

## GERMANY

# The Global Bioenergy Partnership Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy

## Version Zero

The following 10-step greenhouse gas (GHG) inventory framework is intended to guide policy makers and institutions when calculating GHG emissions from bioenergy and to enable life cycle assessments (LCA) of the GHG emissions of bioenergy to be compared on an equal basis. Not all 10 steps will apply to all biofuel or bioenergy systems, so in some applications it will be necessary to skip one or more steps of the Framework. At all stages, the user is invited to provide units of measurement and description of methodologies to add specificity to the report.

### Step 1: GHGs Covered

The user is asked to provide Global Warming Potential values and/or a clear reference (e.g., "IPCC SAR values") for the GHGs included in the analysis. This is necessary to ensure consistency between reports and the repeatability of reported calculations.

CO<sub>2</sub>  \_\_\_

CH<sub>4</sub>  \_\_\_

N<sub>2</sub>O  \_\_\_

HFCs \_\_\_

PFCs \_\_\_

SF<sub>6</sub> \_\_\_

Other \_\_\_\_\_

Please report global warming potential used for each GHG covered.

CO<sub>2</sub>: **1**

CH<sub>4</sub>: **23**

N<sub>2</sub>O : **296**

## Step 2: Source of biomass

The Framework distinguishes between waste and non-waste biofuels because LCA related to feedstock production is not relevant to "waste" biomass. The user is asked to specify the definition of "waste" biomass to ensure transparency at this critical point in the LCA.

Non-waste

Identify Feedstock: \_\_\_\_\_

Residue or Other Waste  **X**

Identify Feedstock: \_\_\_\_\_

\* Please explain definition of waste:

Substance that the holder intended to discard

Substance that had zero or negative economic value

Substance for which the use was uncertain

Substance that was not deliberately produced and not ready for use without further processing

Substance that could have adversely affected the environment

Other:  **No explanation, but waste is understood to include any feedstock of less (or equal) "value" like agricultural crop residues (straw, husks, nut shells and even bagasse and non refined glycerine)**

### Step 3: Land use change

Sub Group 1 was asked to develop a checklist for Parties to indicate what sources of GHG emissions related to land-use change (Step 3) and the production agricultural and forests based biofuel feedstocks (Step 4) they include in their approach to lifecycle analysis.

In developing the content of Steps 3 and 4, Sub-group 1 followed two guiding principles. The first was to avoid even the appearance of promoting or endorsing one methodology or approach over another. It was recognized that differences regarding the approach to LCA analysis or the choice of LCA methodologies could arise due to differences in national circumstances or legitimate differences of opinion regarding what should be included in lifecycle analysis. The second principle was to promote transparency. Suggestions that made it possible for Parties to be clearer about what is included in their LCA GHG emissions estimate for biofuels or allowed additional parties to use the framework were generally incorporated.

Accounting for land use change in a lifecycle framework for estimating emissions for bioenergy is a complicated matter. Many institutions around the world are developing their methodologies. Some account for land use change in a single, holistic assessment while others sub-divide bioenergy-associated land use change into direct and indirect changes. Some further distinguish between indirect land use changes that are domestic versus those that are international. The reporting framework presented below is intended to be flexible in order to clarify which of these multiple approaches is taken by the methodology being described.

Direct land use changes are taken into account **OR**

Indirect land use changes are taken into account **OR**

**Yes (bonus for production on previously degraded land will subtracted from dLUC value)**  A combination of both is included

Explain the choice.

### 3a: Direct Land use Change

Sub Group 1 recognized that including land use changes as sources in frameworks to assess the full lifecycle GHG emissions associated with bioenergy products is very complicated. Any given approach must make choices regarding a number of technical considerations including (but not limited to) the type of baseline (e.g., point in time vs. business as usual), the set of boundaries (e.g., sector, activity, and geographic coverage), and the timeframe over which emissions are allocated. For each of these considerations (and others) there are technically defensible alternatives available that can significantly affect the magnitude of the estimated GHG emissions associated with land use change.

Additionally, there are significant differences in the quantity and quality of information available to Parties to estimate GHG emissions associated with land use change. These include (but are not limited to) availability of relevant data to estimate land use changes and appropriate coefficients to estimate GHG emissions associated with specific land use changes. These differences can substantially limit the methods available to Parties to estimate GHG emissions related to land use change.

