BIOGRACE I

Harmonised Calculations of Biofuel Greenhouse Gas Emissions in Europe

28/04/2015

BioGrace-I calculation rules

Version 4d

Supported by INTELLIGENT ENERGY EUROPE

www.biograce.net

Content

1 Introduction 4
1.1 Updates of this document 4
2 General 5
2.1 Compliance with RED and FQD sustainability criteria 5
2.1.1 BioGrace calculation rules are binding 5
2.1.2 Actual calculations shall be audited and shall be made with the "for Compliance" version of the Excel tool 5
2.1.3 Actual calculations shall be made using Global Warming Potentials of 1, 23 and 296 5
2.1.4 Units of input numbers shall not be changed 5
2.2 Standard Values 6
2.2.1 BioGrace harmonised list of standard values 6
2.2.2 BioGrace list of additional standard values 7
2.2.3 Standard value for fertiliser 7
2.3 Cut-off criteria 7
2.4 Combining disaggregated default values and actual values 9
2.5 Use of starting values in the BioGrace Excel tool 9
2.5.1 Starting values for distribution of the fuel 10
2.5.2 Starting values shall be unchanged if a disaggregated default value is chosen 10
2.6 Using the result(s) from previous and partial GHG calculations 11
2.7 Use of the sheet “user specific calculations” 12
3 Cultivation 13
3.1 Field N_2O emissions 13
3.2 Use of average values 13
3.3 Use of aggregated or measured values 14
3.4 Non artificial fertiliser 15
3.5 Actual input data for use of fertilisers 15
4 Processing 16
4.1 Use of actual values 16
4.2 Allocation 16
4.2.1 Energy allocation 16
4.2.2 Allocation between co-products and the fuel 17

4.3 Electricity Use 20
4.4 Emissions of N_2O, CH_4 and CO_2 from the production unit 21
4.5 Handling of residues and waste 21
4.6 Emissions from process heat 21
5 Land use change 25
6 Emission savings 26
6.1 Excess electricity 26
6.2 Soil carbon accumulation via improved agricultural methods 27

1 Introduction

The BioGrace GHG calculation tool allows reproduction of the calculation of the Annex V default values of the Renewable Energy Directive (2009/28/EC) (RED) for biofuel production pathways as well as to perform individually adapted calculations. The calculations use the BioGrace list of standard values and follow the methodology laid down in the RED.

The calculation rules that are listed below in this document apply for adapted calculations in the BioGrace Excel tool, when calculating new pathways, new processes or for new inputs in the tool. The calculation rules form integral part of this Excel tool: when using the tool the calculation rules shall be respected.

The BioGrace GHG calculation rules are in line with the methodology as given in Annex V.C of the RED and in the communication and decision from the European Commission: Communication on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels [OJ C160, page 8] and Commission decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (2010/335/EU) [OJ L151 page 19], with one exception as explained in footnote 13.

In general, the BioGrace GHG calculation rules are in line with the standard that is prepared under CEN TC 383 “Sustainably produced biomass for energy use” – Working Group 2 “Calculation for the GHG emission balance, fossil fuel balance and respective calculations, using a life cycle approach”. As this standard will not be published before end of 2012, in this document no reference will be made to the CEN TC383 draft standard on GHG calculation. Quite a number of the topics addressed in the BioGrace calculation rules are also addressed in the CEN TC 383 draft standard.

1.1 Updates of this document

For the few items where the BioGrace calculation rules differ from the CEN standard under preparation, additional work on harmonising these rules will take place. This might cause that the BioGrace GHG calculation rules will be updated in the future. Another cause for update might be when the methodology in Annex V is updated, according to the RED article 19.7.

When this document is updated, it will be sent to the European Commission within the procedure of accepting BioGrace as a voluntary scheme. The updated documents would need to be reassessed and approved by the Commission.

2 General

2.1 Compliance with RED and FQD sustainability criteria

The following rules apply when the BioGrace Excel tool is used to show compliance with sustainability criteria as defined in national legislation implementing the RED and FQD sustainability criteria:

2.1.1 BioGrace calculation rules are binding

If the BioGrace Excel tool is used, the BioGrace calculation rules shall be respected. An auditor checking actual calculations shall not approve the calculations when the calculation rules were not respected.

2.1.2 Actual calculations shall be audited and shall be made with the "for Compliance" version of the Excel tool

When actual calculations are made to show compliance with the RED/FQD GHG criteria[1], then the calculations shall:

- be subject to third party independent auditing; and
- be made with the version "for Compliance" of the Excel tool[2] in which the "track changes" option is always turned on. This will allow an auditor that will check the calculations to easily find the actual input numbers that were used for the calculation.

2.1.3 Actual calculations shall be made using Global Warming Potentials of 1, 23 and 296

The BioGrace Excel tool allows to change the set of Global Warming Potentials between [1 for CO_2, 23 for CH_4 and 296 for N_2O] and [1 for CO_2, 25 for CH_4 and 298 for N_2O] for reasons explained elsewhere [3]. Actual calculations shall be made with the Global Warming Potentials of 1 for CO_2, 23 for CH_4 and 296 for N_2O. A verifier checking actual calculations shall verify that the Global Warming Potentials of 1 for CO_2, 23 for CH_4 and 296 for N_2O have been used[4].

2.1.4 Units of input numbers shall not be changed

The units of the input numbers shall not be changed. Therefore the user of the BioGrace Excel tool must convert actual data collected into the units of the BioGrace Excel tool. Auditors checking actual calculations shall make sure that the actual input numbers have been converted into the right units, and that the units in the BioGrace Excel tool have not been changed.

---

[1]: Show compliance with the GHG reduction targets of national legislation implementing RED article 17(2) and FQD article 7b(2)

[2]: The "Version for Compliance" is the version of the tool that is opened after it has been downloaded from www.BioGrace.net. The "Version for Testing" is the version that is created after pressing the orange button "Track changes" causing that track changes is turned off. Please note that track changes cannot be turned on again after turning it off.

[3]: This is further explained on the "About" page of the tool.

[4]: This can be checked in cells D10, D11 and D12 of the sheet "Standard values" in the BioGrace GHG tool.

