5, processing unit P2 has to add its actual GHG values for upstream  $e_{td}$ ,  $e_p$  and  $e_{ee}$ .

Adding own emissions

Furthermore, an allocation of emissions to intermediate and co-products is possible for emissions from cultivation ( $e_{ec}$ ), processing ( $e_p$ ), transport and distribution ( $e_{td}$ ), land use change ( $e_l$ ) and excess electricity ( $e_{ee}$ ). Emission savings like  $e_{sca}$ ,  $e_{ccr}$  or  $e_{ccs}$  do not need to be allocated to co-products. Only emissions up to and including the production of the intermediate product and co-products can be included in allocation, e.g. downstream processing or transport and distribution emissions of an intermediate product cannot be added prior to allocation, as those emissions are not related to the co-

Allocation of emissions

<sup>11</sup> Similarly, also the values for  $e_p$ ,  $e_{td}$ ,  $e_l$  and  $e_{ee}$  need to be adjusted

products. It is not possible to allocate GHG emissions to any products that are considered a waste or residue (including agricultural residues like straw) or to other products without a lower heating value.

The following formula is used for the calculation of allocated emissions when processing intermediate products (for the example of  $e_{ec}$  when processing intermediate product a)<sup>12</sup>:

$$e_{ec} \text{interm. product}_a \text{ allocated} \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}_{\text{dry}}} \right] \\ = e_{ec} \text{interm. product}_a \text{ non - allocated} \left[ \frac{\text{kg CO}_2\text{eq}}{\text{ton}_{\text{dry}}} \right] \\ * \text{Allocation factor interm. product}_a$$

Formulas for allocation

Allocation is done based on the allocation factor, which reflects the relation of the total energy content of the intermediate main-product to the total energy content of all products. The energy content is calculated from the lower heating value and the yield of the respective product. The lower heating value shall always refer to the moisture content of the material.

Allocation factor intermediate product

$$= \frac{\text{Energy content}_{\text{intermediate product}} [MJ]}{(\text{energy content}_{\text{intermediate product}} [MJ] + \text{energy content}_{\text{co-product}} [MJ])}$$

with

Energy content<sub>intermediate product</sub> [MJ]

$$= \text{yield}_{\text{intermediate product}} \left[ \frac{\text{dry - kg}}{\text{yr}} \right] * \text{LHV}_{\text{main product}} \left[ \frac{MJ}{kg} \right]$$

$$\text{Energy content}_{\text{co-product}} [MJ] = \text{yield}_{\text{co-product}} \left[ \frac{\text{dry - kg}}{\text{yr}} \right] * \text{LHV}_{\text{co-product}} \left[ \frac{MJ}{kg} \right]$$

Yields of intermediate and co-products shall be measured on-site, while the lower heating values of intermediate and co-products should come from published sources. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purpose of the calculation. After allocation, the respective product supplier passes on the GHG emission information in kg CO<sub>2</sub>eq/ton intermediate product together with the product itself.

Relevant data

#### 4.3.8.2 Final biofuels

For final biofuels the following formula is applicable for the relevant elements in the calculation methodology (shown for the example of  $e_{ec}$ )<sup>13</sup>:

<sup>12</sup> Similarly, also the values for  $e_p$ ,  $e_{td}$ ,  $e_l$  and  $e_{ee}$  need to be adjusted

<sup>13</sup> Similarly, also the values for  $e_p$ ,  $e_{td}$ ,  $e_l$  and  $e_{ee}$  need to be adjusted. As mentioned above in case of  $e_p$  and  $e_{td}$ , the emissions from the relevant processing step must be added.

$$\begin{aligned}
 e_{ec}^{biofuel} \left[ \frac{g \text{ CO}_2eq}{MJ \text{ biofuel}} \right]_{ec} &= \frac{e_{ec}^{feedstock} \left[ \frac{g \text{ CO}_2eq}{kg \text{ dry}} \right]}{LHV_a \left[ \frac{MJ \text{ feedstock}}{kg \text{ dry feedstock}} \right]} * \text{Biofuel feedstock factor}_a \\
 &* \text{Allocation factor } biofuel_a
 \end{aligned}$$

where

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

$$\text{Biofuel feedstock factor}_a = [\text{Ratio of MJ feedstock required to make 1 MJ biofuel}]$$

For the purpose of this calculation feedstock factors based on plant data have to be applied. FF is calculated by dividing the total energy of input materials by the total energy content of the main-product. The energy content is calculated based on the lower heating value (LHV) of the materials. 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<sup>14</sup> 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 1 of the EC Note BK/abd/ener.c.1(2015)4507918 for information (assuming that the biofuel is produced in one production step).

