D5.1 | Recommendations for the adaptation of the RED GHG calculation methodology

Deliverable:	*Recommendations for the adaptation of the RED GHG calculation methodology*
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Table of Contents

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List of abbreviations

BLE	Bundesanstalt für Landwirtschaft und Ernährung (Agency of the Federal Ministry of Food and Agriculture)
EC	European Commission
Equi.	Equivalent
EU	European Union
EU RED	Renewable Energy Directive 2009/28/EC
FQD	Fuel Quality Directive
GHG	Green House Gases
ILUC	Indirect Land Use Change
LHV	Lower heating value
LCA	Life Cycle Assessment
SWD	Staff working document

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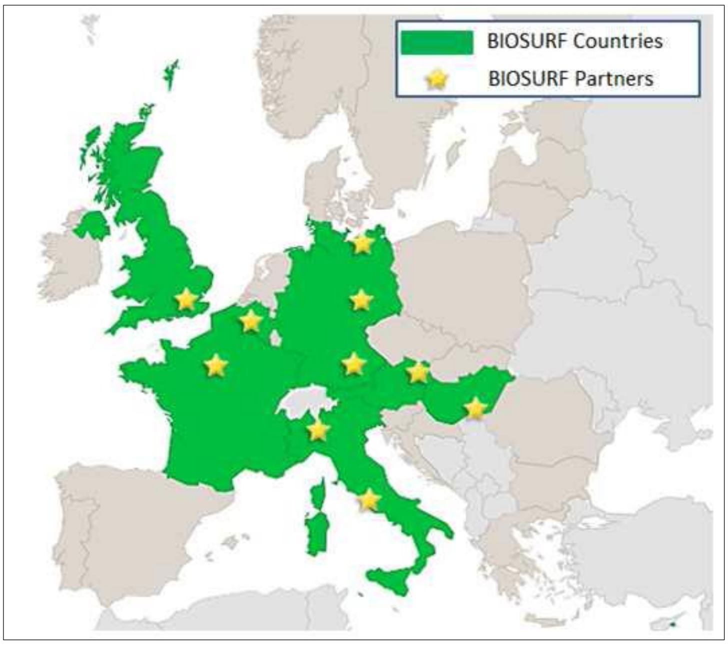
BIOSURF IN A NUTSHELL

BIOSURF is an EU-funded project under the Horizon 2020 programme for research, technological development and demonstration.

The objective of BIOSURF (BIOmethane as SUstainable and Renewable Fuel) is to increase the production and use of biomethane (from animal waste, other waste materials and sustainable biomass), for grid injection and as transport fuel, by removing non-technical barriers and by paving the way towards a European biomethane market.



The BIOSURF consortium consists of 11 partners from 7 countries (Austria, Belgium, France, Germany, Hungary, Italy and United Kingdom), covering a large geographical area, as indicated in the figure on the left.

The intention of the project is:

- To analyse the value chain from production to use, based on territorial, physical and economic features (specified for different areas, i.e., biofuel for transport, electricity generation, heating & cooling);
- To analyse, compare and promote biomethane registering, labelling, certification and trade practices in Europe, in order to favour cooperation among the different countries and cross border markets on the basis of the partner countries involved;
- To address traceability, environmental criteria and quality standards to reduce GHG emissions and indirect land-use change (ILUC), as well as to preserve biodiversity and to assess the energy and CO2 balance;
- To identify the most prominent drivers for CO2-emissions along the value chain as an input for future optimization approaches and to exchange information and best practices all across Europe with regard to biomethane policy, regulations, support schemes and technical standards.

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1. Introduction

Bioenergy is often considered a sustainable option to decrease greenhouse gas (GHG) emissions from the European energy and transportation sector. Hence, anticipated GHG-mitigation effects from the use of these energy carriers are, besides others like energy security or job creation in rural areas, the strongest rationale for their promotion on a European level.

However, the sustainability of a bioenergy production on a large-scale has been the subject of an intense debate over the recent years. A number of authors (e.g. (Searchinger et al., 2008), (Fargione et al., 2008), (Fritsche et al., 2010), etc.) argue that an intensified agricultural production, monocultures, inefficient biomass conversion processes and direct as well as indirect land use change are results of an increasing biomass production which can negate the positive environmental performance of bioenergy carriers. As a direct consequence, the EU Commission has introduced a number of sustainability criteria as part of the EU RED 2009/28/EC Directive (RED). The fulfilment of these criteria is usually verified with a certification process executed under the standard of a certification scheme recognised by the European Commission.

The sustainability criteria to be fulfilled include, amongst others, requirements regarding the GHG-mitigation potential of biofuels. Since the proof of fulfilment for these criteria has become a precondition for any promotion mechanism related to national biofuel quota systems, the individual calculation of GHG-emissions has gained significant importance for biofuel producers as well as for certification schemes and auditors. It is important to note that the scope of the RED focuses on renewable energy carriers for the transportation sector. However, since the general discussion about the sustainability of bioenergy is not limited only to biofuels for transportation purposes, a future expansion of the requirements defined in the EU RED as well as of the character and basic methodology of the GHG calculation approach to other sectors of bioenergy production and use seems to be possible.

Annex V of the EU RED does include a description of the basic methodology on how biofuel producers should calculate the individual GHG-mitigation potential of their biofuel. Furthermore, a number of communications has been published by the European Commission to specify the calculation approach for a number of specialties along the overall value chain (e.g. for the calculation of Emissions from direct land use change). According to Annex V of the EU RED, three possibilities exist for biofuel producers to proof that the GHG-mitigation potential of their biofuel meets the defined requirements and thresholds:

1. The use of the default values for the biofuels included in Annex V of the EU RED
2. An individual calculation based on actual values
3. A combination of actual values and disaggregated default values from EU RED Annex V.

