GHG calculation when using internal electricity and heat

REDcert-EU GHG-Guidance V01

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1 Introduction

Where biofuels, bioliquids or biomass fuels are produced (hereinafter "biofuels"), the electricity required for the process and the heat required for the process can be provided in different ways. It is conceivable that the corresponding amounts of electricity or heat are made available externally or that the process is partially or completely supplied with electricity or heat from own production.[1]

Irrespective of the form of provision, economic operators that are required to demonstrate greenhouse gas savings (GHG savings) must take into account the electricity and heat used when calculating GHG emissions in accordance with the methodology set out in the "*Scheme principles for GHG calculation*".

Where a biofuel plant uses electricity and/or heat from its own production, the emission factor for electricity and/or heat at the point of consumption (biofuel plant) cannot be considered emission-free. This is due to CH_4 and N_2O emissions (hereinafter "non-CO_2 emissions") resulting from the use of biofuel to generate electricity and/or heat. These must be taken into account in accordance with the "*Scheme principles for GHG calculation*" under the formula element e_p (processing).

Installations that fully convert the biofuel produced into electricity and/or heat after its production need not take into account the non-CO_2 emissions separately under e_p. This is due to the fact that these emissions are already included under the element e_u (use) in the GHG calculation of the energy product (electricity and/or heat).

This document describes various examples (see Table 1) in which self-generated electricity or heat is used in the production of biofuels.[2] It serves as guidance for producers of such fuels and is intended to support the actual calculation of GHG emissions.

[1] In this context, own production means that the plant for the production of biofuel, bioliquid or biomass fuel supplies parts of the biomass used, the fuel produced (e.g. biogas) or a generated residue to a (own) combined heat and power plant (CHP-plant), which provides electricity and/or heat to the process or to a (own) boiler, which provides heat to the process.

[2] The list of the examples does not claim to be exhaustive. It merely serves to give guidance for the GHG calculation methodology.

Table 1: Overview of examples described in this document.

Section	Example
2.1	➢ Heat from internal boiler ➢ Proportion of biofuel produced used as fuel
2.2	➢ Electricity and heat from internal CHP-plant ➢ Proportion of biofuel produced used as fuel
2.3	➢ Electricity and heat from internal CHP-plant ➢ Excess electricity is fed into the grid ➢ Process residue used as fuel
2.4	➢ Electricity and heat from internal CHP-plant ➢ Excess electricity is fed into the grid ➢ Proportion of biofuel produced used as fuel

2 Examples of self-generated electricity/heat

2.1 Heat from integrated boiler

Figure 1 schematically shows a producer of biofuels that draws electricity from the grid on the one hand and heat from a boiler integrated on site on the other. The heat is generated from a partial flow of the biofuel produced. The partial conversion of the biofuel into heat reduces the total marketable quantity of the product[3] but optimizes the process in terms of its GHG emissions compared to a fossil-based heat supply.

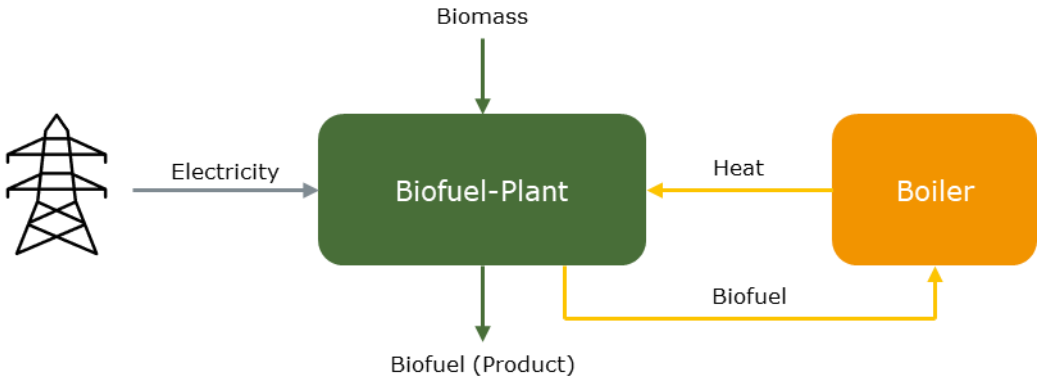

Figure 1: Schematic representation of a process whose required process heat is provided by an integrated boiler.