#### 4.3.9 Further requirements for the producers of final biofuels and bioliquids

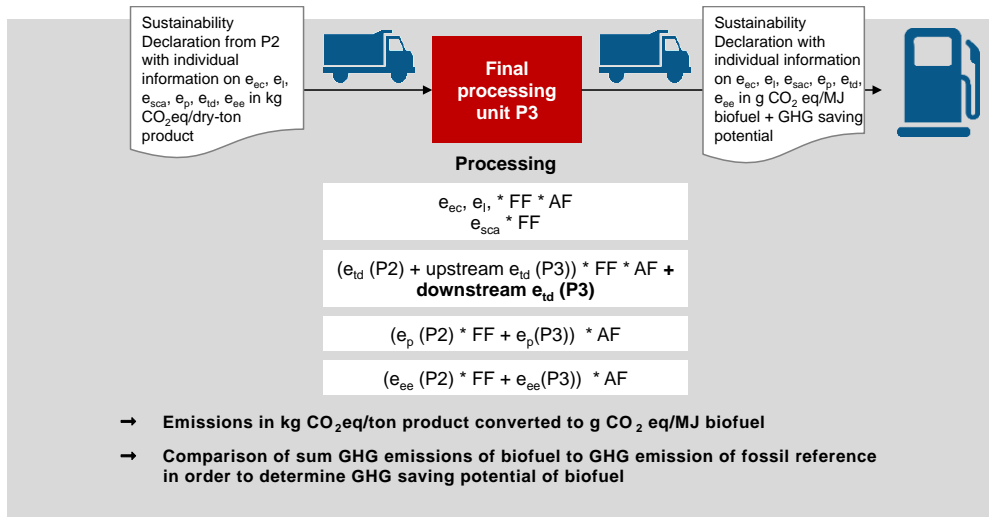
The producers of final biofuels and bioliquids (herein afterwards called final processing unit) must additionally include emissions from the downstream transport and distribution according to the formula provided in chapter 4.3.4 “Emissions from transport and distribution ( $e_{td}$ )”. As those emissions relate only to the biofuel transport, no allocation is possible.

*Downstream  
transport and  
distribution*

Additionally the final processing unit must calculate the GHG emissions of all elements of the calculation formula in g CO<sub>2</sub>eq/MJ biofuel and the GHG saving potential of the final biofuel. The following figure shows the additional requirements for a final processing unit in bold.

*GHG saving  
potential*

<sup>14</sup> 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



FF = Feedstock, AF = Allocation factor. Both factors based on plant data

Figure 6: Requirements of the final processing unit

After the conversion and allocation of all GHG emissions, as referred to in chapter 4.3.8 “Working with incoming emission values and allocation of emissions to main- and co-products”, the final GHG emissions (of e.g. cultivation/extraction of the raw material, processing, excess electricity and transport & distribution) are displayed in kg CO<sub>2</sub>eq per ton of biofuel. In order to determine the GHG emissions per MJ biofuel, the respective lower heating value of the biofuel has to be used.

Calculating  
emissions in g  
CO<sub>2</sub>eq/MJ  
biofuel

For comparing the emissions to the fossil reference, the sum of all emissions has to be build based on the formula shown at the beginning:

Sum emissions  
biofuel

$$GHG \text{ emissions biofuel} = e_{ec} + e_l + e_p + e_{td} - e_{sca} - e_{ccs} - e_{ocr} - e_{ee}$$

The GHG saving potential compared to the fossil reference is calculated according to the following formula:

Formula GHG  
saving

$$GHG \text{ saving potential}[\%] = \frac{GHG \text{ emission fossil reference} - GHG \text{ emission biofuel}}{GHG \text{ emission fossil reference}} * 100$$

The following emission values shall be used for fossil references:

Fossil references

- > Biofuels for transport: 83.8 g CO<sub>2</sub>eq/MJ fossil fuel<sup>15</sup>,
- > Bioliquids used for electricity production: 91 g CO<sub>2</sub>eq/MJ fossil fuel,
- > Bioliquids used for electricity production in CHP plants: 85 g CO<sub>2</sub>eq/MJ fossil fuel and
- > Bioliquids used for heat production: 77 g CO<sub>2</sub>eq/MJ fossil fuel.