While the sustainability certification as well as the individual calculation or the combination of disaggregated and actual values for the investigation of a biofuels GHG-mitigation potential is by now a common practice for liquid biofuels such as biodiesel and bioethanol, calculations for biomethane are often associated with methodological and data-related uncertainties and fuzziness. For individual calculations of GHG-emissions for a biomethane value chain, the main aspects to be

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discussed include: a) the consideration of potential GHG-credits from the processing of agricultural residues and waste materials and the substitution of synthetic fertilisers, b) the allocation of by-products[1] and c) the economic and administrative effort for biofuel producers related to individual calculations for biomethane production.

The project BIOUSRF (within WP5) aims to reduce the identified uncertainties and to propose a number of small adaptations of the general EU RED calculation approach for biomethane in order to provide assistance to economic operators in their day-to-day work. For this purpose, BIOSURF will review the general GHG-calculation approach and its applicability to biomethane and compile the existing data and emission factors to describe the impact from processing agricultural and organic residues and waste materials on the overall GHG-mitigation potential of biomethane.

[1] Often, processes result in more than one product. In this case, the emissions from the production of these products can be divided between the main product (in this case the biofuel or its intermediate product) and the by-product or co-product (e.g. the digestate of the biogas process).

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2. Methodological Background for the Calculation of GHG Emissions from Biomethane Production and Use

Various methodological approaches exist for the investigation of lifecycle GHG-emissions from products or services. In research-based projects, an assessment of lifecycle GHG-emissions is often part of a life cycle assessment (LCA) which is standardized and generally defined within ISO 14040 & 14044 standards. However, the general LCA approach described within these standards contains various levels of freedom regarding aspects such as system boundaries, life cycle impact categories, characterization factors, etc. As a result, LCA studies are typically consistent within its framework but the results are often not comparable across different case studies.

While this flexibility can be described as one of the strengths of the methodology when applied within scientific projects, it is rather inappropriate for the purpose of a regulatory framework that demands a simpler, robust and uniform approach. For this reason, Annex V of the EU RED includes the description of a simplified approach (compared to the more complex and comprehensive ISO or DIN standards for LCA and carbon footprinting) for the calculation of a biofuel producers individual GHG-mitigation potential.

To limit the above mentioned various degrees of freedom regarding the methodological setting, the EU RED methodology defines the basic framework of the investigation by a clear definition of:

- the system boundaries (well-to-wheel),
- the allocation of by-products (based on the lower heating value of products and by-products),
- the functional unit for the expression of the result calculated (per MJ biofuel),
- the life cycle impact assessment approach (GHG-emissions),
- the characterization factors for the conversion of greenhouse gases into CO_2-Equivalents,
- the reference value for the comparison and interpretation of the result.

The clear definition of this methodological framework allows for a consistent comparison of different value chains from individual operators on a common basis as well as a constant benchmark and monitoring of the development of the biofuels GHG-mitigation potential over time.

According to EU RED 2009/28/EC, GHG-emissions from the production and use of transport fuels (biofuels including biomethane) and bioliquids shall be calculated as:

$$E = \underbrace{e_{ec} + e_{l} + e_{p} + e_{td} + e_{u}} \qquad \underbrace{- e_{sca} - e_{ccs} - e_{ccr} - e_{ee}}$$

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E = total emissions from the use of the fuel;

GHG-Emissions from:

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

e_l = the carbon stock changes caused by land-use change;

e_p= processing;

e_{td}= transport and distribution;

e_u= the fuel in use;

GHG-Emission savings[2] from:

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

e_{ccs} = carbon capture and geological storage;

e_{ccr} = carbon capture and replacement;

e_{ee} = excess electricity from cogeneration;

According to this equation, the overall GHG-emissions of a biofuel will be calculated considering both, the emissions from the various process steps (left side of the equation) involved in its production and utilisation and the potential GHG-emission savings from different processes (right side of the equation).

Regarding the overall emissions, the processes of agricultural production and biomass processing typically show the biggest contributions to the overall result.

The calculation of emissions from the extraction or cultivation of raw materials (e_{ec}) should include the extraction or cultivation of the biomass (in case energy crops are used) and/or the collection of wastes or residues (EU RED, 2009).

As an alternative to the use of actual values, the calculation of emissions from the biomass cultivation process can be based on the default values as well as on average values for smaller geographical areas than those used in the calculation of the default values. Unfortunately, the default values do not include most of the currently used energy crops, agricultural by-products or organic waste materials used for the production of biomethane neither typical combinations of both. Different types of waste and agricultural crop residues, including manure or straw as well as residues from processing, are considered to have zero upstream emissions up to the process of collection of those materials.

[2] It should be noted here, that according to this methodology the value of by-products is not considered by a substitution (credit) approach. By-products can be included by allocation based on their energy content (lower heating value).

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As part of the biomass production and supply, emissions from carbon stock changes (e_l) need to be considered in case land not yet used for agricultural production has been converted for biomass production after the January 2008. The Commission has published an appropriate guideline. Contrarily, a bonus of 29 g CO_{2equi} MJ^{-1} biofuel (as part of the term e_l) can be attributed in case the biomass is produced on degraded or contaminated land (with this status in, or after January 2008) and the biomass cultivation initialised by the biofuel production helps to valorise land which would not be used otherwise. This bonus is added in the overall calculation (and subtracted from emissions from cultivation, which also need to be considered for scenarios of biomass production on degraded or contaminated land) (EU RED, 2009).