In the case of an actual calculation of GHG emissions, the non-CO_2 emissions from the use of biofuel for heat production must be taken into account. Annex IX to Implementing Regulation (EU) 2022/996 provides a number of emission factors for this purpose, from which a suitable value must be selected (from page 79 of the PDF version). It should be noted that these emission factors are indicated in [gCO_2eq/MJ feedstock for electricity and heat production]. Thus, if biogas is used for heat production in this example, the raw material for heat production is 'biogas'.

In order to calculate the actual GHG emissions of the heat used, it is necessary to:

- multiply the amount of biofuel used to generate heat in [MJ] by the corresponding emission factor in [gCO_2eq/MJ] (Formula 1) and
- Divide the absolute emissions obtained in [gCO_2eq] by the marketable quantity of biofuel produced in [MJ] in the calculation period (Formula 2).

[3] The term 'product' refers to the remaining biofuel that is not consumed for the purpose of heat generation and can therefore be delivered to downstream processes, such as an upgrading plant.

$$e_{heat,absolute} = \mathbf{EF_{boiler(non\text{-}CO_2)}} \times quantity_{fuel} \qquad \text{Formula 1}$$

$$e_{heat} = \frac{e_{heat,absolute}}{quantity_{product}} \qquad \text{Formula 2}$$

The value obtained via Formula 2 must be taken into account under the formula element e_p as an emission factor for the process heat (= usable heat in the process).

Upstream emissions associated, for example, with the provision of biomass are fully allocated to the product[4]. For this purpose, the fuel feedstock factor must be calculated on the basis of the product (ratio of the quantity of raw material used to the quantity of marketable product produced), and not on the basis of the total yield. Thus, the amount of fuel used internally is included in the overall analysis as a conversion loss.[5]

2.2 Electricity and heat from integrated combined heat and power plant

Figure 2 schematically shows a producer of biofuels that generates both the electricity required for the process and the heat required for the process on site in an integrated combined heat and power plant (CHP-plant). The integrated CHP-plant is operated directly with the biofuel from the process. This reduces the total marketable amount of biofuel but optimises the process in terms of GHG emissions compared to fossil-based energy production.

[4] For the definition of the term 'product', see footnote 3

[5] Due to the partial use of the fuel for the internal energy supply, the yield of the product is lower than in a process in which the energy is provided externally. Consequently, the fuel feedstock factor is higher for internal energy supply than for a process with external energy supply.

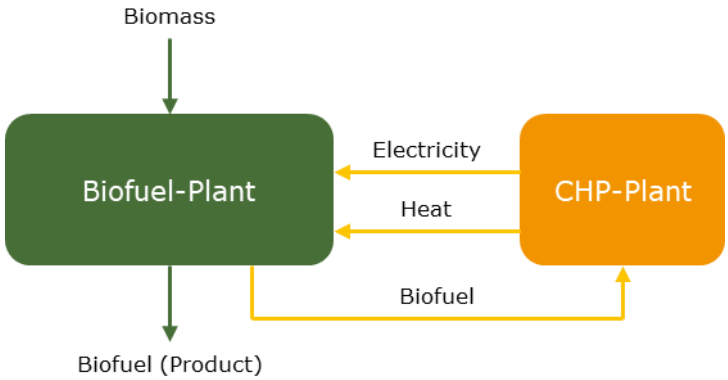

Figure 2: Schematic representation of a process whose required electricity as well as the required process heat is provided by an integrated CHP-plant.

The procedure for determining the GHG emissions of electricity and heat is equivalent to the procedure described in Section 2.1. However, the emission factor must be suitable for to the installation concept used, which means that Formula 1 must be adapted as follows (Formula 3):

$$e_{energy,absolute} = \mathbf{EF_{CHP(non\text{-}CO_2)}} \times quantity_{fuel} \qquad \text{Formula 3}$$

The absolute emissions are thus determined on the basis of the total energy (here electricity and heat) generated in the CHP-plant. There is no need to differentiate between heat and electricity. The absolute emissions obtained in [gCO_2eq] must be divided by the marketable quantity of product produced in [MJ] during the calculation period.