2.2 Standard Values

2.2.1 BioGrace harmonised list of standard values

Standard values are values needed to convert input data into GHG emissions[5]. Standard values shall be taken from the harmonised list of standard values[6] unless:

1. For inputs, (by-/co-)products, process related emissions and transport modes not listed on the harmonised list of standard values,
   - reliable information[7] is given showing where these standard values were obtained; and auditors are allowed and are able to verify this information conform RED Article 18.3.
2. For inputs, (by-/co-)products, process related emissions and transport modes that are listed[8] on the harmonised list of standard values
   - these standard values are explicitly named together with the result of the calculation; and reliable information is documented[7], conform RED article 18.3, showing how these values were determined; and it is shown that this input was used in the production of the biofuels for which the GHG calculation was made[9]; and auditors are allowed and are able to verify that this information conforms to RED Article 18.3.

---

[5]: Examples are Lower Heating Values and values to convert 1 kg N-fertiliser or 1 MJ of natural gas into CO_2, CH_4 and N_2O emissions. Some of the standard values have also been calculated using LCA analysis of both the processes that supply the inputs (like N-fertiliser and natural gas) and their emissions at combustion

[6]: The list of standard values is available on the sheet "Standard values" in the BioGrace Excel tool and is also available on-line both in Excel and Word versions at http://www.biograce.net/content/ghgcalculationtools/standardvalues.

[7]: Data used shall lie within the commonly accepted data range.
In case of
(a) Densities and lower heating values (LHV's),
(b) Fuel efficiencies and (CH_4 and N_2O) transport exhaust gas emissions,
(c) CH_4 and N_2O emissions (also called "emission coefficients" in the BioGrace list of standard values) from boilers, CHP's, machinery operation, steam or heat provision,
reliable information shall consist of reports of analyses following suitable ISO, CEN or ASTM standards or other commonly accepted methods, or public scientifically sound articles or reports that include or refer to such analyses or methods.
In case of
(d) Emission coefficients other than those mentioned under (c),
reliable information shall consist of (references to) peer reviewed or scientifically sound LCA analysis on the provision of the input material. In case of reference, the LCA analysis shall be public. The LCA study shall give the actual emission per MJ or kg of input material;.

[8]: "listed" means "listed as such" or "listed as a similar input". Example 1: using another value for "N-fertiliser" equals taking another value for a standard value from the list of harmonised standard values (as N-fertiliser is listed), so the rules under point 2 have to be followed. Example 2: if a farmer uses urea as a fertiliser, then there is a "similar input" on the list of standard values, which is "N-fertiliser". Therefore, also in this example "urea as a fertiliser" the rules under point 2 shall be followed.

[9]: For instance: when a specific type of N-fertiliser is used, then this shall be demonstrated by evidence that an auditor can check. For instance, a farmer must be able to show the purchase bills mentioning the specific fertiliser, or a farmer's association must be able to show the contracts for delivery of the specific fertiliser to a group of farmers.

- the use of this alternative standard value does not contradict any other calculation rule. In case of contradiction the other calculation rule prevails over this rule on use of alternative standard values. This can for instance be the case for electricity (see chapters 4.3 and 6.1), and for heat (see chapter 4.6)

2.2.2 BioGrace list of additional standard values

BioGrace has developed a list of additional standard values. When using a standard value that does not come from the BioGrace list of standard values, it is recommended to take a number from this list of additional standard values - if available on this list - and to include the reference that is given in this list as reliable information on how the value was determined. Doing so, still the rules above (under 2.2.1 points 1 and 2) shall be respected.

2.2.3 Standard value for fertiliser

The standard value for a fertiliser in the list of BioGrace standard values can only be used when making a calculation **using regional averaged input data** for cultivation.

When making an actual calculation for cultivation with **input data at the farm-level** and the **fertiliser type is *known*** the standard value for this specific type of fertiliser shall be applied (for instance by using a value from the BioGrace list of additional standard values).

When making an actual calculation for cultivation with **input data at the farm-level** and the **fertiliser type is *unknown*** the **highest standard value for that fertiliser shall be applied**. The highest values from the BioGrace list of standard values or additional standard values are listed in Table 1:

N-fertiliser	2827 g CO_2/(kg N)	8.68 g CH_4/(kg N)	9.64 g N_2O/(kg N)	5880.6 g CO_{2eq}/(kg N)
P-fertiliser	1459 g CO_2/(kg P_2O_5)	3.73 g CH_4/(kg P_2O_5)	0.00 g N_2O/(kg P_2O_5)	1544.7 g CO_{2eq}/(kg P_2O_5)
K-fertiliser	536.3 g CO_2/(kg K_2O)	1.57 g CH_4/(kg K_2O)	0.012 g N_2O/(kg K_2O)	576.1 g CO_{2eq}/(kg K_2O)

Table 1: highest values for N-, P- and K-fertiliser from the BioGrace list of standard values or the BioGrace additional standard values

2.3 Cut-off criteria

[RED, Annex V, point 1]: Emissions from the manufacture of machinery and equipment shall not be taken into account.

[OJ C160, page 8], page 11: It would not seem necessary to include in the calculation inputs which will have little or no effect on the result, such as chemicals used in low amounts in processing.

All emissions from processes and products used and associated with the system the economic operator has defined must be included in the GHG calculation. However, if the contribution of that input or process to the total emissions of the biofuel pathway is lower than 0.1 g $CO_{2,eq}$/MJ biofuel, it may be excluded.

As to avoid that a calculation, including finding a standard value, would be needed to show that the contribution is lower than 0.1 g $CO_{2,eq}$/MJ biofuel, this calculation rule can be complied with in the following way :

1. If an input is smaller than the mass or energy threshold[10] in Table 2 below (in the same units as to be inputted in the BioGrace Excel tool), than the contribution of the input may be excluded;
2. If there are several inputs that are relatively small, the sum of the inputs shall be below the mass or energy threshold to allow exclusion of the contribution of the inputs.
3. If the input is larger than the mass or energy threshold but it can be argued - for instance using standard values for similar inputs or using standard values that can be argued to be higher than the standard values for the input - that the emission of the input is below the 0.1 g $CO_{2,eq}$/MJ biofuel, then the contribution of the input may be excluded.
4. If there are several small inputs this shall be demonstrated for the sum of the inputs for which the contribution is to be excluded.

Mass or energy threshold		
0.000005	kg/MJ	(this is equal to 0.005 g/MJ)
0.0002	MJ/MJ	(this is equal to 0.2 kJ/MJ)
10	MJ ha^{-1} $year^{-1}$	
0.3	kg ha^{-1} $year^{-1}$	

Table 2: mass or energy threshold

[10]: The mass and energy thresholds were determined using the BioGrace Excel tool in combination with the highest standard values from the list of standard values, expressed in g $CO_{2,eq}$/kg input and in g $CO_{2,eq}$/MJ input (pesticides and electricity from lignite, respectively). In combination with these standard values, an input which is smaller than the mass or energy threshold gives an emission lower than 0.1 g $CO_{2,eq}$/MJ biofuel.