The emissions from the conversion of biomass into bioenergy (processing, e_p) shall be calculated considering emissions from the processing itself, from waste and leakages and from the production of chemicals, products or energy carriers used in processing (EU RED, 2009). With regard to biomethane production, the emissions from process energy supply as well as direct methane emissions, are typically the biggest contributors of emissions.

Furthermore, individual calculations need to include emissions from transport and distribution (e_{td}). This includes the transport and storage of raw and semi-finished materials and the storage and distribution of the final product (EU RED, 2009).

Apart from the emission savings already discussed in e_p, potential emission savings from carbon capture and geological storage (e_{ccs}) as well as from carbon capture and replacement (e_{ccr}) can be considered in the calculations. Especially e_{ccr} can be an interesting option for biomethane producers to utilise carbon dioxide as a by-product of the fermentation and upgrading process. Once the GHG-emissions of a biofuel have been calculated based on the described methodology, the GHG-mitigation potential can be estimated in relation to a fossil fuel comparator. According to Annex V of the EU RED, the comparator used for biomethane as transport fuel shall be 83.8 g CO_{2equi} MJ^{-1}. (EU RED, 2009) It is a mixture of the common fossil fuel mix, diesel and petrol.

The calculation of individual values based on this approach has become a well-established practice over the recent years. However, a number of specialties and methodological fuzziness can occur, especially for the certification of biomethane and the calculations of individual values. These points will be discussed in the following chapter.

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3. Main Issues, Specialities and Challenges for GHG Accounting of Biomethane in the EU RED Context

The calculation of individual GHG-mitigation values under the EU RED framework can be necessary for several reasons. A number of default values exists for the most common liquid biofuel options and most of these default values are eligible to proof that the defined GHG-mitigation thresholds are met. The trend towards more individual calculations is noticeable, especially in those member states where the environmental performance of a biofuel has become an important criterion for its market success, like in Germany. Furthermore, an official reporting of the certification shows that many biofuel producers tend to use a combination of default values (typically for the biomass cultivation as well as transport and distribution) and individual calculations for the conversion process. This can be attributed to the fact, that the overall administrative effort for the calculations of the biomass production process (especially in case many suppliers are involved) is usually higher than for the calculations of the conversion process (BLE, 2015).

Unfortunately, the existing default values for biomethane are not as detailed as those for liquid biofuels. EU RED Annex V includes three default values for biomethane (from municipal organic waste, from wet manure, from dry manure) which do not represent most of the existing biomethane concepts which are typically based on a combination of substrates. Thus, the necessity for the calculation of individual values is typically higher for biomethane producers who are willing to sell their product as a transportation fuel.

When applying the RED calculation methodology for individual calculations of biomethane production and use, a number of challenges can occur.

This report will focus on the following aspects:

- The consideration of emission savings from the fermentation of agricultural by-products, organic waste, etc.
- The allocation of the digestate, following the approach (lower heating value) of the EU RED.

Concerning the first point identified, two aspects will be discussed within the BIOSURF project. The first aspect is the discussion of potential options to include these emission savings under the equation discussed in chapter 2 above. This will be done in the following chapters, using the example of manure fermentation. The second aspect is the use of scientifically sound credits for the emission savings, based on the best available scientific literature. This will be discussed in BIOSURF Deliverable 5.2.

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GHG-emission savings from the fermentation of agricultural by-products, organic waste, etc

The conventional storage of manure from livestock production inevitably leads to GHG-emissions and can be a remarkable contributor to the overall GHG-emission inventory of the agricultural sector. As an example, the agricultural sector in Germany has been responsible for emissions in the magnitude of approx. 70 Mil. tonnes of CO_2-Equivalent in 2012. (UBA, 2014). Emissions from the conventional storage of manure from livestock production represent approx. 9 Mil. tonnes of CO_2-Equivalent (~10%) (Haenel et al., 2014). The use of manure from livestock production for biomethane production can help to avoid the conventional storage of manure and thus the emissions associated with this process. The magnitude of the mitigation effect is not only dependent on the overall management of the biogas process but also on the type of manure to be treated and the storage system. Emission factors for the potential emission avoidance from manure fermentation in the biogas are subject to BIOSURF Deliverable 5.2.

Independently from the actual magnitude of the emission savings, the question is how these effects can be considered and incorporated under the methodology of the EU RED and the equation presented in chapter 2. This aspect will be discussed in chapter 5.

Allocation of the digestate as by-product of the fermentation process

Another specialty of the biogas process (compared to the most common liquid biofuels) is the production of a digestate as a by-product of the fermentation process. Depending on the type(s) of substrates used for biogas production, the digestate contains nearly all nutrients from the substrate and is therefore typically used as a fertiliser.

According to the GHG-calculation approach of the EU RED, the only option[3] for the consideration of by-products is allocation according to the lower heating value.

Obviously, this approach is not appropriate for by-products whose value is defined by other parameters than their energy content. Unfortunately, due to the usually high water content, the lower heating value of the biogas digestate is often rather low and the corresponding allocation factors does not necessarily reflect the actual value of the by-product digestate which can help to avoid emissions from the production from synthetic fertilisers in agricultural processes.