2.3 Electricity and heat from residual materials from integrated combined heat and power plant including excess electricity

Preliminary remark: If the integrated CHP-plant feeds excess electricity into the grid and is not obliged to prove GHG savings, the allocation between electricity and heat can be dispensed with. As a result, the total emissions of the CHP-plant are allocated to the biofuel production process, and the calculation can be made equivalent to Section 2.2. Otherwise, the following must be followed:

Figure 3 schematically shows a producer of biofuels that generates both the electricity needed for the process and the heat needed for the process in an integrated CHP-plant. The integrated CHP-plant is operated with a process residue and generates excess electricity, which is fed into the electricity grid.

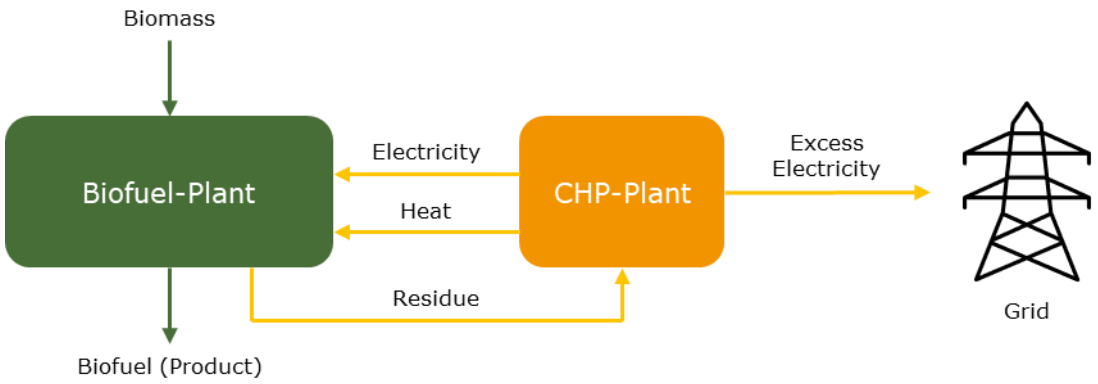

Figure 3: Schematic representation of a process whose required electricity as well as the required process heat is provided by an integrated CHP-plant that is operated with residual material originating from the process. In addition, excess electricity is fed into the grid.

In accordance with the revised Directive (EU) 2018/2001 (RED III)[6], the GHG intensity of excess useful heat and electricity is determined as follows:

"*The greenhouse gas intensity of excess useful heat or excess electricity is the same as the greenhouse gas intensity of heat or electricity delivered to the (biomass) fuel production process and is determined from calculating the greenhouse gas intensity of all inputs and emissions, including the feedstock and CH_4 and N_2O emissions, to and from the cogeneration unit, boiler or other apparatus delivering heat or electricity to the biomass fuel production process.*"

If in an in-process residual material is used to produce electricity and heat, upstream emissions (from cultivation and supply of biomass) need not be taken into account. This means that they enter 'zero' in the calculation. However, non-CO_2 emissions from the use of the residue must be taken into account.

The non-CO_2 emissions are to be divided between the energy products (electricity and heat) on the basis of exergy.[7] The GHG intensity of the electricity in [gCO_2eq/MJ] determined in accordance with Formula 4 represents the GHG intensity of the electricity used internally and the electricity fed into the grid.

$$e_{electricity} = \frac{EF_{CHP(non\text{-}CO_2)}}{\eta_{el}} \times \left(\frac{C_{el} \times \eta_{el}}{C_{el} \times \eta_{el} + C_h \times \eta_h} \right) \qquad \text{Formula 4}$$

[6] Annex V, Part C, point 17 or Annex VI, Part B, point 17

[7] RED III, Annex V, Part C, point 16: "*Where a cogeneration unit – providing heat and/or electricity to a fuel production process for which emissions are being calculated – produces excess electricity and/or excess useful heat, the greenhouse gas emissions shall be divided between the electricity and the useful heat according to the temperature of the heat (which reflects the usefulness (utility) of the heat).*"

Formula 5 shall be used to determine the GHG intensity of the heat.

$$e_{heat} = \frac{EF_{CHP(non\text{-}CO_2)}}{\eta_h} \times \left(\frac{C_h \times \eta_h}{C_{el} \times \eta_{el} + C_h \times \eta_h} \right) \qquad \text{Formula 5}$$

