

## **AGROILS**

# **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.

**As indicated on the UNFCCC website:**

**[http://unfccc.int/ghg\\_data/items/3825.php](http://unfccc.int/ghg_data/items/3825.php)**

**IPCC SAR: Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, page 22.**

| Species              | Chemical formula                              | Lifetime (years) | Global Warming Potential (Time Horizon) |           |           |
|----------------------|---|------------------|---|-----------|-----------|
|                      |   |                  | 20 years                                | 100 years | 500 years |
| CO <sub>2</sub>      | CO <sub>2</sub>                               | variable §       | 1                                       | 1         | 1         |
| Methane *            | CH <sub>4</sub>                               | 12±3             | 56                                      | 21        | 6.05      |
| Nitrous oxide        | N <sub>2</sub> O                              | 120              | 280                                     | 310       | 170       |
| HFC-23               | CHF <sub>3</sub>                              | 264,00           | 9100                                    | 11700     | 9800      |
| HFC-32               | CH <sub>2</sub> F <sub>2</sub>                | 5,60             | 2100                                    | 650       | 200       |
| HFC-41               | CH <sub>3</sub> F                             | 3,70             | 490                                     | 150       | 45        |
| HFC-43-10mee         | C <sub>5</sub> H <sub>2</sub> F <sub>10</sub> | 17,10            | 3000                                    | 1300      | 400       |
| HFC-125              | C <sub>2</sub> H <sub>2</sub> F <sub>5</sub>  | 32,60            | 4600                                    | 2800      | 920       |
| HFC-134              | C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>  | 10,60            | 2900                                    | 1000      | 310       |
| HFC-134a             | CH <sub>2</sub> FCF <sub>3</sub>              | 14,60            | 3400                                    | 1300      | 420       |
| HFC-152a             | C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>  | 1,50             | 460                                     | 140       | 42        |
| HFC-143              | C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>  | 3,80             | 1000                                    | 300       | 94        |
| HFC-143a             | C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>  | 48,30            | 5000                                    | 3800      | 1400      |
| HFC-227ea            | C <sub>3</sub> H <sub>2</sub> F <sub>7</sub>  | 36,50            | 4300                                    | 2900      | 950       |
| HFC-236fa            | C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>  | 209,00           | 5100                                    | 6300      | 4700      |
| HFC-245ca            | C <sub>3</sub> H <sub>3</sub> F <sub>5</sub>  | 6,60             | 1800                                    | 560       | 170       |
| HFCs                 |   | 1,5-264          | 460-9100                                | 140-11700 | 42-9800   |
| Sulphur hexafluoride | SF <sub>6</sub>                               | 3200             | 16300                                   | 23900     | 34900     |
| Perfluoromethane     | CF <sub>4</sub>                               | 50000            | 4400                                    | 6500      | 10000     |
| Perfluoroethane      | C <sub>2</sub> F <sub>6</sub>                 | 10000            | 6200                                    | 9200      | 14000     |
| Perfluoropropane     | C <sub>3</sub> F <sub>8</sub>                 | 2600             | 4800                                    | 7000      | 10100     |
| Perfluorobutane      | C <sub>4</sub> F <sub>10</sub>                | 2600             | 4800                                    | 7000      | 10100     |
| Perfluorocyclobutane | c-C <sub>4</sub> F <sub>8</sub>               | 3200             | 6000                                    | 8700      | 12700     |
| Perfluoropentane     | C <sub>5</sub> F <sub>12</sub>                | 4100             | 5100                                    | 7500      | 11000     |
| Perfluorohexane      | C <sub>6</sub> F <sub>14</sub>                | 3200             | 5000                                    | 7400      | 10700     |

|             |  |                   |                        |                        |                         |
|-------------|--|-------------------|------------------------|------------------------|-------------------------|
| <b>PFCs</b> |  | <b>2600-50000</b> | <b>4400-<br/>16300</b> | <b>6500-<br/>23900</b> | <b>10000-<br/>34900</b> |
|-------------|--|-------------------|------------------------|------------------------|-------------------------|