In some biogas production facilities digestate separated into a solid and a liquid fraction to reduce the water content and thus costs for transportation and handling. In this case, the lower heating value of the digestate (per m^3) is significantly higher and an allocation of this digestate could lead to a better result for the biogas (after allocation). However, it could be argued that the separated solid phase of the digestate is not directly the by-product of the fermentation process (or in other

[3] In case the digestate is used in a closed loop and is brought back to the land used for the production of the biogas substrate, the substitution of mineral fertilisers would be indirectly included in the calculation of the cultivation emissions of these substrates. Since, in this case, a large amount of nutrients for cultivation would be provided by organic fertiliser, the overall emissions from the cultivation process would be significantly lower compared to a scenario without organic fertiliser (digestate). This effect is also included in a recent working document of the JRC. See http://publications.jrc.ec.europa.eu/repository/handle/JRC95618

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words, the upgrading process is not directly part of the biogas/biomethane production process) and the allocation has to be conducted between biogas and the untreated digestate. This aspect will be discussed in chapter 4.

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4. Allocation of Digestate as a By-Product from the Fermentation Process

The allocation/consideration of by-products is a central aspect of carbon accounting and LCA. Within the EU RED context and for the specific problem of (separated) digestate allocation, two aspects need to be considered. The first issue is the definition of the term by-product and its demarcation from wastes or production residues which cannot be allocated. The other aspect is the actual procedure for by-product allocation. This procedure is explicitly defined within EU RED Annex V. According to this methodology, the emissions resulting from the production of a product and by-product can be divided between both, based on their lower heating value. The demarcation of the terms by-products, waste and production residues can be a more difficult exercise. In case the digestate from the fermentation process is upgraded[4] in a downstream process, it is the question whether or not this digestate can be considered a by-product of the biogas/biomethane production.

The EU RED does not include a clear definition of the term by-product. Additional insight to this discussion is provided by the „Communication from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels" (COM 2010).

According to this communication, the "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." (COM 2010).

This basically means that for those cases where individual process steps are connected and where feedback loops do exist or in case mass and energy flows cannot be allocated explicitly to a single process step, the overall system can be considered a black box (or refinery). In this case, the overall emissions resulting from sub-processes within the black box unit are allocated between the different (by-)products from the process. This is illustrated in the following figure.

[4] For this example, we define digestate upgrading as a separation of the dry and liquid phase by means of a mechanical process. The dry phase can be considered the by-product of the system while the liquid phase is recirculated.

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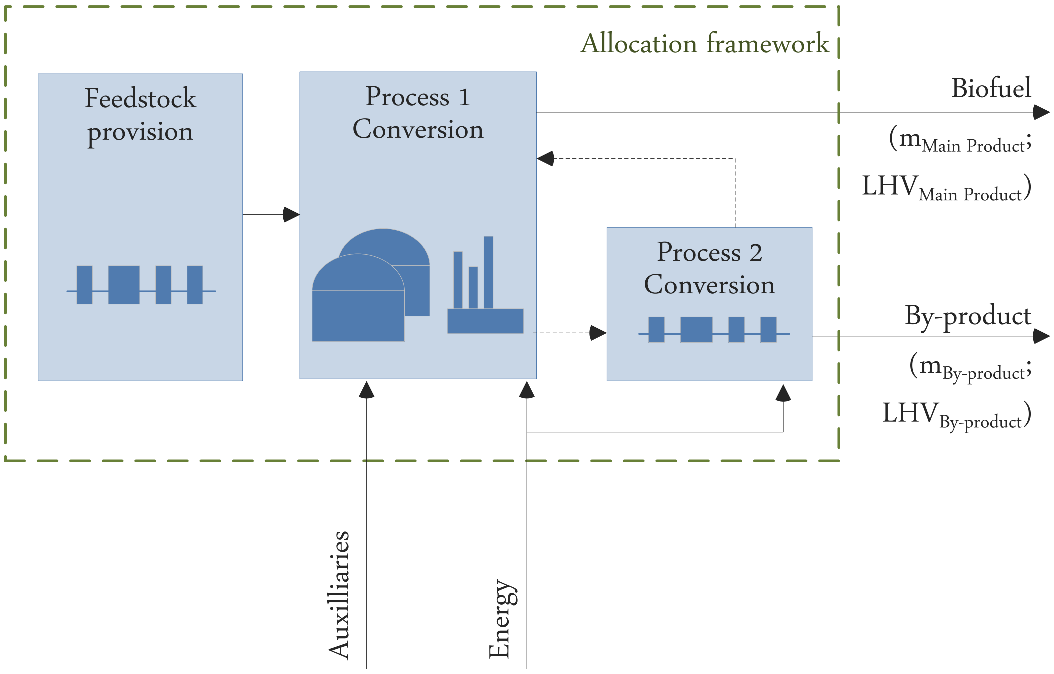

Figure 4-1: Allocation between main- and by-products, DBFZ 2016

For biomethane, it can be concluded that the integrated, close connection of the individual process steps (due to the recirculation of the liquid phase from the digestate separation) allows for an application of the above described term biorefinery as defined in the COM 2010 communication. According to this approach, allocation of by-products should be applied after no further downstream processing (that is connected by material or energy feedback loops with an upstream part of the processing) takes place. For the issue of biomethane production and digestate separation/upgrading this means that the allocation could be applied after the treatment (upgrading) of the digestate (since the recirculation of the liquid phase from the upgrading process does represent a feedback loop).

Exemplary calculation

In order to illustrate the potential impact from the consideration of (an upgraded) digestate as a by-product in the calculation of GHG-emissions, an exemplary calculation will be conducted, following the EU RED calculation approach. The basic system boundaries of the system as well as the products for the allocation are shown in Figure 4-2. The exemplary value chain includes the entire process chain, from the collection of waste, through processing to the distribution of biomethane.