Due to the above complications, Parties hold very strong views regarding the inclusion of land use change sources in frameworks to assess lifecycle GHG emissions associated with bioenergy products. Initially, Sub Group 1 tried to accommodate these concerns by developing a comprehensive list the sources, methods, and underlying assumptions as well as descriptive information relating to data and emissions coefficients. The Sub Group realized, however, that the length of list raised serious questions about who would use it. Ultimately, the Sub Group settled on an approach that explicitly identifies 5 key components that any method for estimating emissions related to land use change must address (see description of Step 3). It then asks Parties to provide related the information they feel are necessary to adequately clarify their approach and resulting estimates of emissions related to land use change.

**Direct land use changes, when they occurred, are accounted for (Y or N).**

If yes:

1. Identify the reference period or scenario

Historic (identify year or period)

**After January 2008**

Business-as-Usual (BAU) scenario (identify time frame: **\_ no trends considered \_**)

Other (explain)

2. Describe how the methodology attributes this type of land use change to biofuels

**By tracing back the biofuel to the biomass production site (by traversing the geographical coordinates by an accuracy of 20 m)**

3. Explain key reference assumptions and characteristics relevant to estimating GHG emissions from direct land use change. Examples include (but are not limited to) identifying or describing:

- System boundaries (such as sector, activity, and geographic coverage) :

**Sector, activity: → each batch of biofuel**

**Geogr. coverage: → global scope, no limits**

- For BAU scenarios, assumed trends in key variables and land uses
- Omitted emissions sources
- Time period over which land use change emissions are allocated **20 YEARS**
- Definition of land cover classes and associated estimates of above and below ground carbon /

**Identical with EU RES-Directive:**

**Annualised emissions from carbon stock changes caused by land use change,  $e_l$ , shall be calculated by dividing total emissions equally over 20 years. For the calculation of these emissions the following rule shall be applied:**

$$e_l = (CS_R - CS_A) \times 3.664 \times 1/20 \times 1/P - e_B,$$

where

$e_l$  = annualised greenhouse gas emissions from carbon stock change due to land use change (measured as mass of CO<sub>2</sub>-equivalent per unit biofuel energy);

$CS_R$  = the carbon stock per unit area associated with the reference land use (measured as mass of carbon per unit area, including both soil and vegetation). The reference land use shall be the land use in January 2008 or 20 years before the raw material was obtained, whichever was the later;

$CS_A$  = the carbon stock per unit area associated with the actual land use (measured as

mass of carbon per unit area, including both soil and vegetation). In cases where the carbon stock accumulates over more than one year, the value attributed to  $CS_A$  shall be the estimated stock per unit area after twenty years or when the crop reaches maturity, whichever is the earlier;

$P =$  the productivity of the crop (measured as biofuel or other bioliquid energy per unit area per year);

4. Briefly describe the type of direct land-use changes accounted for (2–3 paragraphs). Examples include (but are not limited to) identifying or describing:

**(Biomass is produced on land that has not been cropland before 1.1.2008)**

- Areas of land that change land use by type (such as forest, grassland, peat lands, pasture, to feedstock production)

**Yes, exactly that**

- Carbon stocks, before shift to feedstock production, on lands that change land use by type

**Yes, exactly that**

5. The following impacts of direct land use change are accounted for:

Accounted for net changes of carbon stocks in:<sup>1</sup>

living biomass,  dead organic matter,  soils

Changes in carbon stocks in products (such as harvested wood products)

6. The methodology and data used are publicly available: Methodology (**Y** or N), Data (Y or **N**)

### **3b: Indirect Land use Change**

Parties hold even stronger views regarding the inclusion of indirect land use change sources in frameworks to assess lifecycle GHG emissions associated with bioenergy products than they do views concerning direct land use change emissions. First, all of the complications described above for developing estimates of emissions for direct land use apply to developing estimates of emissions from indirect land use

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<sup>1</sup> Depending on choice of methodology and temporal system boundary, the net changes in carbon stock in these carbon pools from land use conversion may be positive (increased carbon stock) or negative (decreased carbon stock). In responding to this question, please indicate the reason for including or disregarding changes in any of the carbon pools.

change sources. Additionally, the methods for estimating indirect land use changes associated with increases in acreage of biofuel feedstock commodities within a country or region are in the early stages of development. As such, the methods are still being developed, have had little peer review, and lack consensus among scientist overall quality of the estimates or the relative accuracy of alternative approaches.