2.4 Combining disaggregated default values and actual values

[RED, Article 19.1]

For the purposes of Article 17(2), the greenhouse gas emission saving from the use of biofuel and bioliquids shall be calculated as follows:

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

(b) by using an actual value calculated in accordance with the methodology laid down in part C of Annex V; or

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

A user may calculate greenhouse gas emissions of his biofuels by using disaggregated default values for cultivation, processing and/or transport. In the BioGrace Excel tool, this can be done by choosing “A” (actual values) or “D” (disaggregated default values) in the box next to the calculation result for cultivation, processing and transport.

2.5 Use of starting values in the BioGrace Excel tool

When the BioGrace Excel tool is downloaded, it contains starting values in the white boxes in columns A - L. These starting values are the values that have been used to calculate the RED default values, as is demonstrated by the BioGrace Excel tool. Actual GHG values are calculated by replacing starting values in columns A - L with actual input vales.

When changing a starting value into an actual value, all other starting values in columns A - L in that part of the biofuel production chain (either cultivation, processing or transport) shall be changed into actual values as well, including the starting values in columns A - L of other steps within the same part of the biofuel production chain (either cultivation, processing or transport). There is one exception to this rule which is given in paragraph 2.5.1.

Cultivation and processing can consist of several steps and transport does in most pathways consist of several steps. Both a cultivation and a processing step are defined as an operation at a distinct geographical location. A transport step is defined as the movement of a material from one cultivation or processing step to the next. A transport step can therefore consist of several transport modes (for instance transport by truck, followed by transport by ship). The separate steps are visible in the BioGrace Excel tool, the user of the tool must understand that this rule for changing starting values applies to all inputs for cultivation, all inputs for processing and/or all inputs for transport (except for the exception given below).

Example: when a user gives an actual value for the yield, also actual input values must be given for all the other input values in the cultivation of the feedstock, which are (amongst others) the moisture content of the crop, the amount of diesel used, the amount of (N-, P-, K- and Ca-) fertiliser used, the amount of seed material and pesticides used, and the field N_2O emission. If a previous or next step is also part of cultivation but is defined as a separate step (eg. “Feedstock drying” in the production of FAME from rapeseed) then actual input values have to be given also for the inputs in this step.

2.5.1 Starting values for distribution of the fuel

[OJ C160, page 8], page 9:

“Member States need to define which economic operators need to submit the information concerned. Most transport fuels are subject to excise duty, which is payable on release for consumption (9). The obvious choice is to place the responsibility for submitting information on biofuels on the economic operator who pays the duty. At this point information with regard to the sustainability criteria along the entire fuel chain should be available (10).”

(10) The one exception could be the greenhouse gas emissions from distribution of the fuel (if needed for the calculation of an actual value). It would be appropriate to use a standard coefficient for this.

The starting values for distribution of the fuel in the step “Transport to filling station” or (in case of biogas) “CNG filling station” may be kept when making actual calculations. As a consequence a standard coefficient is used for the transport of the fuel to the filling station plus consumption of electricity in the filling station. This standard coefficient is 0,93 g $CO_{2,eq}$ per MJ of ethanol, 0,80 g $CO_{2,eq}$ per MJ of FAME, 0,74 g $CO_{2,eq}$ per MJ of HVO, 0,81 g $CO_{2,eq}$ per MJ of PVO and 2,84 g $CO_{2,eq}$ per MJ of biomethane.

2.5.2 Starting values shall be unchanged if a disaggregated default value is chosen

Starting values shall not be changed in parts of the biofuel production pathway for which a disaggregated default value is chosen.

Example: if a disaggregated default value is chosen for "processing" in the pathway "FAME from Rapeseed", then none of the starting value in the steps "Extraction of oil", "Refining of vegetable oil" and "Esterification" shall be replaced by actual input numbers.

When the user wants to use actual values in any part of these steps then all the numbers in all these steps must be replaced by actual values (see calculation rule 2.5) and the "A" (Actual values") shall be selected next to "Processing" at the top of the calculation sheet.

2.6 Using the result(s) from previous and partial GHG calculations

Some voluntary certification schemes (that are used to show compliance with the sustainability criteria for biofuels) allow that GHG calculations are made for part of the biofuel pathway and – after verification – are used as input in a new calculation for the rest of the biofuel pathway.

In order to use the result from previous partial GHG calculations in the BioGrace Excel tool:

- These results of the previous calculation shall be expressed in g $CO_{2,eq}$ per kg of feedstock (including moisture) or in g $CO_{2,eq}$ per kg of raw vegetable oil.
- The economic operator that uses these previous and partial GHG calculations as input for the BioGrace Excel tool must have received, and must keep in his administration, a delivery note that shall contain the following information:
  - The result of the previous calculation.
  - The GHG calculation tool, including version number, that was used to calculate the result of the previous calculation.
  - A statement on what has been included in this calculation: cultivation and/or feedstock transport and/or an oil mill and/or raw vegetable oil transport to the next processing unit.
  - Whether or not land use change has occurred and – if so – whether land use change has been included in the calculation.
  - Whether improved agricultural management has been included in the calculation.
  - Once the European Commission has defined severely degraded or heavily contaminated land and if applicable: a statement that the feedstock was produced on severely degraded or heavily contaminated land, allowing to use the 29 g $CO_{2,eq}$/MJ bonus.
  - A statement that the calculation and the information on land use change has been verified by an independent verifier during an earlier audit, and that since that audit the feedstock and process inputs have not changed.

Values expressed in g $CO_{2,eq}$/kg biofuel, which have been previously calculated and which have been verified by an independent auditor, may be put into the BioGrace tool. Changing such a value will overwrite all values and calculations in that step.

There are two different kind of values that can be entered, for which the following requirements shall be taken into account:

1. <u>One or more unallocated results for individual steps</u>
   a. Result(s) for individual step(s) (like cultivation and/or transport and/or the oil mill) shall be entered in the cells with white background colour in column N for the corresponding step.
   b. In the result section (cells A6-E20) it shall be indicated in row E that an “individual result from a previous calculation” has been inputted, causing the result line(s) (rows A-G) for the individual step(s) in question to become orange-coloured.[11]

[11]: This is explained in detail in paragraph 4.2 of the user manual.