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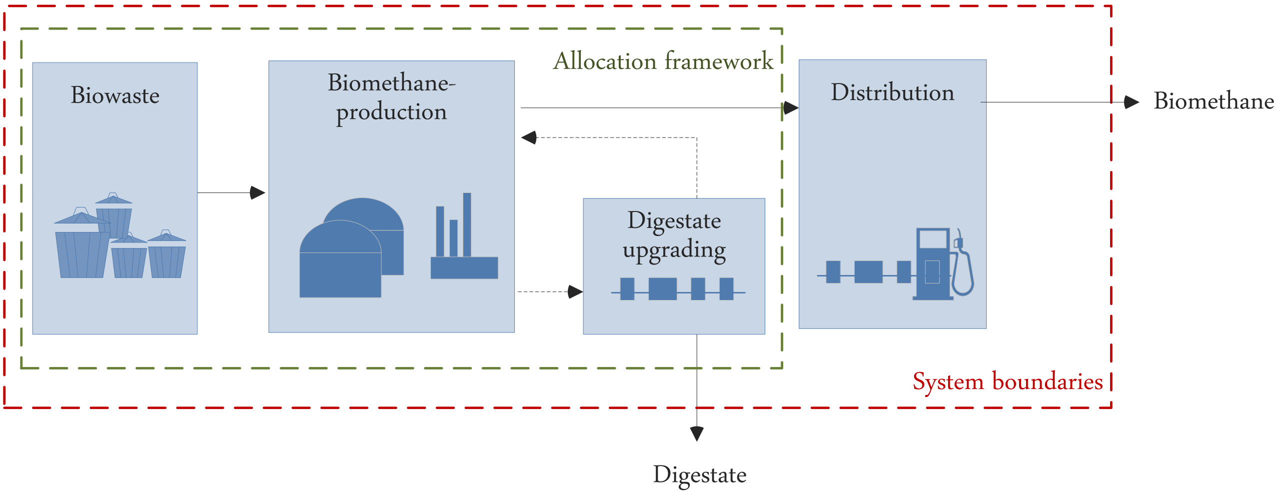

Figure 4-2 system boundaries for the exemplary calculation, DBFZ 2016

The calculation follows the basic methodology and the corresponding equation outlined in chapter 2. The relevant terms of the equation are marked in green.

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

It is important to notice, that the following calculation is based on exemplary values. BIOSURF D 5.2 will focus on specific emission factors and provide more profound data and values.

The values for processing (e_p), and transport/distribution (e_{td}) have been taken from (BioGrace, 2014). Biograce is a calculator (acknowledged by the EC) which can be used by biofuel producers for the calculation of GHG-emissions in the RED context. The Biograce tool does also contain a number of background data which have been used for the calculation of the EU RED default values.

According to the allocation framework illustrated in Figure 4-2, emissions from e_{ec} and e_p are allocated between the main product biomethane and the by-product digestate.

$$Allocation\ factor\,(AF) = \frac{LHV_{Biomethane}[MJ]}{LHV_{Biomethane}[MJ] + LHV_{Digestate}[MJ]}$$

$$LHV_{Biomethane}[MJ] = 1$$

$$LHV_{Digestate}[MJ] = 0.148[kg] \cdot 2.8[\frac{MJ}{kg}] = 0.4MJ$$

$$AF = \frac{1MJ_{Biomethane}}{1MJ_{Biomethane} + 0{,}4MJ_{Digestate}}$$

$$AF = 72\%$$

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Given this calculated allocation factor and the GHG-emissions from the single process steps (taken from BioGrace) the overall calculation for the GHG-emission factor of the main product biomethane can be completed as follows:

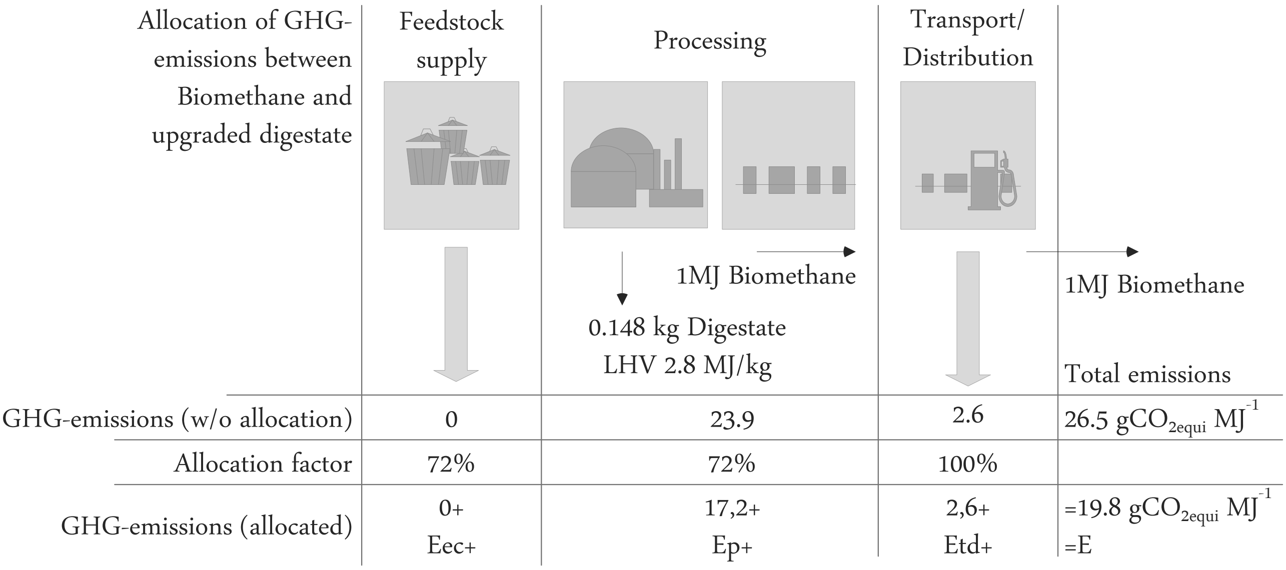

Figure 4-3 Exemplary GHG-emission calculation including by-product allocation, DBFZ 2016

The exemplary calculation shown in Figure 4-3 illustrates the impact of an allocation of the upgraded digestate on the overall result of the main product biomethane. Without allocation of the digestate, the emissions associated with the production and distribution of the biomethane amount to 26.5 gCO_{2equi} MJ^{-1}. Including the by-product digestate into the calculations allows to allocate a small amount of those emissions to the by-product and thus, reduces the emissions associated to the biomethane productions to 19.8 gCO_{2equi} MJ^{-1}.