ISCC requires a minimum of GHG savings for final biofuels. In the case of installations that were in operation on or before 5 October 2015, biofuels and

GHG saving  
requirements for  
biofuels

<sup>15</sup> This value shall be used until a new value according to Directive 98/70/EC is available which supersedes the value of 83,8 g CO<sub>2</sub>eq/MJ fossil fuel.

bioliquids shall achieve a GHG saving of at least 35% until 31 December 2017 and at least 50% from 1 January 2018. The greenhouse gas emission saving from the use of biofuels and bioliquids shall be at least 60% for biofuels and bioliquids produced in installations starting operation after 5 October 2015. An installation shall be considered to be in operation if the physical production of biofuels or bioliquids has taken place.

The processing unit which produces the biofuel or bioliquids, or where applicable also the fuel supplier, shall provide information to the respective member state whether the installation was in operation on or before 5 October 2015 or after 5 October 2015.

## 5 Switching between different options of GHG information

A switch between different GHG information approaches is only possible, if all relevant information and data is verifiable for the auditor. Hence, doing an individual calculation at a later stage of the supply chain for upstream processes is not possible, as relevant input data would not be verifiable. A switch to a disaggregated default value or a total default value is possible as long as the relevant information have been delivered by certified economic operators. This means that if information on the crop type and the region of cultivation is provided on the Sustainability Declaration of a certified first gathering point, a processing unit could switch from actual value to default values or NUTS2/ NUTS2-equivalent values if all requirements of the RED and ISCC are met. Further information on the conditions to change the GHG information type are provided in the below tables.

*Requirements  
for switching*

Table 1: Conditions for using total default value and switching to another GHG information type

Farm/plantation/ Central office/FGP	Following processing units
"Use of total default value"	Default value can only be applied if the RED and ISCC requirements are met (i.e. if type of processing allows the use of total default value). If not:
	1 Switch to <b>disaggregated default</b> value $e_{ec}$ (and individual calculation for $e_p$ )
	2 Switch to <b>actual value</b> $e_{ec}$ not possible as relevant data not verifiable

Table 2: Conditions for switching GHG information types for  $e_{ec}$  (emissions from cultivation/extraction of raw materials)

Element of calculation	Farm/plantation/ Central office/FGP	Following processing units
		1 Switch to <b>total default value</b> : Possible in case that processing type allows for use of total default value
		2 Switch to <b>actual value</b> $e_{ec}$ : <b>a.</b> Individual calculation not possible as relevant data not available <b>b.</b> Switch to typical emission values from feedstock cultivation published on the Commission web site (such as NUTS2 values) only possible for processing unit receiving the feedstock (e.g. un-processed rapeseed): If sourcing region is known, respective typical emission value in kg CO <sub>2</sub> eq per dry-ton feedstock can be used, if country of origin is known highest typical emission value can be used (if for whole country typical values have been published on the Commission web site)
$e_{ec}$		1 Switch to <b>disaggregated default value</b> $e_{ec}$ : Possible if crop type and country of origin are known and fulfil RED requirements for default value (e.g. corn comes from EU)
		2 Switch to <b>total default value</b> : Possible if above criteria are met and if processing type allows for use of total default value
	"Actual value"	3 Switch to typical emission values from feedstock cultivation published on the Commission web site (such as NUTS2 values) only possible for processing unit receiving the feedstock (e.g. un-processed rapeseed): If sourcing region is known, respective typical emission value in kg CO <sub>2</sub> eq per dry-ton feedstock can be used, if country of origin is known highest typical emission value of country can be used (if for whole country typical values have been published on the Commission web site)



Table 3: Conditions for switching GHG information types for  $e_p$  (emissions from processing)

Element of calculation	Farm/plantation/Central office/FGP	1 <sup>st</sup> processing unit	2 <sup>nd</sup> and following processing units
$e_p$	-	“Use of disaggregated default value”	<p>1 Switch to <b>total default value</b>: Possible, if all requirements (of crop and process type of 2<sup>nd</sup> processing unit) are met</p> <p>2 Switch to <b>actual value <math>e_p</math></b>: Not possible as relevant data of 1<sup>st</sup> processing unit not verifiable</p>
		“Actual value”	<p>1 Switch to <b>total default value</b>: Only possible if information about 1<sup>st</sup> processing unit (e.g. palm biodiesel: Information on methane capture methodology of oil mill) and crop information are available and can be verified by the auditor</p> <p>2 Switch to <b>disaggregated default value <math>e_p</math></b>: Only possible if information about 1<sup>st</sup> processing unit (e.g. palm biodiesel: Information on methane capture methodology of oil mill) is available and can be verified by the auditor</p>