2. One result for multiple steps
    a. One combined result for more than one step (like cultivation plus transport or like cultivation plus oil mill) shall be entered in the cells with white background colour in column N for the last step in the combined result (so the combined result for cultivation plus oil mill is put into the result in column N for the step "Extraction of oil")
    b. In the cells with white background colour in column N for the other steps that are included in the combined result, the value "0" shall be entered.
    c. In the result section (cells A6-E20) it shall be indicated in row E that a "combined result from a previous calculation" has been inputted. This shall be done for al the steps included in the combined result, causing the result lines (rows A-G) for these steps become orange-coloured.[11]
    d. If a co-product is formed in one of the steps included in the combined result, then in the BioGrace Excel tool the allocation factor for this step shall be set to 100% towards the main product and 0% to the co-product. This shall be done by entering the value "100" into cell J6 in the calculation in the BioGrace Excel tool.

Land use change (e_l) as well as improved agricultural management (e_{sca}) shall be considered to be steps different from cultivation and as a result the combination of "cultivation" plus "land use change" as well as the combination "cultivation" plus "improved agricultural management" shall be considered to be multiple steps. Also for e_l and for e_{sca} it shall be indicated in row E when a "combined result from a previous calculation" has been inputted.[11]

2.7 Use of the sheet "user specific calculations"

The BioGrace Excel tool contains a sheet "User specific calculations" which allows users of the tool to make company- or user-specific calculations, such as converting company- or user-specific data into the format in which the data can be entered into BioGrace.

For the sheet "User specific calculations" the following calculation rules apply:
- The entire content of this sheet shall be subject to third party auditing;
- Calculations made on this sheet shall be company/user specific;
- The outcome of calculations made on this sheet shall be intermediate results that serve as input values in other BioGrace GHG calculation sheets (the sheets with the calculations on the biofuel production pathways);
- This sheet shall not be used to calculate results to be entered in column N of other BioGrace GHG calculation sheets ("use of results from previous and partial GHG calculations" as explained in paragraph 2.6);
- All calculations made on this sheet shall comply with the BioGrace calculation rules.

3 Cultivation

3.1 Field N_2O emissions

[OJ C160, page 8], page 15: An appropriate way to take into account N_2O emissions from soils is the IPCC methodology, including what are described there as both ‘direct’ and ‘indirect’ N_2O emissions . All three IPCC tiers could be used by economic operators.

When calculating emissions of N_2O from cultivation, both direct and indirect emissions shall be included.

For this calculation one of the methods laid down in the IPCC guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11 (2006) tier one, two or three shall be used. The data established in this methodology is to be used when calculating field N_2O emissions.

A calculation sheet for this is included in the BioGrace Excel tool.

3.2 Use of average values

[OJ C160, page 8], page 15: The methodology for ‘cultivation’ allows — as an alternative to actual values — for the use of averages for smaller geographical areas than those used in the calculation of the default values. The default values were (with one exception) calculated for a global level. However, within the EU, the Directive places restrictions on their use. These restrictions operate at the level of NUTS 2 areas. It seems to follow that within the EU, the averages shall be for NUTS 2 areas or for a more fine-grained level. A similar level would logically also be appropriate outside the EU.

For cultivation, it is allowed to use average values for geographical areas at the level of NUTS-2 areas or more fine-grained level. In the reports that had to be prepared in accordance with RED article 19.2, member states have listed average GHG emission values at such levels. These values are, however, calculated in different member states and the calculation of some values might not have been done in accordance with the BioGrace calculation rules. It is therefore not allowed in the BioGrace calculations to use the GHG emission results from these reports directly. However, the input data, for example yield and amount of N-fertiliser, may be used if they are complete. In the calculation, the appropriate standard value from the BioGrace list shall be applied. The studies according to article 19.2 can be found on the EC Transparency platform.

If different feedstocks or feedstocks with different sustainability characteristics are used together in a biofuel process it is not allowed to make calculations based on averages of their different sustainability characteristics. For each feedstock with different sustainability characteristics a separate calculation has to be made.

3.3 Use of aggregated or measured values

For agricultural management (e_{ec} and e_l in the methodology) it is allowed to use either measured or aggregate values. When using aggregate values:

- The regional differences for these values shall be taken into consideration when using this data. For the EU, a value relevant for the NUTS2 level or more fine-grained level shall be used. For other countries a similar level would be applicable.
- Such numbers shall primarily be based on official statistical data from government bodies when available and of good quality. If not available, statistical data published by independent bodies may be used. As a third option, the numbers may be based on scientifically peer-reviewed work, with the precondition that data used lies within the commonly accepted data range when available.
- The data used shall be based on the most recent available data from the above-mentioned sources. Typically, the data shall be updated over time, unless there is no significant variability of the data over time.
- For fertiliser use, the typical type and quantity of fertiliser used for the crop in the region concerned may be used. Emissions from the production of fertiliser shall either be based on measured values or on technical specifications of the production facility. When the range of emissions values for a group[12] of fertiliser 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 for the calculations, it is required to also use a measured value for fertiliser input and vice versa.

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

[12]:It refers to for example a situation where an economic operator knows that the fertiliser was produced by a certain company in a certain country. 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.

3.4 Non artificial fertiliser

[RED, Annex V, point 18]: Wastes, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined), shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials.

[OJ C160, page 8]

- Page 16: No emissions shall be allocated to agricultural crop residues and processing residues, since they are considered to have zero emissions until the point of their collection. Similarly, when these materials are used as feedstock they start with zero emissions at the point of collection.
- Page 13: Examples of residues include crude glycerine, tall oil pitch and manure.

GHG emissions from a non-artificial fertiliser consist of emissions from its production and from its use. No emissions are allocated to the production of manure until the point of collection. However when field N_2O emissions are calculated, the contribution from manure is to be included according to IPCC tier 1 (see 3.1 above).

3.5 Actual input data for use of fertilisers

If a GHG calculation is made using actual input data for mineral and/or organic fertilisers, then all mineral and organic fertilisers shall be taken into account that were used between the harvest of the previous crop and the harvest of the crop that is input for the calculation.

4 Processing

4.1 Use of actual values

Actual values for emissions from processing steps (e_p in the methodology) in the production chain must be measured or based on technical specifications of the processing facility. When the range of emissions values for a group of processing facilities to which the facility concerned belongs is available, the most conservative number of that group shall be used.