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5. The Inclusion of GHG-Emission Savings from the Fermentation of Agricultural By-Products (Focus Manure), Organic Waste, etc. under the RED Framework

Biogas and biomethane production can be integrated into the treatment, disposal or utilisation of agricultural by-products (e.g. straw, manure), organic wastes and residues (e.g. municipal organic waste, wastes from food processing, etc.) or sewage sludge and landfills. In all of these cases, the integration of biogas and biomethane production can help to avoid methane emissions, which would occur during the conventional treatment of these materials. In the context of the EU RED framework, when the biomethane produced from such waste materials or residues should be used as a transportation fuel, it is the question how these mitigation effects can be included in the calculation of the GHG-mitigation potential of the biomethane. It is important to notice, that this discussion has two aspects. The first point is the discussion of potential options to include these emission savings under the equation discussed in chapter 2. This will be done, using the example of manure fermentation in the following paragraphs. The second aspect is the use of scientifically sound credits for the emission savings attained, based on the best available scientific literature. This will be discussed in BIOSURF Deliverable 5.2.

The use of manure for biogas production can help to avoid emissions from other agricultural production systems. Options for including these savings under the EU RED calculation framework are not clearly described or defined. Furthermore, corresponding credits for emission savings from manure fermentation are not (yet[5]) included in the EU RED default values for biogas/biomethane from manure.

In principle, the EU RED methodology (see equation in chapter 2) allows for the accounting of different options to save GHG-emissions along the value chain of biofuel production and utilisation. Most of these aspects address specific measures to save GHG-emissions, for example due to carbon sequestration and soil carbon accumulation from improved agricultural management or GHG-savings from carbon capture and replacement. Emissions saved due to these measures can be accounted for with a credit under the EU RED equation. Since the overall methodology has been designed mostly for liquid biofuels, process specific options for such GHG-savings along the biogas/biomethane value chain (e.g. emission savings from manure fermentation, carbon capture and replacement, etc.) are not specifically mentioned.

Emission savings from an avoided conventional storage due to manure fermentation (or other agricultural by-products or organic wastes and residues) are directly connected to the substrate

[5] The JRC staff working document (See http://publications.jrc.ec.europa.eu/repository/handle/JRC95618) highlights the emission savings from manure fermentation and uses credits under the EU RED calculation approach.

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provision for biomethane production (for those pathways that are based or partly based on manure). In those cases where the manure (or other agricultural by-products or organic wastes and residues) is promptly feed into a biogas fermenter, the avoided emissions should be accounted under the term e_{ec} in the EU RED equation.

According to the definition given in Annex V of the EU RED, the term e_{ec} includes emissions from the feedstocks of the liquid and gaseous biofuels under investigation. For residues and wastes, the EU RED defines that the life-cycle-emissions of those materials (including straw, husks, cobs, nutshells, etc.) do not have to be calculated, up to the point of their collection. However, this does not necessarily mean that those residues will come into the calculations with a footprint of zero emissions. Climate related effects associated with the use of such waste or residue materials should be included into the calculations. In addition, if such residues are collected on a large-scale they may not be residues any more but goods and thus should be attributed cultivating emissions as well.

As an example, the default value for ethanol from straw material included a disaggregated value for e_{ec} of 3 g CO_2-Eq./MJ which result from straw handling and processes such as baling and pressing. Contrarily, emissions from the grain and straw production are, according to the definition in Annex V not included under e_{ec}. This example is illustrated in the following Figure 5-1.

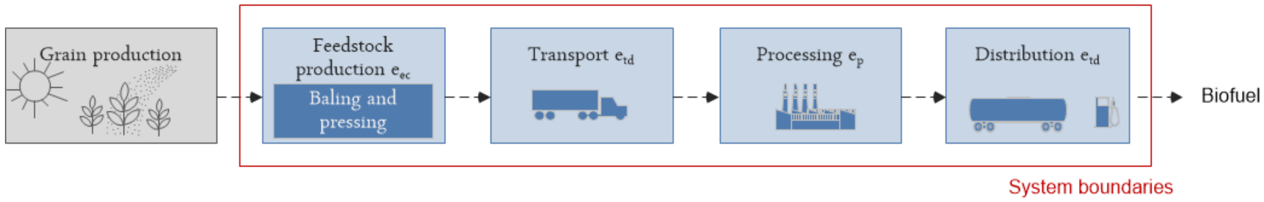

Figure 5-1 System boundaries for the calculation of GHG-emissions from the production and distribution of ethanol according to the RED methodology

In case manure is used for biogas/biomethane production, the basic system boundaries would be comparable to the example for straw ethanol. The calculation of emissions starts with the collection of the manure from livestock production systems but the emissions associated with livestock production itself or produced up to this point are not accounted for. Since the fermentation of manure for biogas production leads to climate relevant and related effects at the stage of feedstock supply, the corresponding GHG-emission savings should be considered under the term e_{ec}, using an emission credit.