Table 4: Conditions for switching GHG information types for  $e_{td}$  (emissions from transport & distribution)

Element of calculation	Farm/plantation/Central office/FGP	1 <sup>st</sup> processing unit	2 <sup>nd</sup> and following processing units
$e_{td}$	-	“Use of disaggregated default value”	<p>1 Switch to <b>total default value</b>: Possible, if all requirements (of crop and process type of processing unit) are met</p> <p>2 Switch to <b>actual value <math>e_{td}</math></b>: Not possible as relevant data of 1<sup>st</sup> processing unit not verifiable</p>
		“Actual value”	<p>1 Switch to <b>total default value</b>: Only possible if information about 1<sup>st</sup> processing unit (e.g. palm biodiesel: Information on methane capture methodology of oil mill available) and crop information are available and can be verified by the auditor</p> <p>2 Switch to <b>disaggregated default value <math>e_{td}</math></b>: Possible</p>

## 6 Documentation and verification requirements

Depending on the type of GHG information an economic operator is using, different evidence must be kept for audit verification.

In case a total default value or a disaggregated default value is used, the auditor has to verify:

- > If the upstream supply chain fulfils the requirements for using (disaggregated) default values. This can be verified by checking the Sustainability Declarations of the incoming input material.
- > If the economic operator fulfils the requirements for using (disaggregated) default values. This can be verified by checking the heating system (especially relevant for ethanol plants) or the palm oil mill's methane capture technology, etc.
- > The methane capture technology at the palm oil mill must ensure 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 emission are reduced so that without allocating emissions to palm oil mill effluent (POME) plants emit less than 5.46 kg of methane per ton of CPO;

*Verification of default values*

Specific requirements for the use of methane capture devices. If a methane capture device, that can guarantee actual methane capture, is run by the unit, e.g. for pre-treatment of wastewater, the following aspects need to be checked and fulfilled:

- > Absorption of total wastewater in a closed system (only short-term storage of fresh wastewater) and supply to a methane capture device,
- > Use of the produced biogas for energy purposes (see also chapter "Excess electricity"), or in the worst case flaring of the biogas and
- > The methane capture device is in good condition, leakages are non-existent, and the producer provides a guarantee about the maximum methane leakage that does not exceed the current state of the technology.

*Verification of methane capture devices at palm oil mills*

In case an individual calculation was conducted, the economic operator has to keep records and evidence on the following data. They will be subject to the audit:

- > Evidence on all data for all relevant in and outputs and feedstock factors of the production process (e.g. production reports, Sustainability Declarations, invoices)

*Verification of actual values*

- > Sources of emission factors (ISCC list of emission factors or other scientifically peer-reviewed literature/databases) including the year of publication and the applicability (with respect to time period and region)
- > In case external suppliers (e.g. of steam) provide individual emission factors, it must be possible to verify the emission factor and the data/methodology used for the calculation within the scope of the audit or the emission factor must be certified under ISCC
- > Sources of the used lower heating values for main- and co-products (e.g. RED, ISCC list, scientifically peer-reviewed literature/databases, documents from laboratory test results)
- > The methodology used for the individual calculation and the calculation itself must be transparent. The calculation itself should be done in a way that allows the auditor to verify the calculation
- > For Carbon Capture and Replacement (CCR), the auditor has to check, if the emission saving from CCR is limited to emissions of which the carbon originates from biomass and which is used to replace fossil-derived CO<sub>2</sub>. This requires access to information such as: Declaration from recipient of the CO<sub>2</sub>, in writing, that fossil-derived CO<sub>2</sub> is avoided due to the CO<sub>2</sub> coming from CCR. The declaration should include information on the purpose for which the captured CO<sub>2</sub> is used
- > For Carbon Capture and Storage (CCS), the auditor has to check, if the emission saving from CCS is limited to emissions of which the carbon originates from biomass. This requires access to information such as: For direct storage: Quality of storage; For CO<sub>2</sub> sold for storage: Contracts, invoices of a professional recognised storage company
- > The auditor has to record emissions occurring at the audited site (for all relevant elements) and if relevant the achieved savings in the audit report. Should the emissions deviate significantly from typical values then the report also has to include information that explains the deviation.