4.2 Allocation

4.2.1 Energy allocation

[RED, Annex V, point 17]: Where a fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (co-products), greenhouse gas emissions shall be divided between the fuel or its intermediate product and the co-products in proportion to their energy content (determined by lower heating value in the case of co-products other than electricity).

[OJ C160, page 8], page 16:

- The lower heating value used in applying this rule shall be that of the entire (co-)product, not of only the dry fraction of it. In many cases, however, notably in relation to nearly-dry products, the latter could give a result that is an adequate approximation.
- Since heat does not have a lower heating value no emissions can be allocated to it on that basis.

If a production process produces both the biofuel for which total emissions are calculated and one or more co-products, the emissions have to be allocated between the fuel and its co-products in relation the lower heating value (LHV) of the products.

The lower heating value to be used is the LHV for the whole product and not just the dry part of it. The wet content of the product shall be included.

No emissions shall be allocated to heat.

For calculating the allocated emissions for each of the products, the lower heating values included in the BioGrace list of standard values shall be used.

For calculating the LHV for the wet content of the stream, the following formula shall be used:

$$LHV = LHV_{dry}\left(\frac{100 - \%W}{100}\right) - \left(\frac{\%W \cdot 2{,}44}{100}\right)$$

LHV_{dry} is the LHV of the dry matter expressed in MJ/kg (as listed in the list of standard values)

2,44 is the latent heat of vaporisation of water at 25°C expressed in MJ/kg

%W is the mass percentage of water in the stream (material)

4.2.2 Allocation between co-products and the fuel

[RED, Annex V, point 18]: In the case of fuels produced in refineries, the unit of analysis for the purposes of the calculation [allocation][shall be the refinery.

[OJ C160, page 8], page 16: Allocation should be applied directly after a co-product (a substance that would normally be storable or tradable) and biofuel/bioliquid/intermediate product are produced at a process step. This can be a process step within a plant after which further 'downstream' processing takes place, for either product. However, if downstream processing of the (co-) products concerned is interlinked (by material or energy feedback loops) with any upstream part of the processing, the system is considered a 'refinery' and allocation is applied at the points where each product has no further downstream processing that is interlinked by material or energy feedback-loops with any upstream part of the processing.

When allocating emissions between co-products and the fuel, the emissions to be allocated are the emissions that arise up and until the process step where a co-product is formed. The allocation takes place after the process step directly after the forming of a co-product. When leaving a process, the co-product takes the allocated emissions with it, see figure 1 below.

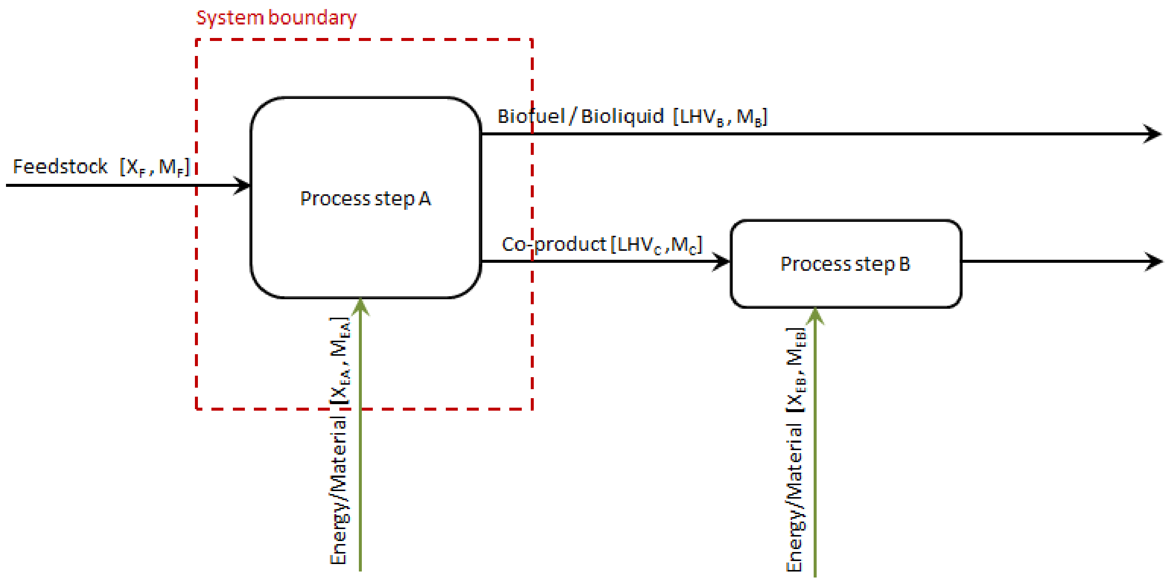

Figure 1 - Allocation takes place after the process step where the biofuel and the co-product are separated.

The following acronyms refer to Figure 1 as well as to the equations below:

E: energy

X: emissions expressed per mass (CO_{2eq}/kg):

- X_F: the emissions from the feedstock stream (CO_{2eq}/kg)
- $X_{E/A}$: the emissions from material and/or energy stream to process step A (CO_{2eq}/kg)
- $X_{E/B}$: the emissions from the material and/or energy stream to process step B (CO_{2eq}/kg)

M: quantity (kg):

- M_F: the quantity of the feedstock stream (kg)
- $M_{E/A}$: the quantity material and/or energy stream to process step A (kg)
- $M_{E/B}$: the quantity material and/or energy stream to process step B (kg)
- M_B: the quantity of the biofuel/bioliquid stream (kg)
- M_C: the quantity of the co-product stream (kg)

LHV: the lower heating value expressed per mass (MJ/kg)

GHG emissions allocated to the biofuel when leaving the process, X_B, can be calculated as:

$$X_B = \frac{LHV_B \cdot M_B}{((LHV_B \cdot M_B) + (LHV_C \cdot M_C))} \cdot \left((X_F \cdot M_F) + (X_{EA} \cdot M_{EA})\right)$$

GHG emissions allocated to the co-product, X_C, can be calculated as:

$$X_C = \frac{LHV_C \cdot M_C}{((LHV_B \cdot M_B) + (LHV_C \cdot M_C))} \cdot \left((X_F \cdot M_F) + (X_{EA} \cdot M_{EA})\right) + (X_{EB} \cdot M_{EB})$$

If processing of co-products and/or the fuel is interlinked with feedback loops with earlier steps in the production process, the production process is defined as a refinery. Allocation of emissions then takes place after the step where no more feedback loops interlink with earlier parts in the process, see figure 2 below.