$e_{electricity}$	GHG intensity of electricity produced in [gCO_2eq/MJ]
e_{heat}	GHG intensity of heat produced in [gCO_2eq/MJ]
$EF_{CHP(non\text{-}CO_2)}$	Non-CO_2 emissions of the fuel used in [gCO_2eq/MJ fuel]
η_{el}	Electrical efficiency, defined as the annual electrical output, divided by the annual fuel used on the basis of the energy content
η_h	Heat efficiency, defined as the useful heat produced annually, divided by the fuel used annually based on the energy content
C_{el}	Exergy fraction of electricity and/or mechanical energy set at 100 % ($C_{el} = 1$)
C_h	Carnot efficiency (fraction of exergy in the useful heat), as defined in Annex V, part C, point 16 or Annex VI, part B, point 16

The values in [gCO_2eq/MJ] obtained via formulae 4 and 5 can now be used to determine the absolute emissions associated with the provision of the internal electricity or heat. For this purpose, the respective GHG intensity shall be multiplied by the amount of electricity or heat used in the calculation period (Formulas 6 and 7).

$$e_{electricity,absolute} = e_{electricity} \times quantity_{electricity} \qquad \text{Formula 6}$$

$$e_{heat,absolute} = e_{heat} \times quantity_{heat} \qquad \text{Formula 7}$$

The absolute emissions in [gCO_2eq] thus determined shall be related to the quantity of marketable product produced produced in [MJ] in the calculation period (formulas 8 and 9). This value shall be taken into account under the formula element e_p as the emission factor for the electricity or heat used.

$$e_{electricity} = \frac{e_{electricity,absolute}}{quantity_{product}}$$ Formula 8

$$e_{heat} = \frac{e_{heat,absolute}}{quantity_{product}}$$ Formula 9

2.4 Electricity and heat from biofuels from integrated combined heat and power plant including excess electricity

Preliminary remark: If the integrated CHP-plant feeds excess electricity into the grid and is not obliged to prove GHG savings, the allocation between electricity and heat can be dispensed with. As a result, the total emissions of the CHP-plant are allocated to the biofuel production process, and the calculation can be made equivalent to Section 2.2. Otherwise, the following must be followed:

In the example shown in Figure 4, no residual material is used; instead, a part of the biofuel produced in the the process is used to generate electricity and heat. The CHP-plant supplies the process biofuel production process with electricity and heat and also feeds excess electricity into the grid.

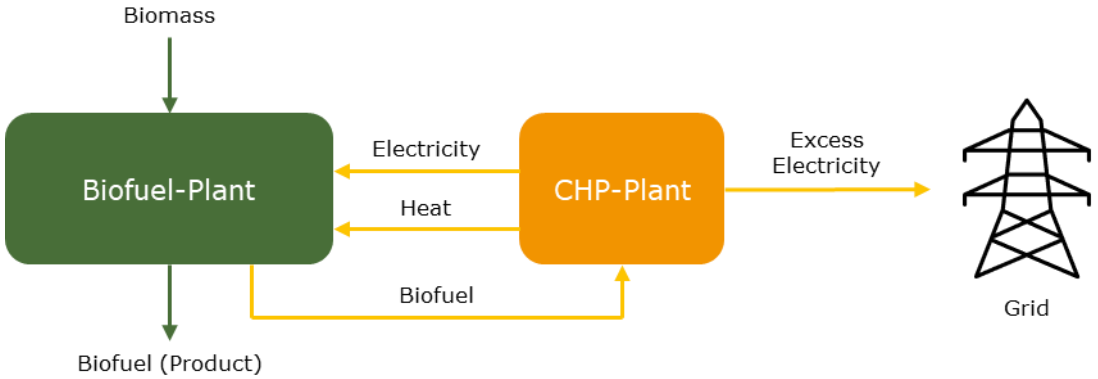

Figure 4: Schematic representation of a process, the required electricity as well as the required process heat is provided by an integrated CHP-plant, which is operated with a part of the biofuel produced in the the process. In addition, excess electricity is fed into the grid.

The rules for determining the GHG intensity of excess useful heat and electricity of the revised Directive (EU) 2018/2001 (RED III) set out in Section 2.3 above apply.