The following verification approach is required for all individual calculations:

- > ISCC System User has to make available to Certification Bodies' GHG expert all relevant information concerning the calculation of actual GHG values in advance of the planned audit,
- > GHG expert checks information (e.g. methodology, emission factors, lower heating values, other standard values etc.): in case of any questions and/or corrections, he/she is in direct contact with the client,

*Verification steps  
for individual  
calculations*

- > During audit, auditor verifies relevant data from on-site data gathering (e.g. amounts of consumed electricity),
- > Auditor records emissions from processing of the ISCC System User and if relevant achieved savings (e.g.  $e_{ccf}$ ) in audit report,
- > Every Certification Body that verifies individual GHG emission calculations needs to have at least one GHG expert auditor, who is responsible for verifying the methodology and the input data prior to the audit. In order to become a GHG expert, the auditor has to additionally participate in an ISCC GHG training,
- > ISCC System Users are only allowed to use the actual value, if the audit was successful.

## Annex I List of emission factors and lower heating values (LHVs)

The choice of emission and energy factors has an impact on the results of the GHG emissions calculation.

Emission factors describe the relationship between the amount of released GHG emissions and the amount of input material. They are needed in order to calculate the CO<sub>2</sub>eq emissions related to a specific input material. Emission factors for energy supply must include direct and indirect effects. Direct effects are air emissions from combustion, waste, effluents and electricity use. They mainly depend on the carbon content of the fuel. Indirect effects are the upstream emissions of a material. They include e.g. emissions from extraction or processing steps. Both factors – direct and indirect – must be considered in the emission factor used.

*Relevant parts of emission factors*

Lower heating values are needed to calculate the feedstock factor (FF) of the final biofuel but also for allocation of emissions.

The variance of individual emission factors may be large and for some inputs emission factors might not be available or just an approximation can be used. However, to avoid cherry picking and to support objective, transparent and verifiable Individual calculations and audits, ISCC has developed a list of emission factors. The list is mainly based on the list of standard calculation values published on the Commission website, Biograce and Ecoinvent. Alternative values might be used but must be duly justified and flagged in the documentation of the calculations in order to facilitate the verification by auditors.

*Possible sources*

Table 5: List of emission factors, lower heating values (LHVs) and their respective sources

Input	Unit	Standard factor	Source, description
<b>A) Emission factors for cultivation</b>			
N-fertiliser	kg CO <sub>2</sub> eq/kg N <sup>16</sup>	5.881	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Urea	kg CO <sub>2</sub> eq/kg N	1.92	Biograce v 4d, 2014
Urea ammonium nitrate	kg CO <sub>2</sub> eq/kg N	2.68	Biograce v 4d, 2014
Ammonium nitrate	kg CO <sub>2</sub> eq/kg N	3.45	Biograce v 4d, 2014
Ammonium sulphate	kg CO <sub>2</sub> eq/kg N	1.68	Ecoinvent v. 3.1, 2014: market for ammonium sulphate, as N, GLO
Ammonium nitrate phosphate	kg CO <sub>2</sub> eq/kg N	RER <sup>17</sup> : 1.9 RoW: 1.65	Ecoinvent v. 3.1, 2014: ammonium nitrate phosphate production, as N,

<sup>16</sup> For all N-fertilisers the emission factor refers to the amount of nitrogen in the fertiliser.