Aside from technical issues, there are philosophical differences among Parties as to whether to include indirect land use change sources in lifecycle frameworks, and if so whether or not to distinguish them direct emissions sources.

After much discussion, Sub Group 1 addressed the philosophical issue by adding the chapeau at the top of Step 3. With respect to the technical issues, the Sub Group followed Guiding Principle 2, and included a section dealing with domestic indirect land use change sources and a section dealing with international indirect land use change sources. The information sought from Parties in these sections mirrored the information sought with respect to direct land use change.

**GENERALLY: Will be included in line with the ongoing development at EU level → answers below are preliminary and notional**

Domestic indirect land use change is taken into account **OR**

International indirect land use change is taken into account **OR**

Both are taken into account separately **OR**

Both are taken into account without making the distinction

Explain the choice.

**ILUC is a global transboundary phenomena, so the effect are assessed internationally**

**Domestic indirect land use changes are accounted for (Y or N ). If yes:**

1. Identify the reference period or scenario

Historic (identify year or period) **after 1.1.2008**

Business-as-Usual scenario (identify time frame:  **OPEN** )

Other (explain)

2. Describe how the methodology attributes this type of land use change to biofuels

## Upcoming method Open

**Existing status method: granting a bonus of 29 g CO<sub>2</sub>/MJ biofuel if the biomass is produced on degraded land**

3. Explain key reference assumptions and characteristics relevant to estimating GHG emissions from domestic indirect land use change. Examples include (but are not limited to) identifying or describing:

- System boundaries **global**
- For BAU scenarios, assumed trend in key variables and land uses

**Yes (ILUC factor concept allocates 25% of maximum BAU scenario estimation to biofuel taking increasing yield and other trends into account)**

- Rules, methods, and assumptions used to assign indirect land use changes to biofuels (Such as, whether emissions allocated to products using a marginal, average, or other approach)

**“25% rule” (see above) as a best estimate (will be substantiated and updated by empirical data)**

- Time period over which land use change emissions are allocated  
**20 years**
- Land categories considered in the model, their definition, and associated estimates of above and below-ground carbon
- Data set that provides baseline land cover or land use for the model; categories of land cover that are assumed to be available for human use

4. Briefly describe the type of domestic indirect land-use changes accounted for (2 – 3 paragraphs). Examples include (but are not limited to) identifying or describing:

**All types of areas are included concerning the previous land-use type (forestland, grassland, peatland, cropland) and the type of cropland that is created by the land-use change.**

**Carbon stock values are assigned to all these types of land-use by using default values (for the time being referring to IPCC);**

- Areas of land that change land use by type (such as forest, grassland, peat lands, pasture, to commodity production) **See above**
- Carbon stocks, before shift to feedstock production, on lands that change land use by type **See above**

5. The following impacts of indirect domestic land use change are accounted for:

Accounted for net changes of carbon stocks in<sup>2</sup>:

living biomass,  dead organic matter,  soils

Changes in carbon stocks in products (such as harvested wood products)

6. The methodology and data used are publicly available: Methodology (Y or N), Data (Y or N) **Methodology and data for "bonus-value" is not yet publicly available**

**International indirect land-use changes are accounted for (Y or N). If yes:**

1. Identify the reference period or scenario

Historic (identify year or period)

Business-as-Usual scenario (identify time frame: \_\_\_\_\_ )

Other (explain)

2. Describe how the methodology attributes this type of land use change to biofuels

3. Explain key reference assumptions and characteristics relevant to estimating GHG emissions from international indirect land use change. Examples include (but are not limited to) identifying or describing:

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<sup>2</sup> Depending on choice of methodology and temporal system boundary, the net changes in carbon stock in these carbon pools from land use conversion may be positive (increased carbon stock) or negative (decreased carbon stock). In responding to this question, please indicate the reason for including or disregarding changes in any of the carbon pools.