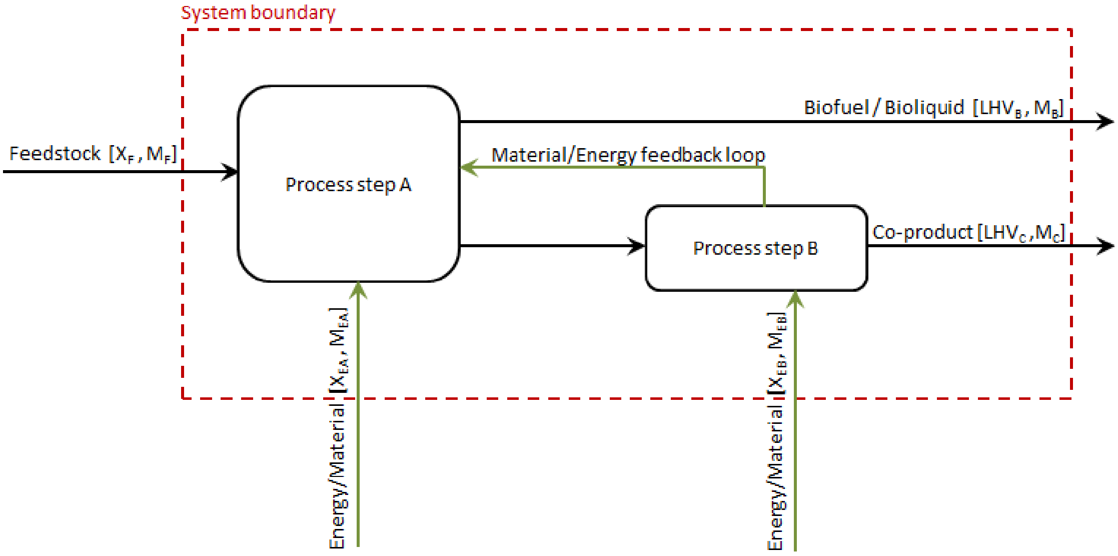

Figure 2: Feedback loop of energy or material in the biofuel production system, considered a "refinery". Allocation takes place where no more feedback loops occur.

The following acronyms refer to Figure 2 as well as to the equations below:

E: energy

M: material

X: emissions expressed per mass (CO_{2eq}/kg)

- X_F: the emissions from the feedstock stream (CO_{2eq}/kg)
- $X_{E/A}$: the emissions from material and/or energy stream to process step A (CO_{2eq}/kg)
- $X_{E/B}$: the emissions from the material and/or energy stream to process step B (CO_{2eq}/kg)

M: quantity (kg)

- M_F: the quantity of the feedstock stream (kg)
- $M_{E/A}$: the quantity material and/or energy stream to process step A (kg)
- $M_{E/B}$: the quantity material and/or energy stream to process step B (kg)
- M_B: the quantity of the biofuel/bioliquid stream (kg)
- M_C: the quantity of the co-product stream (kg)

LHV: the lower heating value expressed per mass (MJ/kg)

GHG emissions allocated to the biofuel when leaving the process, X_B, can be calculated as:

$$X_B = \frac{LHV_B \cdot M_B}{((LHV_B \cdot M_B) + (LHV_C \cdot M_C))} \cdot \left((X_F \cdot M_F) + (X_{EA} \cdot M_{EA}) + (X_{EB} \cdot M_{EB})\right)$$

GHG emissions allocated to the co-product, X_C, can be calculated as:

$$X_C = \frac{LHV_C \cdot M_C}{((LHV_B \cdot M_B) + (LHV_C \cdot M_C))} \cdot \left((X_F \cdot M_F) + (X_{EA} \cdot M_{EA}) + (X_{EB} \cdot M_{EB})\right)$$

4.3 Electricity Use

[RED, Annex V, point 11]: In accounting for the consumption of electricity not produced within the fuel production plant, the greenhouse gas emission intensity of the production and distribution of that electricity shall be assumed to be equal to the average emission intensity of the production and distribution of electricity in a defined region. By derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid.

[OJ C160, page 8], page 16: The Directive requires the use of the average emission intensity for a 'defined region'. In the case of the EU the most logical choice is the whole EU. In the case of third countries, where grids are often less linked-up across borders, the national average could be the appropriate choice.

Emissions from using grid electricity shall be calculated from the average emission intensity for the country in which the electricity is taken from the grid. Country-average emission intensities for electricity shall be taken from the BioGrace list of additional standard values. It is not allowed to use the average emission intensity for the EU electricity mix.[13] Therefore when making an actual calculation in the BioGrace Excel tool a user-defined standard value for electricity shall be used.[14]

In case the BioGrace list of additional standard values does not contain an average value for the national grid for a country and such a value cannot be obtained from other sources, it is allowed to use the value for "Other Africa", "Other Asia" or "Other South and Central America" in the BioGrace list of additional standard values for countries in Africa, Asia and South and Central America, respectively.

Average emissions from a power plant can be applied only if the power plant is not connected with the grid. Emissions shall be averaged over the last year for which data are available.

It is not allowed to decrease the GHG emissions of electricity used by buying green certificates from a Green certificate scheme.

13: This rule therefore deviates from "Communication on the practical implementation …. [OJ C160, page 8]" which states that the most logical choice is to take the average emission intensity for the EU. The reason for deviating from "the most logical choice" from the Communication, is that under other voluntary sustainability schemes it is allowed the use the national average emission intensity also for EU countries and because BioGrace aims to avoid disharmonised calculation rules.

14: In the BioGrace Excel tool, the starting values (see also paragraph 2.5) for electricity are given for the parameter "EU electricity mix". This is as to show how the GHG default values from the RED were calculated.

4.4 Emissions of N_2O, CH_4 and CO_2 from the production unit

[RED, Annex V, C],

- Point 1: Greenhouse gas emissions from the production and use of transport fuels, biofuels and bioliquids shall be calculated as: $E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$,

- Point 5: The greenhouse gases taken into account for the purposes of point 1 shall be CO_2, N_2O and CH_4.

The GHG emissions from a production plant include emissions from combustion of fossil fuels as well as from any venting of methane and nitrous oxide to the atmosphere occurring during the process.