## 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.

***As research activities are ongoing worldwide, almost every product coming from the Jatropha production chain can be valorized according to biorefinery concept. Moreover Jatropha biofuel production can present different "configurations" (e.g. mechanical vs chemical extraction, production of crude vegetable oil vs biodiesel) and hence different products, co-products and waste according to developers' choices.***

Non-waste: **every product, co-product or by-product of Jatropha production chain that can be used to produce energy conveniently or that has an economical value and can be sold to specific markets (e.g. fertilizers, cattle feed, construction materials).**

Identify Feedstock: **Jatropha methyl-ester (in case of biodiesel production), Jatropha crude vegetable oil (JCVO), Jatropha presscake (by-product of mechanical extraction), Jatropha meal (by-product of chemical extraction), Jatropha shells (by-product of chemical extraction), Compost (by-product, in case of anaerobic digestion of Jatropha husks), Glycerol (by-product, in case of JCVO transesterification)**

Residue or Other Waste : **every other product of the production chain**

Identify Feedstock\_\_ **Jatropha husks, dead wood, litter, wastewater (in case of biodiesel production)**

\* Please explain definition of waste:

Substance that the holder intended to discard \_\_\_ **none**

Substance that had zero or negative economic value \_\_\_ **dead wood, litter**

Substance for which the use was uncertain \_\_\_ **none**

Substance that was not deliberately produced and not ready for use without further processing \_\_\_ **none**

Substance that could have adversely affected the environment \_\_\_\_ **wastewater discharged from biodiesel production if not treated properly**

Other: \_\_\_\_\_

### 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**

\_\_\_ A combination of both is included

Explain the choice.

**Uncertainty in evaluating indirect effects, mainly due to lack of standard procedures.**

### **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).**

**Y**

If yes:

1. Identify the reference period or scenario

\_\_\_ Historic (identify year or period: **at year 0 of project activities**)

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

\_\_\_ Other (explain)

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

**QUESTION NOT CLEAR**

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

**Direct LUC is estimated by 1) identification of Jatropha plantation boundaries and extraction plant facilities, 2) analysis of public Land Cover databases (JRC, Global Land Cover 2000; University of Maryland, Global Land Cover Facility), 3) plantation site vegetation inventory and soil survey, 4) Existing carbon stock definition in above and below ground biomass and soil organic carbon, 5) farming practices design (e.g. plugging).**

**Such data provided, LUC emissions are evaluated according to IPCC's Good Practice Guidance for Land Use, Land-Use Change and Forestry.**

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:

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

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

**Common land classes that are used for plantation sites are grassland, cropland, shrubland, bare ground, deforested areas and relatively degraded classes. Since *Jatropha curcas* is a tree species (stock capacity about 50-100 tCO<sub>2</sub>e/ha with common plantation density) with soil improvement capabilities (in certain conditions) carbon negative shift in land use changes (in type) are not practiced.**

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

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

**X** \_\_\_ living biomass, \_\_\_ dead organic matter, **X** \_\_\_ 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) **PARTIALLY**, Data (Y or N) **PARTIALLY**

### **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 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.

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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.

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.

- 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.

**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)
- 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 domestic indirect land use change. Examples include (but are not limited to) identifying or describing:

- System boundaries
- 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 domestic 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 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)

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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.

**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:

- 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

- \_\_\_ 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
- \_\_\_ 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)

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

**Many emission sources are taken into account in terms of diesel fuel consumption (tractors, machineries, power & heat generators for processing, transportation).**

**Diesel values come from IPCC as indicated in UNFCCC CDM Methodology ACM0017:**

**Net calorific value of DIESEL fuel: 46 GJ/tonne**

**Carbon dioxide emissions factor for DIESEL fuel: 0,0741 tCO<sub>2</sub>/GJ**

⇒ **CO<sub>2</sub> emission coefficient of DIESEL fuel: 3,41 tCO<sub>2</sub>/tonne**

**N<sub>2</sub>O Emissions from the application of fertilizers, CO<sub>2</sub> emission from urea application, CO<sub>2</sub> Emission from application of limestone and dolomite, CH<sub>4</sub> and N<sub>2</sub>O Emissions from the field burning of biomass, are also taken into account as recommended by the same CDM Methodology ACM0017.**

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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.