- System boundaries (such as sector, activity, and geographic coverage)
- For BAU scenarios, assumed trend in key variables and land uses
- Rules, methods, and assumptions used to assign indirect land use changes to biofuels (Such as, whether emissions allocated to products using a marginal, average, or other approach)
- Time period over which land use change emissions are allocated
- Land categories considered in the model, their definition, and associated estimates of above and below-ground carbon
- Data set that provides baseline land cover or land use for the model; categories of land cover that are assumed to be available for human use

4. Briefly describe the type of international indirect land-use changes accounted for (2–3 paragraphs). Examples include (but are not limited to) identifying or describing:

- Areas of land that change land use by type (such as forest, grassland, peat lands, pasture, to commodity production)
- Carbon stocks, before shift to feedstock production, on lands that change land use by type

5. The following impacts of international indirect land use change are accounted for:

Accounted for net changes of carbon stocks in<sup>3</sup>:

\_\_\_ living biomass, \_\_\_ dead organic matter, \_\_\_ soils

\_\_\_ Changes in carbon stocks in products (such as harvested wood products)

6. The methodology and data used are publicly available: Methodology (Y or N), Data (Y or N)

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<sup>3</sup> Depending on choice of methodology and temporal system boundary, the net changes in carbon stock in these carbon pools from land use conversion may be positive (increased carbon stock) or negative (decreased carbon stock). In responding to this question, please indicate the reason for including or disregarding changes in any of the carbon pools.

## Step 4: Biomass feedstock production

Step 4 consists of two parts – a checklist reflecting direct sources of emissions related to feedstock production, and, a checklist of embodied sources of emissions (i.e., emissions that occur in the production of inputs used in feedstock production. There was quick agreement among the group that the sources of direct emissions should be included in Step 4 and discussion centered around which sources to list explicitly and which to bundle into the “Other” group.

There was considerable debate on whether or not to include embodied emissions in Step 4. There were two main concerns that argued against including embodied emissions. First, if the GBEP framework is adopted for use in a broader (say national) LCA framework, including embodied emissions increases the likelihood of double counting. Second, there are no logical or generally agreed on guidelines for Parties to follow in establishing boundaries for embodied emissions. Hence, what sources a Party chooses to include in this group of emissions are arbitrary.

There was general agreement that the two concerns raised with respect to embodied emissions were valid. However, based on the second guiding principle, it was ultimately decided to include them in Step 4. To address the “double counting” concern, direct and embodied emissions are reported separately. To address the boundaries concern, Parties are asked to make clear the assumptions they use in developing the emissions estimate for each source (direct and embodied). Finally, to increase transparency Parties are asked to indicate whether or not the methods and the data used to develop the emissions associated with sources indicated in Step 4 are publicly available.

### GHG Sources and Sinks due to land use and management:

1. Sources of direct GHG emissions and removals are accounted for:

Emissions from operating farm/forestry machinery

Emissions from energy used in irrigation

Emissions from energy used to prepare feedstocks (drying grains, densification of biomass, etc.)

Emissions from energy used in transport of feedstocks **No, this is included in step 5**

- CO<sub>2</sub> emissions from lime/dolomite applications
- N<sub>2</sub>O emissions resulting from the application of nitrogen fertilizers:  
\_\_\_direct; \_\_\_volatilization; \_\_\_runoff/leaching (**according to a model by JRC**)
- CH<sub>4</sub> emissions from lands (especially wetlands)
- Net changes in soil organic carbon (due to management practices, not land use conversion (step 3a.5 and 3b.5, for both domestic and international)<sup>4</sup>
- \_\_\_ Other (please specify) **GHG emissions from N, P, K, Ca-fertilizer production**

2. For all checked, clarify assumptions and emissions reference values used

3. The methodology and data used are publicly available: Methodology (Y or N), Data (Y or N)

**Partly**

**Embodied Emissions:**

1. Sources of GHG emissions embodied in inputs accounted for:

\_\_\_ Emissions embodied in the manufacture of farm/forestry machinery

\_\_\_ Emissions embodied in buildings

Emissions embodied in the manufacture of fertilizer inputs.

Emissions embodied in the manufacture of pesticide inputs

Emissions embodied in purchased energy:

\_\_\_  electricity; \_\_\_  transport fuels; \_\_\_ other (e.g., fuel for heat)

\_\_\_  Emissions embodied in the production of seeds

\_\_\_ Other (please specify)

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<sup>4</sup> Depending on choice of methodology and temporal system boundary, the net changes in carbon pool due to management practices may be positive (increased carbon stock) or negative (decreased carbon stock). In responding to this question, please indicate the reason for including or disregarding changes in this carbon pool.