4.5 Handling of residues and waste

[RED, Annex V, point 18: Wastes, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined), shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials.

[OJ C160, page 8], page 13

- a processing residue is a substance that is not the end product that a production process directly seeks to produce. It is not a primary aim of the production process and the process has not been deliberately modified to produce it.

- waste can be understood as any substance or object which the holder discards or intends or is required to discard . Raw materials that have been intentionally modified to count as waste (e.g. by adding waste material to a material that was not waste) should not be considered as qualifying.

All operations that need to be carried out in order to dispose all waste and residues shall be included in the GHG emission calculation. Waste and residues leave the system without any GHG emissions.

Waste and residues used for biofuel production have zero GHG emissions up and until the point of collection. If the waste or residue need further processing before it can be used in the biofuel process, the emissions from that processing shall be included in the biofuel GHG emission calculation.

4.6 Emissions from process heat

Waste heat is considered to have an emission factor of zero. This is because this energy – if not used in the biofuel production – will in most cases not be used elsewhere.

When calculating emissions from energy input from solid biomass or biomass derived fuels, the standard value for "average biomass" in the BioGrace list of additional standard values is recommended to be applied (see chapter 2.2).

4.7 Electrical and thermal efficiency

In the BioGrace Excel tool the electrical and thermal efficiencies are calculated in the separate sheet "Calculate efficiencies". When using that sheet, this rule shall be respected.

When determining the electrical efficiency of a power plant the Formula 1 shall be used and relevant requirements stated in this rule shall be respected. When determining the thermal efficiency of a district heating plant the Formula 2 shall be used and relevant requirements stated in this rule shall be respected. When determining the electrical- and thermal efficiency of a combined heat and power plant (CHP) the Formula 1 and Formula 2 shall be used and all requirements below shall be respected:

Formula 1. Determining the electric efficiency

$$\eta_{el} = \frac{El - El_s - El_h}{F_f + B_f}$$

Formula 2. Determining the thermal efficiency

$$\eta_h = \frac{H - H_h - H_l}{F_f + B_f}$$

Where

- El is the gross electricity production (MWh/year)
- El_s is the total amount of start-up electricity used within the plant (MWh/year)
- El_h is the total amount of help system electricity (also known as "auxiliary electricity") used for electrical utilities belonging to the plant (MWh/year)
- F_f is the total amount of fossil fuel input (MWh/year). F_f shall be calculated as F_f = Mass (fossil fuel input) * LHV_{dry} (fossil fuel) * (1 – [mass percentage of water in fossil fuel]/100)
- B_f is the total amount of biomass fuel input during the period (MWh/year). B_f shall be calculated as B_f = Mass (biomass fuel input) * LHV_{dry} (biomass fuel) * (1 – [mass percentage of water in biomass fuel]/100)[15]
- H is the gross heat production (MWh/year) and is calculated according to formula 3

[15]: The consequence of not taking into account the latent heat of vaporisation of water in this calculation (which could have been done by using the formula "*B_f = Mass (biomass fuel input) * (LHV_{dry} * (1 – [mass percentage of water]/100) – 2,441*[mass percentage of water]/100)*" in which 2,441 is the latent heat of vaporisation of water at 25°C expressed in MJ/kg) is that the amount of biomass fuel input, expressed in MWh/year, is still significant also in case the biomass fuel is very wet. Because of neglecting the latent heat of vaporisation of water, using a very wet biomass fuels will result in a very low electrical and thermal efficiencies when using Formulas 1 and 2. The reason for not taking into account the latent heat of vaporisation of water is further explained in the methodological background document.

- H_h is the total amount of help system heat (also known as "auxiliary heat") used within the plant (preheating fuel or air) (MWh/year)
- H_l is the total amount of heat that does not leave the "gate" of the plant as useful heat, for example heat that is cooled off or other losses that occur before the "gate" of the plant. Losses that occur after the "gate" of the plant are neglected.
- $H-H_h-H_l$ is the useful heat delivered at the "gate" of the plant. 'Useful heat' shall mean heat produced in a cogeneration process to satisfy an economically justifiable demand for heat or cooling. 'Economically justifiable demand' shall mean the demand that does not exceed the needs for heat or cooling and which would otherwise be satisfied at market conditions by energy generation processes other than cogeneration.[16] The point of delivery for the useful heat is set at the "gate" of the plant due to feasibility reasons.

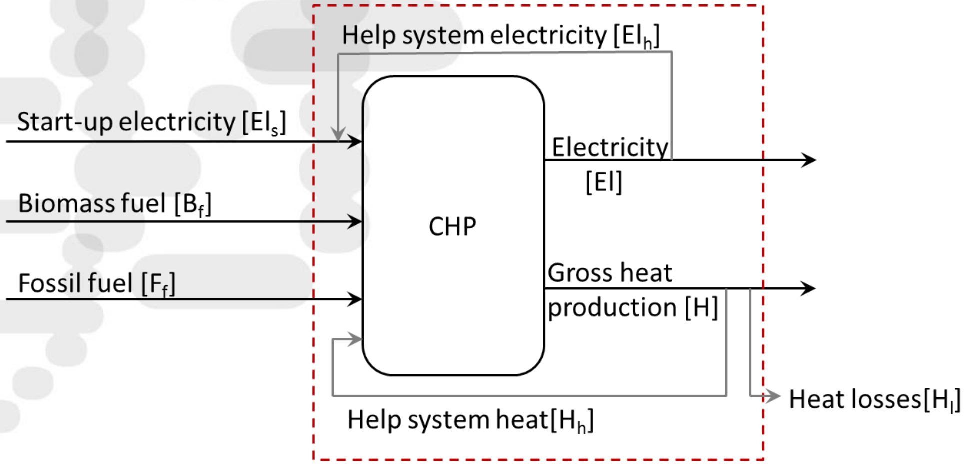

Figure 1 - A schematic Illustration of the CHP process and description of input and output used in the Formula and Formula . The gross useful heat production shall of course be calculated by taking the returning heat into account even though it is not included in this schematic illustration. This is done according to formula 5.

Formula 5. Determining the gross useful heat

$$H = \frac{C_P \cdot F \cdot \Delta T}{3.6 \cdot 10^9}$$

Where C_P is the heat capacity of the medium that is heated [J/[kg·K]]

- F is the flow rate of the medium that is heated [kg/year]
- ΔT the temperature difference in Kelvin: $T_{out} - T_{in}$ [K] [17]
- The number $3.6 \cdot 10^9$ is to convert the unit of H from J to MWh which is the unit of input in the sheet Calculate efficiencies in the BioGrace-II Excel tool.