Since in this example a partial flow of biofuel is used to produce electricity and heat, upstream emissions (e.g. cultivation, supply of biomass) and non-CO_2 emissions from thermal use must be taken into account.

It must be comprehensible what proportion of the biomass is used to produce the biofuel for the CHP-plant and what proportion is used to produce the biofuel (Figure 5). A distinction must be made between the CHP-process and the process from which the final product is derived when calculating the GHG intensity of the electricity (Figure 6).

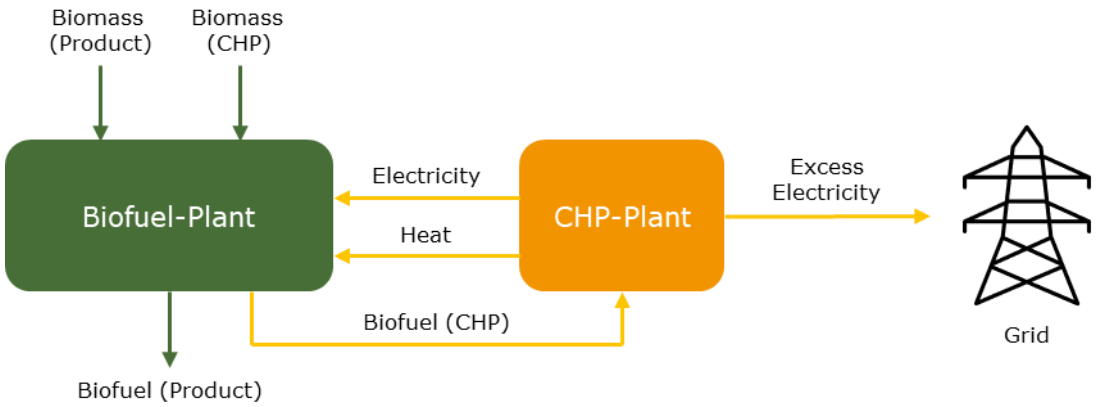

Figure 5: Schematic representation of a process whose required electricity as well as the required process heat is provided by an integrated CHP plant. A distinction is made at accounting level between the biomass needed to produce the product and the biomass needed to operate the cogeneration plant.

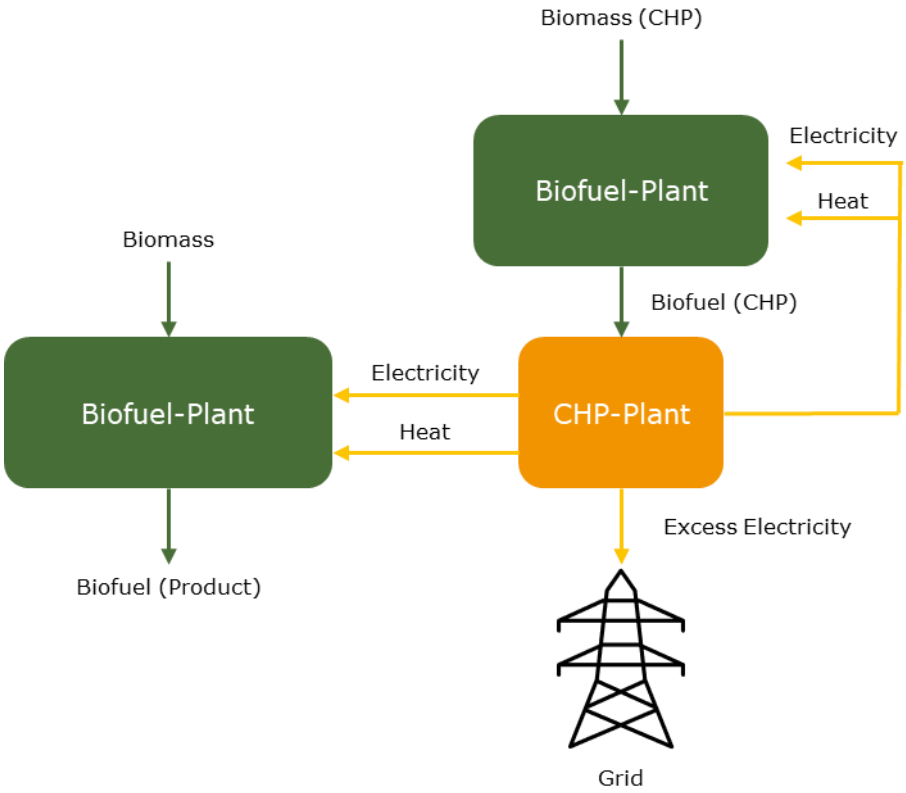

Figure 6: Virtual distinction between the CHP-process and the process from which the final product emerges.