2. For all checked, clarify assumptions

3. The methodology and data used are publicly available: Methodology (Y or N),  
Data (Y or N) **Partly**

## Step 5: Transport of biomass

Production chains of bioenergy commonly include a number of transport processes. Following parameters have a decisive effect on the level of transport contribution to the GHG balance of a biofuel: The distance between the location of production and of use, the number of single stages, the type of vehicle and the question whether there are empty returns. The user is asked to give information about these parameters.

There are several transport data models available which facilitates data provision, transparency and standardization. The user shall explain if such a data model is applied.

From a general point of view long transport distances are perceived to be a crucial aspect in terms of environmental respectively GHG performance. However existing state of the art GHG balances for biomass transport processes mostly provide comparably minor contribution to the total GHG performance. Nevertheless transport is a non-negligible component of the life-cycle.

### **Biomass is transported from farm/plantation/forest to processing plant (Y or N)**

If yes:

1. \_\_\_ The biomass transported in a different commodity type.
  - 1a. \_\_\_ A description of intermediate processing steps is available.
  - 1b. \_\_\_ Emissions associated with intermediate processing are accounted for (including, e.g., electricity used for processing). **See processing into fuel**
  
2. **X** There is a multi-stage transport chain (e.g. truck to ship to truck or train).
  - 2a. List all stages in the transport chain. **Depends on pathway, generally included: Truck, sea vessel,**
  - 2b. Specify the stages for which emissions are accounted. **All stages**

3. Transport from production site to use/processing plant is dedicated to this purpose (Y or N) **Can be applied according to the case**

If Yes:

3a.  All transport emissions are included

If No:

3b.  A portion of transport emissions are allocated, and the allocation methodology is described.

4.  Return run of transport equipment is accounted for.

**Can be applied according to the case**

4a. During the return run, transport equipment is:

empty  otherwise utilized

**Can be applied according to the case**

5. For relevant sections, clarify assumptions

## Step 6: Processing into fuel

The user is asked where biomass is processed into fuel which associated GHG emissions related to this process are taken into account. For those types of emissions where different methods of taking them into account could be envisaged, further specification is asked in order to allow for a complete comparison of LCAs.

### The biomass requires processing to produce fuel (Y or N)

1.  GHG emissions associated with material inputs used in the conversion process (e.g. chemicals, water) are accounted for.

2.  GHG emissions associated with the energy used in the conversion process are accounted for.

2a. Specify the method used to account for grid-related emissions (e.g. average/marginal, national/regional, actual/future): \_\_\_\_\_

### Average, European/national, actual

3.  GHG emissions from wastes and leakages (including waste disposal) are accounted for.

4.  Other GHG emissions from the process are accounted for.

4a. List which ones:  **Direct, if given**

5.  GHG emissions associated with the plant construction are accounted for.

5a. Estimates of emissions associated with plant construction have been pro-rated to account for:

Other uses of the plant

Design life of the plant

Other parameters; specify which ones: \_\_\_\_\_

6. For relevant sections, clarify assumptions

## Step 7: By-products and co-products

The user is asked how co- and/or by-products are considered in the LCA. This is an area where different approaches in LCAs can potentially produce quite different results and therefore clarity of the approach is important for useful comparison of LCAs. The framework identifies three general points related to whether feedstocks for the co- and/or by-products originate from biomass or non-biomass, what would actually fall under the definition of co- and/or by-products and the methodology to take them into account. On some of those points, further methods are asked to allow for a full comparison.