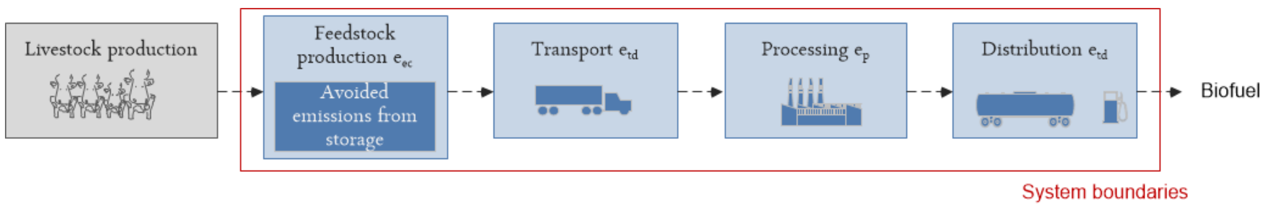

Figure 5-2 System boundaries for the calculation of GHG-emissions from the production and distribution of biomethane from manure according to SWD methodology

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A similar approach is taken for the calculation of the GHG-emissions in the EU Commission publication „Commission Staff Working Document – State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU" (SWD, 2014), (EC, 2014) published in August 2014. As already mentioned, the EU RED 2009/28/EC addresses liquid and gaseous biofuels used for transportation purposes. In 2010, the EU Commission published a set of recommendations for the sustainable use of solid and gaseous biomass sources for electricity and heat production in order to extend the overall debate of a sustainable production and utilisation of biomass also to other sectors of bioenergy. (EC, 2010) The methodology for the calculation of GHG-emissions described in this publication is similar to the EU RED methodology and the equation discussed in chapter 2 of this report. The respective methodology has been developed further in the staff working document (SWD, 2014). The document explicitly mentions some of the specialities of biomethane regarding the GHG-emission calculations under the RED/SWD framework. The calculations included in the document do address the issue of emission savings from manure fermentation. Simultaneously, at different points within the documents, the authors highlight the methodological compatibility between the EU RED and the SWD approach. Reversely, this means that including emission savings from manure fermentation (and other agricultural by-products or organic wastes and residues) during biomethane production should also be possible under the framework of the EU RED methodology.

Exemplary calculation

Besides the methodological discussion, including emission savings from manure fermentation must be based on scientifically sound and robust emission factors. Analysing and discussing such values is not the scope of this deliverable. However, the respective work will be conducted in BIOSURF WP5 Task 5.1. The results of this exercise will be published in BIOSURF Deliverable 5.2

An exemplary calculation is shown in the following paragraphs to illustrate the overall approach and to indicate the potential magnitude and impact from including the emission savings from manure fermentation into the overall GHG-emission calculation for biomethane. The calculation includes exemplary emission factors of 79 gCO_{2equi} MJ^{-1} biomethane for cattle manure and 115 gCO_{2equi} MJ^{-1} biomethane for pig manure. The emission factors are based on (Friehe et al., 2013) and (UBA, 2014). The credit for emission savings from manure fermentation included in the Commission staff working document is 45 gCO_{2equi} MJ^{-1} manure. Assuming a yield of 0.4027 MJ biomethane per MJ manure, the calculated emission saving credit results to 112 gCO_{2equi} MJ^{-1} biomethane. This value is in the range of the exemplary emission credits for the biomethane production from pig and cattle manure.

Based on the methodology discussed and the given exemplary emission credit values and exemplary calculation has been conducted. The relevant terms of the equation are marked in green.

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

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The credit for emission savings from manure fermentation will be included under the term E_{ec}. Values for the process steps production and transport/distribution have been taken form (BioGrace, 2014) and (Westerkamp et al., 2014).

e_{ec}+		**e_p+**			**e_{td}**	**=E_{total}**
$e_{ec(cultivation)}$+	$e_{ec(manure\ savings)}$	$e_{p(biogas\ production)}$+	$e_{p(upgrading)}$+	$e_{p(grid\ injection)}$+	e_{td}	=E_{total}
0	-79	6.6+	8.8+	0.16	3	=-60.44

Table 5-1: Exemplary GHG-emission calculations for the production of biomethane from cattle manure in gCO_{2equi} MJ^{-1} biomethane

e_{ec}+		**e_p+**			**e_{td}**	**=E_{total}**
$e_{ec(cultivation)}$+	$e_{ec(manure\ savings)}$	$e_{p(biogas\ production)}$+	$e_{p(upgrading)}$+	$e_{p(grid\ injection)}$+	e_{td}	=E_{total}
0	-115	6.6+	8.8+	0.16	3	=-96.44

Table 5-2 Exemplary GHG-emission calculations for the production of biomethane from pig manure manure in gCO_{2equi} MJ^{-1} biomethane

The results of these exemplary calculations show the significant impact of the corresponding emission saving factors and the importance of including these aspects into the calculations under the EU RED framework.

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6. Additional Aspects

Besides the aspects of by-product allocation and the acknowledgment of the GHG savings from the fermentation of agricultural residues and by-products and organic waste materials, a number of additional aspects with regard to the methodology for GHG-accounting for biomethane in the RED context need to be considered. Since these aspects are not directly part of the scope of this deliverable, they will only be highlighted briefly. Some of the points are subject to other BIOSURF tasks and deliverables.

- As a consequence of the mass balancing system which is part of the certification process, the lack of adequate default values, and the existing rules for averaging GHG-emissions for biogas/biomethane feedstocks, the administrative effort for plant operators (especially in case a plant is sourced by several feedstock suppliers) during the certification process can be very high. This aspect will be subject to BIOSURF Deliverable 4.3.