<sup>17</sup> Europe

Input	Unit	Standard factor	Source, description
Calcium ammonium nitrate	kg CO <sub>2</sub> eq/kg N	3.65	Biograce v 4d, 2014
Monoammonium phosphate	kg CO <sub>2</sub> eq/kg N	1.82	Ecoinvent v. 3.1, 2014: monoammonium phosphate production, RER
Diammonium phosphate	kg CO <sub>2</sub> eq/ kg N	2.05	Ecoinvent v. 3.1, 2014: diammonium phosphate production, RER
P2O5-fertiliser	kg CO <sub>2</sub> eq/kg P <sub>2</sub> O <sub>5</sub>	1.011	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Triple superphosphate (TSP)	kg CO <sub>2</sub> eq/kg P <sub>2</sub> O <sub>5</sub>	0.54	Biograce v 4d, 2014
Rock phosphate	kg CO <sub>2</sub> eq/kg P <sub>2</sub> O <sub>5</sub>	0.09	Biograce v 4d, 2014: 21%P2O5 23%SO3
K2O-fertiliser	kg CO <sub>2</sub> eq/kg K <sub>2</sub> O	0.576	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
CaO-fertiliser	kg CO <sub>2</sub> eq/kg CaO	0.13	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Pesticides	kg CO <sub>2</sub> eq/kg a.i. <sup>18</sup>	10.97	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Glyphosate	kg CO <sub>2</sub> eq/kg a.i.	9.79	Ecoinvent v. 3.1, 2014: market for glyphosate, GLO
Seeds corn	kg CO <sub>2</sub> eq/kg seed	0.35	Biograce v 4d, 2014: Non-GMO
Seeds corn	kg CO <sub>2</sub> eq/kg seed	1.81	Ecoinvent v. 3.1, 2014: maize seed production for sowing (12% max H <sub>2</sub> O)
Seeds rapeseed	kg CO <sub>2</sub> eq/kg seed	0.73	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Seeds soy bean	kg CO <sub>2</sub> eq/kg seed	0.40	Biograce v 4d, 2014: Non-GMO
Seeds soy bean	kg CO <sub>2</sub> eq/kg seed	1.81	Ecoinvent v. 3.1, 2014: soybean seed production for sowing (13% max H <sub>2</sub> O)
Seeds sugarbeet	kg CO <sub>2</sub> eq/kg seed	3.54	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Seeds sugarcane	kg CO <sub>2</sub> eq/kg seed	0.0016	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Seeds rye	kg CO <sub>2</sub> eq/kg seed	0.74	Ecoinvent v. 3.1, 2014: rye seed production for sowing (15% max H <sub>2</sub> O)
Seeds sunflower	kg CO <sub>2</sub> eq/kg seed	0.73	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015

<sup>18</sup> Active ingredient

Input	Unit	Standard factor	Source, description
Seeds wheat	kg CO <sub>2</sub> eq/kg seed	0.276	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015

## B) Emission factors for processing

### Process inputs

Process water	kg CO <sub>2</sub> eq/kg	RER: 0.0003 RoW: 0.0004	Ecoinvent v. 3.1, 2014: tap water, at user
Deionised water	kg CO <sub>2</sub> eq/kg	0.001	Ecoinvent v. 3.1, 2014: market for water, deionised, from tap water, GLO
Cyclo-hexane	kg CO <sub>2</sub> eq/kg	0.723	Biograce v 4d, 2014
Sodium methylate	kg CO <sub>2</sub> eq/kg	4.88	Biograce v 4d, 2014
Magnesium oxide	kg CO <sub>2</sub> eq/kg	1.11	Ecoinvent v. 3.1, 2014: market for magnesium oxide, GLO
Sodium hydroxide	kg CO <sub>2</sub> eq/kg	1.1	Ecoinvent v. 3.1, 2014: market for sodium hydroxide, without water, in 50% solution state, GLO
Potassium hydroxide	kg CO <sub>2</sub> eq/kg	1.93	Biograce v 4d, 2014
Methanol <sup>19</sup>	kg CO <sub>2</sub> eq/kg	0.42	Ecoinvent v. 3.1, 2014: Market for methanol, GLO
Methanol	kg CO <sub>2</sub> eq/kg	1.98	Calculated from Biograce v 4d, 2014.
Hydrochloric acid	kg CO <sub>2</sub> eq/kg	0.75	Biograce v 4d, 2014
Fuller's earth	kg CO <sub>2</sub> eq/kg	0.20	Biograce v 4d, 2014
Phosphoric acid	kg CO <sub>2</sub> eq/kg	3.01	Biograce v 4d, 2014
Hydrogen	kg CO <sub>2</sub> eq/kg	RER: 2.08 RoW: 2.19	Ecoinvent v. 3.1, 2014: Market for hydrogen, liquid
Nitrogen	kg CO <sub>2</sub> eq/kg	0.43	Biograce v 4d, 2014
Ammonia	kg CO <sub>2</sub> eq/kg	2.66	Biograce v 4d, 2014
Lubricants	kg CO <sub>2</sub> eq/kg	0.95	Biograce v 4d, 2014
Pure CaO for processes	kg CO <sub>2</sub> eq/kg	1.03	Biograce v 4d, 2014
Citric acid	kg CO <sub>2</sub> eq/kg	0.96	Biograce v 4d, 2014

<sup>19</sup> Please note that this emission factor only covers upstream activities.