### By-products or co-products are produced (Y or N)

1.  By/Co-products from the biomass are accounted for.
2.  By/Co-products from non-biomass feedstocks are accounted for.
3. Explain definition of by/co-products: \_\_\_\_\_

### No specific definition

4. An allocation method is used (Y or N):
  - Allocation by mass
  - Allocation by energy content
    - Method to determine energy content: **Lower heating value of fresh substances**
  - Allocation by economic value
    - Method to determine economic value: \_\_\_\_\_
  - Other allocation method
    - Specify method: \_\_\_\_\_
    - Method to determine parameters needed: \_\_\_\_\_

5. A substitution method is used (Y or N)

Identify method used to determine the exact type of use/application of a co-product: \_\_\_\_\_

Identify method used to determine what product the co-product would substitute for and what the associated GHG emissions are for that product:  
\_\_\_\_\_

6. Another method or combination of methods is used (Y or N)

Specify method: \_\_\_\_\_

Method to determine parameters needed: \_\_\_\_\_

7. For relevant sections, clarify assumptions

## Step 8: Transport of fuel

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### Fuel is transported from processing plant to use site (Y or N)

If yes:

(please consider all emissions, including, for example, methane emissions from biogas equipment)

1. \_\_\_ The fuel transported in a different commodity type.
  - 1a. \_\_\_ A description of intermediate processing steps is available.
  - 1b. \_\_\_ Emissions associated with intermediate processing are accounted for (including, e.g., electricity used for processing). **SEE PROCESSING INTO FUEL**
2. **X** There is a multi-stage transport chain (e.g. truck to ship to truck or train).
  - 2a. List all stages in the transport chain. **Depends on pathway, generally included: Truck, sea vessel**
  - 2b. Specify the stages for which emissions are accounted. **All stages**
3. Transport from the processing plant to the use site is dedicated to this purpose. (Y or N) **Can be applied according to the case**

If Yes:

  - 3a. **X** All transport emissions are accounted for.

If No:

  - 3b. \_\_\_ Transport emissions are pro-rated, and the methodology for pro-rating is described.
4. \_\_\_ Return run of transport equipment is accounted for. **Can be applied according to the case**
  - 4a. During the return run, transport equipment is:  
\_\_\_ empty    \_\_\_ otherwise utilized

**Can be applied according to the case**

5. For relevant sections, clarify assumptions

## Step 9: Fuel use

The use of biomass is the core process converting the carbon feedstock into the non-fossil CO<sub>2</sub> replacing fossil fuel and therefore fossil CO<sub>2</sub> emissions. At the beginning the basic type of use has to be explained: biofuel for transportation or biofuel for stationary use (electricity). In both cases the user shall explain whether efficiency of use is taken into account, and if yes, the approach shall be explained.

**For solid biomass and liquid and gaseous fuels used in stationary applications:**

1. Analysis addresses electricity and/or heat (thermal energy)? (Y or N)
  - 1a. Facility is a CHP plant? (Y or N) **Depends on case**
  - 1b. Electric efficiency of the use process \_\_\_\_\_
  - 1c. Thermal efficiency of the use process \_\_\_\_\_
  - 1d. Electricity sent to a general grid (Y or N) **Depends on case**
  - 1e. In case of CHP, indicate method used to account for electricity and heat (i.e., allocation, substitution, etc.), as in LCA Step 7. **No analysis at level of useful energy but fuel**
  
2. Specific emissions are addressed by the usage (Y or N)
  - 2a. Identify conversion/combustion technology **Depends on case**
  
3. The technique specifically causes significant non-CO<sub>2</sub> emissions of:
  - \_\_\_ N<sub>2</sub>O (e.g. CFB-type boilers) **Depends on case**
  - \_\_\_ CH<sub>4</sub> (e.g. low level technique or small-scale) **Depends on case**
  - \_\_\_ Other
  - 3a. Describe evidence to exclude the occurrence of such specific GHG emissions.

4. Biomass is tainted with fossil material (e.g. in case of waste sources) (Y or N)

**Depends on case**

4a. If yes, provide analysis on degree of fossil content, if available

**Depends on case**

5. The analysis addresses a technology upgrade (e.g. pile burning to modern energy technology) **Depends on case**

5a. If yes, provide emissions data on the replaced way of biomass burning, if available. **Depends on case**

6. For relevant sections, clarify assumptions

#### **For transport fuels:**

1. Miles (km) per energy unit are addressed (Y or N)

1a. Miles (km) per energy unit: \_\_\_\_\_ **No (can be an option)**

1b. Describe how energy efficiency is factored into fuel use analysis.