- The current calculation approach is not appropriate to account for the specific benefits of crop rotation systems. Neither the EU RED nor the SWD include suggestions as to how to deal with catch crops in that regard. Biogas from catch crops can provide environmental advantages but if greenhouse gas emissions calculated individually for each crop of a rotation, those effects will not be visible.

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7. Conclusions & Recommendations

The GHG-mitigation potential of biofuels and bioenergy carriers has gained significant importance over the recent years. It is not only important to proof fulfilment regarding the existing GHG-mitigation thresholds existing in the EU RED context, the GHG-mitigation potential has also become an important criterion for the market success of a biofuel. In this regard, the methodology for the calculation of the GHG-mitigation potential is of critical importance. The EU RED has defined a calculation approach which is mandatory for any biofuel producers acting under national biofuel quota regimes within the EU. Furthermore, existing reports and recommendations for other bioenergy sectors published by the EU commission are using similar methodological approaches. It is therefore one of the questions to be discussed within BIOSURF WP5, whether or not this approach is appropriate and applicable for the calculation of biomethane. While the general approach is appropriate and applicable for biomethane calculations, a number of details have been identified and discussed in Chapters 3, 4 and 5. Based on these discussions, a number of conclusions and recommendations for future adaptations of the EU RED calculation approach can be drawn.

7.1 Conclusions

The GHG-mitigation threshold and the corresponding calculation approach included in the EU RED address biofuels in the European transportation sector. Since most of the biofuels used in the transportation sector are (and have been) liquid biofuels, most of the explanatory notes included in the RED Annex or the additionally published communications address specific issues and details associated with liquid biofuels. This also becomes evident when looking at the default values included in the EU RED. Unfortunately, the existing default values for biomethane are not as appropriate as those for liquid biofuels. EU RED Annex V includes three default values for biomethane (from municipal organic waste, from wet manure, from dry manure) which do not represent most of the existing biomethane concepts typically based on a combination of substrates. Thus, the necessity for the calculation of individual values is typically higher for biomethane producers that are willing to sell their product as a transportation fuel. We have identified two main issues that can occur when applying the RED calculation methodology for individual calculations of biomethane production and use. These conclusions regarding these aspects will be discussed in the following paragraphs:

Allocation of the digestate from biogas/biomethane production

- The EU RED methodology allows only one allocation approach (based on the LHV), this does not necessarily reflect the true value of the digestate which is often used as fertiliser and thus, substitutes synthetic fertiliser in agricultural production processes.
- Two potential options to avoid the allocation of the digestate based on its LHV would be.

  i) The use of the digestate within a closed loop and thus a direct substitution of synthetic fertiliser during the production of the substrates used for biogas/biomethane production (in the same biogas facility which has produced the respective digestate).

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ii) And/or a credit for potential carbon sequestration effects in case these effects occur during the cultivation of substrates for biofuel production due to the application of the digestate (from the biofuel production).

- An adaptation of the methodology regarding the allocation procedure is rather unlikely (the procedure can be considered as some kind of compromise).
- Separating the digestate into a dry and a liquid phase to reduce its water content can help to allocate a bigger part of the overall emissions to the by-product digestate and thus increase the GHG-mitigation potential of the biomethane.

Emission savings from the fermentation of agricultural by-products and organic residues and wastes

- The GHG-emission savings from the fermentation of agricultural by-products and organic residues and wastes and thus the avoidance of emissions from the conventional treatment of these materials can have a significant impact on the overall result of the GHG-mitigation potential for biomethane.
- The procedure for including these savings into the calculations is not specified within the EU RED. However, this factor is included in other publications from the commission, especially for the use of biomass for the production of electricity and for heating and cooling. Since these publications highlight the methodological compatibility to the RED approach, it should be possible to include the respective savings under the term E_{ec} into the calculations for biomethane in the RED context.

7.2 Recommendations

Completion of the EU RED default values

- Additional default values for biomethane should be introduced, to address the most commonly used feedstock and feedstock combinations. This would significantly reduce the overall administrative effort for biomethane producers and the related uncertainties.
- Appropriate default values could be calculated and prepared by the biomethane industry on a European level. The respective values should be proposed to the European Commission.

Allocation of the digestate from biogas/biomethane production

- We have shown, that for an upgrading/separation of digestate from biogas/biomethane production, the biorefinery definition from the communication (COM, 2010) should be applied. As a consequence, the allocation should be applied to the products biogas and (separated) digestate. In order to support biomethane producers during the process of sustainability certification, a positioning paper explaining the basic rationale and argumentation of this process could be prepared and published by the BIOSURF consortium. The paper should be submitted to the acknowledged certification schemes.

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- The JRC[6] highlights the value of digestate as an organic fertiliser and uses respective credits to include emission savings from the substitution of synthetic fertilisers. Furthermore, they claim methodological compatibility with the EU RED methodology. Therefore, additional ways to reflect the true value of the digestate under the EU RED calculation framework by using credits should be discussed and proposed. This will be done in BIOSURF D5.5.

Emission savings from the fermentation of agricultural by-products and organic residues and waste materials

- Besides the methodological discussion, the availability of scientifically sound emission saving factors is one of the preconditions for an appropriate reflection of this issue in the GHG-calculation methodology of the EU RED. BIOSURF WP5 will support this discussion with a comprehensive review of the available literature and data. The results available and the methodological reflections from chapter 5 of this report should be submitted to the responsible working groups on EU level. To clarify the methodological fuzziness associated with this point, the commission could publish or update an appropriate communication document.

[6] See http://publications.jrc.ec.europa.eu/repository/handle/JRC95618

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