Input	Unit	Standard factor	Source, description
<b>Electricity consumption from grid (electricity mix)</b>			
EU	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.46	Biograce v 4d, 2014
Indonesia	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	1.05	Biograce v 4d, 2014
Malaysia	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.88	Biograce v 4d, 2014
Brazil	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.11	Biograce v 4d, 2014
Argentina	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.51	Biograce v 4d, 2014
<b>Energy consumption from internal production</b>			
Wind electricity	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.01	Ecoinvent v. 3.1, 2014: Electricity production, wind, 1-3 MW turbine, onshore, RoW
Solar electricity	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.06	Ecoinvent v. 3.1, 2014: Electricity production, photovoltaic, 3kWp flat-roof install. multi-Si
Heat from boiler (NG)	kg CO <sub>2</sub> eq/MJ <sub>th</sub>	0.07	Ecoinvent v. 3.1, 2014: heat from natural gas, at industrial furnace >100kW (EU without CH)
Heat from boiler (light fuel oil)	kg CO <sub>2</sub> eq/MJ <sub>th</sub>	0.09	Ecoinvent v. 3.1, 2014: heat production, light fuel oil, at industrial furnace 1MW, RoW
Heat from boiler (lignite)	kg CO <sub>2</sub> eq/MJ <sub>th</sub>	0.18	Ecoinvent v. 3.1, 2014: heat production, lignite briquette, at stove 5-15kW, EU without CH
Heat from boiler (hard coal)	kg CO <sub>2</sub> eq/MJ <sub>th</sub>	0.11	Ecoinvent v. 3.1, 2014: heat production, hard coal industrial furnace 1-10MW, EU without CH
Heat/electricity from CHP (NG)	heat: 0.03 kg CO <sub>2</sub> eq/MJ and electricity: 0.5 kg CO <sub>2</sub> eq/kWh		Ecoinvent v. 3.1, 2014: Heat and power co-generation, NG, 1MWe, lean burn, RoW
Heat/electricity from CHP (diesel)	heat: 0.03 kg CO <sub>2</sub> eq/MJ and electricity: 0.68 kg CO <sub>2</sub> eq/kWh		Ecoinvent v. 3.1, 2014: Heat and power co-generation, diesel, 200kW electrical, SCR-NOx reduction, RoW
Heat/electricity from CHP (biogas) <sup>20</sup>	heat: 0.01 kg CO <sub>2</sub> eq/MJ and electricity: 0.29 kg CO <sub>2</sub> eq/kWh or biogas input: 0.02 kg CO <sub>2</sub> eq/cbm		Ecoinvent v. 3.1, 2014: Heat and power co-generation, biogas (biowaste, sewage sludge), gas engine, RoW
Diesel	kg CO <sub>2</sub> eq/kg	0.48	Ecoinvent v. 3.1, 2014: market for diesel, low-sulfur, RoW
	kg CO <sub>2</sub> eq/MJ	0.0876	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Waste wood	kg CO <sub>2</sub> eq/kg	0.01	Ecoinvent v. 3.1, 2014: treatment of waste wood, post consumer, sorting and shredding

<sup>20</sup> All emissions of co-generation have been distributed to the heat output based on fixed efficiencies: electricity: 0.32, heat: 0.55



Input	Unit	Standard factor	Source, description
Natural gas	kg CO <sub>2</sub> eq/MJ	4000 km, Russian quality: 0.066 4000 km, EU Mix quality: 0.0676	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015

#### Electricity production in conventional power plants (reference for credit calculation e<sub>ee</sub>)

NG in Combined Cycle Gas Turbine	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.44	Biograce v 4d, 2014. Conversion factor 1 MJ = 0.28 kWh
Lignite in Steam Turbine	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	1.03	Biograce v 4d, 2014. Conversion factor 1 MJ = 0.28 kWh
Straw in Steam Turbine	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.02	Biograce v 4d, 2014. Conversion factor 1 MJ = 0.28 kWh
Electricity (Oil)	kg CO <sub>2</sub> eq/kWh <sub>el</sub>	0.71	Ecoinvent v. 3.1, 2014: electricity from heavy fuel oil, RoW