2. Tailpipe gas is addressed (Y or N). If yes, describe methodology:

e.g.: CO<sub>2</sub> emissions associated with combustion source and feedstock sink are netted out; CH<sub>4</sub> and N<sub>2</sub>O emissions from combustion are included. **Yes;**  
**no**

## Step 10: Comparison with replaced fuel

The production processes of fossil fuel and biofuels are intrinsically different. Therefore, some of their stages are not directly comparable. It is important to list every single stage of the production processes and evaluate which of them should be included in the LCA, being comparable to one another or not. One of the main difficulties in setting up a comparison between the fossil fuel LCA and the biofuel LCA is exactly the depth of this analysis, that is, the production stages included and evaluated in both LCAs should present an equivalent level of complexity.

Rational: The user is asked to perform a LCA for the replaced fossil fuel as similar as possible to LCA performed for the bio-fuel.

The user is asked to answer all questions listed in step 10 keeping in mind what was considered in previous steps.

1. Identify Methodology for LCA of replaced fuel(s) / energy production system(s)

### Generic Default value

2. This methodology is publicly available (Y or N) **No, taken from EU directive**
  - If yes, provide references

3. Gases covered:

CO<sub>2</sub> **X** \_\_\_

CH<sub>4</sub> **X** \_\_\_

N<sub>2</sub>O **X** \_\_\_

HFCs \_\_\_

PFCs \_\_\_

SF<sub>6</sub> \_\_\_

Other \_\_\_\_\_

Please report global warming potential used for each GHG covered.

### See step 1

4. An LCA is performed on the replaced fuel(s) / energy production system(s). (Y or N)

4a. Please list any sources of inconsistency between LCA of biofuel and LCA of replaced fuels/systems.

4b. Describe the system boundaries. **Roughly known: extraction, transportation, refining, distribution**

4c. Indicate how direct and indirect land use change is addressed in the LCA of the replaced fuels/systems

**5.** Specify which sources of emissions embodied in infrastructure are accounted for and clarify assumptions. **None**

Emissions embodied in buildings and facilities

Emissions embodied in transportation fleet and infrastructure

Emissions embodied in the manufacture of machinery

Other sources of emissions embodied in infrastructure (please specify)

**I. Biofuel is used to replace transport fossil fuel (for stationary use, skip to section II)**

6. Relevant characteristics of crude:

6a. Type of crude:

Conventional crude

Canadian oil sands

Canadian/Venezuelan heavy oil

Other

Not specified

6b. Origin of fuel (region, refinery, etc), if specified

6c. Other important fuel characteristics, if specified

6d. Applicability conditions of the replaced fuel characteristics

The reference fuel is a world average

The reference fuel applicable only to one region (specify region)

Other applicability conditions apply (please specify)

7. Emissions prior to extraction/production are accounted for (Y or N) **No (but unclear)**

7a. If yes, specify pre-production sources included (e.g., geophysics, prospecting) and geographic/temporal coverage of analysis.

7b. Explain method for applying pre-production emissions to per barrel calculations.

8. Emissions from extraction/production are accounted for (Y or N)

8a. Direct and embodied emissions in extraction/production accounted for:

Fuel combustion from drilling **Yes (but unclear)**

Fugitive methane emissions from equipment **Yes (but unclear)**

Fuel combustion from turbines and compressors **Yes (but unclear)**

Transportation emissions from helicopters and supply vessels **Yes (but unclear)**

Use of electricity (e.g., gasoil or fuel oil generators) **Yes (but unclear)**

Use of chemical inputs **Yes (but unclear)**

Other

8b. Natural gas emissions accounted for:

Emissions from flaring natural gas **Yes (but unclear)**

Emissions from combustion equipment (specify gases included) **Yes (but unclear)**

Emissions from reinjection of natural gas **Unclear**

Emissions from direct use of natural gas **Yes (but unclear)**

Emissions from other processing of natural gas **Yes (but unclear)**

Emissions from gas processing point to remove liquids **Yes (but unclear)**

Emissions from extracted liquids **Yes (but unclear)**

Emissions from electricity production **Yes (but unclear)**

8c. Describe method for allocating emissions between crude oil and natural gas production **Unclear**

8d. Emissions for other extraction/production by/co-products are accounted for (Y or N) **Unclear**

- If yes, describe methodologies for calculating emissions and for allocating emissions between crude and by/co-products.

9. Crude is transported to the refinery (Y or N)

9a. Specify transport distance and mode(s) of transport (pipeline, tanker, etc.).