[16]: Directive 2012/27/EU of the European parliament and of the council of 25 October 2012 on energy efficiency.

[17]: In case of a CHP that delivers heat to a district heating network, T_{in} is the temperature of the returning district heating water.

Any electricity consumed by utilities belonging to the CHP or power plant shall be counted as help electricity (also known as "auxiliary electricity") (El_h) (when taken from the grid during operation of the plant or using internally produced electricity) and shall be subtracted from the amount of electricity generated (El). Such utilities can include utilities for conditioning of the fuel (e.g. coal mills for a coal plant), conveyer belts, pumps, lighting and compressors. The mentioned utilities shall not be considered as an exhaustive list of utilities that should be included.

When thermal energy is used for pre-heating the fuel, intake air or for other heat purposes within the power plant, district heating plant or CHP[18], this heat shall be regarded as help system heat (also known as "auxiliary heat") (H_h) and be subtracted from the heat produced by the power plant when calculating the amount of useful heat. Also losses, for example heat that is cooled off, shall be subtracted. The point of delivery for the useful heat shall be at the "gate" of the plant due to feasibility reasons.

Fossil fuel input includes any fossil fuel used for start-up, stopping and supporting the power plant, district heating plant or CHP.

When calculating the annual fuel input, the energy content shall be calculated by multiplying the lower heating value (on a dry basis) with the dry part of the annual fuel input. The lower heating value shall be the weighted average lower heating value for the fuel during the period for which the emissions are being calculated.

A reference-period of 365 consecutive days shall be used to avoid annual fluctuations in heat requirement or production cycles[19].

If a plant both has input of fossil fuels and biomass fuels, the actual annual input of both fossil and biomass fuels in the plant shall be used in the formula.

In cases where several useful heat qualities are produced, different heat efficiencies shall be calculated for the different heat qualities.

[18]: If the power plant is integrated with the production of the fuel, heat used for the production of the fuel shall also be subtracted from the total amount of delivered heat.

[19]: If the plant has not been in operation for 365 days the calculations shall be based on real production data which is available. When doing so, a representative period must be taken (ie it is not allowed to determine the efficiency of a CHP only over winter months if the efficiency of the CHP is different in winter than in summer).

5 Land use change

[RED, Annex V, C]:

- Point 7: Annualised emissions from carbon stock changes caused by land-use change, e_l, shall be calculated by dividing total emissions equally over 20 years.
- Point 10: The Commission guidelines shall serve as the basis for the calculation of land carbon stocks for the purposes of this Directive.

[OJ C160, page 8], page 13: Land-use change should be understood as referring to changes in terms of land cover between the six land categories used by the IPCC (forest land, grassland, cropland, wetlands, settlements and other land) plus a seventh category of perennial crops, i.e. multi-annual crops whose stem is usually not annually harvested such as short rotation coppice and oil palm.

For determining if the bonus for restored degraded land 29 g CO_{2eq}/MJ shall apply, the definitions laid down by the COM of degraded land and heavily contaminated land must be considered[20]. For the calculation of carbon stock emissions from land use change, the rules lain down in Commission decision on guidelines for the calculation of land carbon stocks for the purpose of Annex V of Directive 2009/28/EC [OJ L151, page 19] shall be used. A template for this is included in the BioGrace Excel tool.

[20]: The Commission has not yet (April 2015) defined whether land that falls within the scope of a national or regional recovery programme aimed at improving severely degraded or heavily contaminated land fulfils the criterion enabling to use the bonus.

6 Emission savings

6.1 Excess electricity

[RED, Annex V, C, point 16]: Emission saving from excess electricity from cogeneration, e_{ee}, shall be taken into account in relation to the excess electricity produced by fuel production systems that use cogeneration except where the fuel used for the cogeneration is a co-product other than an agricultural crop residue. In accounting for that excess electricity, the size of the cogeneration unit shall be assumed to be the minimum necessary for the cogeneration unit to supply the heat that is needed to produce the fuel. The greenhouse gas emission saving associated with that excess electricity shall be taken to be equal to the amount of greenhouse gas that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit.

[OJ C160, page 8], page 16

The general allocation rule in point 17 [in RED] does not apply for electricity from CHP when the CHP runs on (i) fossil fuels; (ii) bioenergy, where this is not a co-product from the same process; or (iii) agricultural crop residues, even if they are a co-product from the same process. Instead, the rule in point 16 [in RED] applies as follows:

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

(b) To the amount of electricity that remains after this notional adjustment and after covering any actual internal electricity needs a greenhouse gas credit should be assigned that should be subtracted from the processing emissions.

(c) The amount of this benefit is equal to the life cycle emissions attributable to the production of an equal amount of electricity from the same type of fuel in a power plant.

If the process heat used in the biofuel/bioliquid facility is produced by a CHP process, emissions from excess electricity shall be subtracted from the total emissions of the biofuel, for all fuels to the CHP process except from co-products from the biofuel production process.

Excess electricity produced in a cogeneration plant (producing both heat and electricity) is considered to be the electricity produced in proportion to the heat needed in the biofuel production process. The size of the emissions saving shall be the same as the life cycle emissions that would arise if the same amount of electricity was produced in a power plant with the same fuel.

For any electricity produced in the biofuel production plant but not produced by co-generation, the allocation rule given in chapter 4.2 shall apply.

6.2 Soil carbon accumulation via improved agricultural methods

[OJ C160, page 8], page 15: The emission savings in terms of g $CO_{2,eq}$/MJ can be calculated by using a formula as indicated in point 7 of the method, replacing the divisor '20' by the period (in years) of cultivation of the crops concerned.

When calculating soil carbon accumulation due to improved agricultural methods, the method in chapter 5 for land use change shall be applied. The emissions shall be divided over 20 years.

BIOGRACE I
Harmonised Calculations of Biofuel Greenhouse Gas Emissions in Europe

Align biofuel GHG emission calculations in Europe (BioGrace)

Project funded by the Intelligent Energy Europe Programme

Contract number: IEE/09/736/SI2.558249

Project coordinator: John Neeft - Agentschap NL (Agency NL) (formerly SenterNovem)

info@biograce.net

www.biograce.net

INTELLIGENT ENERGY EUROPE
FOR A SUSTAINABLE FUTURE