In order to determine the GHG emissions of the CHP-process, it is first necessary to determine the total emissions from the production of the biofuel before the energy conversion (Formula 10, Formula 11 in the case of co-digestion). See also "*Scheme principles for GHG calculation*".

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} \qquad \text{Formula 10}$$

$$E = \sum_{1}^{n} S_n\left(e_{ec,n} + e_{td,feedstock} + e_{l,n} - e_{sca,n}\right) + e_p + e_{td,product} + e_u - e_{ccs} - e_{ccr} \qquad \text{Formula 11}$$

elements	Defined according to "*Scheme principles for GHG calculation*"

Total emissions from biofuel production are determined in [gCO_2eq/MJ]. The amount of fuel in [MJ] used for this calculation shall be equal to the amount of biofuel supplied to the CHP-plant.

The non-CO_2 emissions from the use of the biofuel shall be determined by an appropriate emission factor, which shall be taken from Annex IX to Implementing Regulation (EU) 2022/996, where available (from page 79 of the PDF version).[8]

The emissions determined in accordance with Formula 10 or Formula 11 in [gCO_2eq/MJ] must now be converted into the unit [gCO_2eq/MJ electricity] (Formula 12) or [gCO_2eq/MJ heat] (Formula 13) and allocated between electricity and heat.

$$EC_{el} = \frac{E}{\eta_{el}} \times \left(\frac{C_{el} \times \eta_{el}}{C_{el} \times \eta_{el} + C_h \times \eta_h} \right) \qquad \text{Formula 12}$$

$$EC_h = \frac{E}{\eta_h} \times \left(\frac{C_h \times \eta_h}{C_{el} \times \eta_{el} + C_h \times \eta_h} \right) \qquad \text{Formula 13}$$

EC_{el}	GHG intensity of electricity produced in [gCO_2eq/MJ]
EC_h	GHG intensity of heat produced in [gCO_2eq/MJ]
E	Total emissions from fuel production before energy conversion to [gCO_2eq/MJ fuel]
η_{el}	Electrical efficiency, defined as the annual electrical output, divided by the annual fuel used on the basis of the energy content
η_h	Heat efficiency, defined as the useful heat produced annually, divided by the fuel used annually based on the energy content
C_{el}	Exergy fraction of electricity and/or mechanical energy set at 100 % ($C_{el} = 1$)
C_h	Carnot efficiency (fraction of exergy in the useful heat), as defined in Annex V, part C, point 16 or Annex VI, part B, point 16

The values in [gCO_2eq/MJ] obtained from formulae 12 and 13 are now used to determine the absolute emissions from the internal supply of electricity and heat. For this purpose, the respective GHG intensity shall be multiplied by the amount of electricity or heat used in the period under consideration (formulas 14 and 15). In addition, Formula 12 provides the GHG intensity for the electricity fed into the grid.

[8] The virtual cogeneration process represents a process in which the generated power/biofuel is completely converted into electricity and heat. As a result, non-CO_2 emissions are fully accounted for under e_u. The pro-rata consideration of these emissions under e_p is therefore not necessary.

$$e_{electricty,absolute} = EC_{el} \times quantity_{electricity} \quad \text{Formula 14}$$

$$e_{heat,aboslute} = EC_{h} \times quantity_{heat} \quad \text{Formula 15}$$

The absolute emissions in [gCO_2eq] thus determined shall be related to the quantity of marketable product produced produced in [MJ] in the calculation period (formulas 16 and 17). This value shall be taken into account under the formula element e_p as the emission factor for the electricity or heat used.

$$e_{electricity} = \frac{e_{electricity,absolute}}{quantity_{product}} \quad \text{Formula 16}$$

$$e_{heat} = \frac{e_{heat,absolute}}{quantity_{product}} \quad \text{Formula 17}$$

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