**Combination of all (but unclear)**

9b. For internationally transported crude, specify whether domestic, international, or total transport emissions are accounted for. **Unclear**

- Describe use of country-specific parameters in calculating transport emissions.

9c. Fugitive emissions during transport are accounted for (Y or N) **Unclear**

9d. Return journeys of transport fleet are accounted for (Y or N) **Unclear**

9e. The production/transport system involves liquified natural gas (Y or N) **No (but unclear)**

9f. Emissions from the regasification plant are accounted for (Y or N) **No (but unclear)**

10. Refinery emissions are accounted for (Y or N)

10a. Describe assumptions on refinery characteristics (e.g., existing, typical, local average) **Unclear**

10b. Describe method for calculating direct refinery emissions **Unclear**

10c. Emissions embodied in chemicals (catalysts, solvents, etc.) are accounted for (Y or N) **No (but unclear)**

- If yes, describe method.

10d. Fugitive emissions accounted for (Y or N) **Yes (but unclear)**

- If yes, describe method.

10e. Emissions for hydrogen production are accounted for (Y or N) **Yes (but unclear)**

- If yes, specify the production process.

10f. Emissions for purchased and generated electricity are accounted for (Y or N) **Yes (but unclear)**

- If yes, specify electricity mix of the purchased electricity

10g. Emissions from wastes and leakages are accounted for (Y or N) **Yes (but unclear)**

- If yes, describe method

10h. Emissions for refinery by-products and co-products are accounted for (Y or N) **Yes (but unclear)**

- If yes, describe methodologies for calculating emissions and for allocating emissions between fuel and by/co-products.

11. Fuel is transported or distributed prior to use (Y or N) **Yes (but unclear)**

11a. Specify transport distance and mode(s) of transport (truck, tanker, etc.).

11b. For internationally transported fuels, specify whether domestic, international, or total transport emissions are accounted for.

- Describe use of country-specific parameters in calculating transport emissions.

11c. Fugitive emissions during transport are accounted for (Y or N)

11d. Return journeys of transport fleet are accounted for (Y or N)

12. Fuel use emissions are accounted for (Y or N) **Yes (but unclear)**

(please consider consistency with Step 9)

If no:

12a: Please explain how equivalency with the biofuel system is defined (e.g. lower heating value) **LHV**

If yes:

12b: Please explain how equivalency with the biofuel system is defined. **Equal energy value of fuels**

Do you refer to energy content of the fuel **\_X\_**

Do you refer to miles (km) per energy unit \_\_\_\_

12c: Describe how energy efficiency is factored into fuel use analysis. **Netted out**

12d: Tailpipe gas is addressed (Y or N). If yes, describe methodology. **Fossil C to CO<sub>2</sub>**

13. Please identify any elements of the fossil fuel LCA not included in the above questions and describe methodology used to calculate emissions.

## II. Stationary use of biofuel for electricity/heat

7. Describe technologies, methodologies and data for calculating the extraction/production/transport of replaced energy source, using Transport Fuel questions 6-11, above, as guidance where appropriate.

8. Fuel use emissions are accounted (Y/N)

(please consider consistency with Step 9)

If no:

8a: Please explain how equivalency with the biofuel system is defined (e.g. lower heating value of utilized fuel) **Due to adoption of EU RES directive: equivalency of energy content (LHV) of applied/replaced fuel**

8b: What type of fossil fuel is assumed to be replaced by the biofuel system? **European average mix of fossil fuels applied for electricity production/ heat production**

Explain the assumption. **Broad baseline**

If yes:

8c: Please explain how equivalency with the biofuel system is defined.

Do you refer to energy content of the fuel (Y/N)

Do you refer to useful energy taking end use efficiency into account (Y/N)

If yes:

8d: Which method is used to define the production of replaced electricity/heat?

\_\_\_ national average mix

\_\_\_ marginal production

\_\_\_ other \_\_\_\_\_

please explain your choice and assumptions.

8e: Report energy efficiency for electricity generation, and/or heat generation and describe how it is used in emissions analysis.

8f: Describe methodology for calculating evaporative emissions.

8g: Describe conversion/combustion technologies and method for calculating associated emissions, including trace gases.

9. Please identify any elements of the fossil fuel LCA not included in the above questions and describe methodology used to calculate emissions.