#### Waste treatment

Wastewater treatment	kg CO <sub>2</sub> eq/cbm	0.33	Ecoinvent v. 3.1, 2014: market for wastewater, average, GLO
POME <sup>21</sup> treatment in open ponds	kg CO <sub>2</sub> eq/kg CPO <sup>22</sup>	0.51	BLE, 2010, Guideline Sustainable Biomass Production
	kg CO <sub>2</sub> eq/kg POME	0.16	BLE, 2010, Guideline Sustainable Biomass Production. 3.25 kg POME per kg CPO
POME treatment in closed ponds and flaring of emissions	kg CO <sub>2</sub> eq/kg CPO	0	Biogenic CO <sub>2</sub> set to zero, No CH <sub>4</sub> , N <sub>2</sub> O if pond appropriately covered without any leakages, methane is properly captured
EFB burning	kg CO <sub>2</sub> eq/kg EFB	0	Biogenic CO <sub>2</sub> set to zero
EFB and POME Co-composting	kg CO <sub>2</sub> eq/kg CPO	0.03	Stichnothe et al. 2010
	kg CO <sub>2</sub> eq/kg POME	0.01	

#### C) Emission factors for transport & distribution

Diesel consumption truck (loaded)	litre/km	0.49	BLE, 2010, Guideline Sustainable Biomass Production
Diesel consumption: truck (unloaded)	litre/km	0.25	BLE, 2010, Guideline Sustainable Biomass Production
Diesel	kg CO <sub>2</sub> eq/litre	3.14	Biograce v 4d, 2014
HFO	kg CO <sub>2</sub> eq/litre	3.42	Biograce v 4d, 2014

<sup>21</sup> POME: Palm Oil Mill Effluent

<sup>22</sup> CPO: Crude Palm Oil

Input	Unit	Standard factor	Source, description
	kg CO <sub>2</sub> eq/MJ	0.085	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
HFO for maritime transport	kg CO <sub>2</sub> eq/MJ	0.087	European Commission: <a href="#">Standard values for emission factors</a> , v 1.0. 2015
Electricity consumption train (electricity)	MJ/ton-km	0.06	Biograce v 4d, 2014. Conversion factor 1 MJ = 0.28 kWh
Freight train	kg CO <sub>2</sub> eq/ton-km	0.04	Ecoinvent v. 3.1, 2014: transport, freight train, RoW
Barge tanker	kg CO <sub>2</sub> eq/ton-km	0.04	Ecoinvent v. 3.1, 2014: transport, freight, inland waterways, barge tanker, GLO
Transoceanic tanker	kg CO <sub>2</sub> eq/ton-km	0.002	Ecoinvent v. 3.1, 2014: market for transport, freight, sea, transoceanic tanker, GLO
Pipeline (oil, liquids) onshore	kg CO <sub>2</sub> eq/ton-km	0.02	Biograce v 4d, 2014
Pipeline (natural gas) offshore	kg CO <sub>2</sub> eq/ton-km	0.02	Ecoinvent v. 3.1, 2014: transport, pipeline, offshore, long distance, natural gas, GLO
Emissions at filling station from energy consumption	g CO <sub>2</sub> eq/MJ biofuel	0.44	Biograce v 4d, 2014

#### D) Lower Heating Values (at 0% water, unless otherwise stated)

Corn	MJ/kg	18.5	Biograce v 4d, 2014
FFB	MJ/kg	24.0	Biograce v 4d, 2014
Rapeseed	MJ/kg	26.4	Biograce v 4d, 2014
Soybeans	MJ/kg	23.5	Biograce v 4d, 2014
Sugar beet	MJ/kg	16.3	Biograce v 4d, 2014
Sugar cane	MJ/kg	19.6	Biograce v 4d, 2014
Sunflower	MJ/kg	26.4	Biograce v 4d, 2014
Wheat	MJ/kg	17.0	Biograce v 4d, 2014
BioOil (co-product FAME from waste oil)	MJ/kg	21.8	Biograce v 4d, 2014
DDGS (10 wt% moisture)	MJ/kg	16.0	Biograce v 4d, 2014
Glycerol	MJ/kg	16.0	Biograce v 4d, 2014

Input	Unit	Standard factor	Source, description
Palm kernel meal	MJ/kg	17.0	Biograce v 4d, 2014
Palm oil	MJ/kg	37.0	Biograce v 4d, 2014
Rapeseed meal	MJ/kg	18.7	Biograce v 4d, 2014
Crude and refined vegetable oil	MJ/kg	37.0	Biograce v 4d, 2014
Waste vegetable / animal oil	MJ/kg	37.1	Biograce v 4d, 2014
Sugar beet pulp	MJ/kg	15.6	Biograce v 4d, 2014
Sugar beet slops	MJ/kg	15.6	Biograce v 4d, 2014
Wheat straw	MJ/kg	17.2	Biograce v 4d, 2014