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

**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)

2. For all checked, clarify assumptions

**Only for synthetic fertilizers as prescribed in ACM0017 Methodology.**

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

## 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)**

**Y**

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).
  
2. \_\_\_ There is a multi-stage transport chain (e.g. truck to ship to truck or train).
  - 2a. List all stages in the transport chain.
  - 2b. Specify the stages for which emissions are accounted.
  
3. Transport from production site to use/processing plant is dedicated to this purpose (Y or N)

**Y**

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.

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

empty  otherwise utilized

5. For relevant sections, clarify assumptions

**Fruits are harvested and transported to processing plant. Each step of the process (from dehusking to oil production) is executed in the same facility.**

## 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)

**Y**

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

2. **X**\_\_\_ 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):  
**national/regional**\_\_\_\_\_

3. **X**\_\_\_ 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: \_\_\_

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: **co-products involve similar revenues to the main product, by-products result in smaller revenues. At the time being, Jatropha production chains produce only by-products but big efforts are being made in order to increase value of by-products (e.g. detoxification of press-cake, biochar production with husks).**
4. An allocation method is used (Y or N):
  - Allocation by mass
  - Allocation by energy content
    - Method to determine energy content: \_\_\_\_\_
  - 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).

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.

**In case of production for international export: truck/train to ship and then ship to truck/train.**

2b. Specify the stages for which emissions are accounted.

**Every stage, according to fuel type and consumption.**

3. Transport from the processing plant to the use site is dedicated to this purpose.  
(Y or N) **Y, in case of fuel production for national/regional use**

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. **X**\_\_\_ Return run of transport equipment is accounted for.

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

**X**\_\_\_ empty \_\_\_ otherwise utilized

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) **Y**
  - 1a. Facility is a CHP plant? (Y or N) **Y**
  - 1b. Electric efficiency of the use process **X** \_\_\_\_\_
  - 1c. Thermal efficiency of the use process **X** \_\_\_\_\_
  - 1d. Electricity sent to a general grid (Y or N) **Y**
  - 1e. In case of CHP, indicate method used to account for electricity and heat (i.e., allocation, substitution, etc.), as in LCA Step 7. **allocation**
  
2. Specific emissions are addressed by the usage (Y or N)
  - 2a. Identify conversion/combustion technology: **Jatropha Crude Vegetable Oil combustion in generating sets equipped with stationary diesel engines.**
  
3. The technique specifically causes significant non-CO<sub>2</sub> emissions of:
  - X** \_\_\_ N<sub>2</sub>O (e.g. CFB-type boilers)
  - \_\_\_ CH<sub>4</sub> (e.g. low level technique or small-scale)
  - \_\_\_ Other
  - 3a. Describe evidence to exclude the occurrence of such specific GHG emissions.

### **Tuning of oil combustion period.**

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

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

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

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

6. For relevant sections, clarify assumptions

**For transport fuels:**

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

1a. Miles (km) per energy unit: \_\_\_\_\_

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

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

**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.**

## 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)

2. This methodology is publicly available (Y or N)

- If yes, provide references

3. Gases covered:

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.

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.
- 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.
- 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)
- 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
  - Fugitive methane emissions from equipment
  - Fuel combustion from turbines and compressors
  - Transportation emissions from helicopters and supply vessels
  - Use of electricity (e.g., gasoil or fuel oil generators)
  - Use of chemical inputs
  - Other
- 8b. Natural gas emissions accounted for:
- Emissions from flaring natural gas
  - Emissions from combustion equipment (specify gases included)
  - Emissions from reinjection of natural gas
  - Emissions from direct use of natural gas
  - Emissions from other processing of natural gas
    - Emissions from gas processing point to remove liquids
    - Emissions from extracted liquids
    - Emissions from electricity production
- 8c. Describe method for allocating emissions between crude oil and natural gas production
- 8d. Emissions for other extraction/production by/co-products are accounted for (Y or N)
- 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.).
  - 9b. For internationally transported crude, specify whether domestic, international, or total transport emissions are accounted for.
    - Describe use of country-specific parameters in calculating transport emissions.
  - 9c. Fugitive emissions during transport are accounted for (Y or N)
  - 9d. Return journeys of transport fleet are accounted for (Y or N)
  - 9e. The production/transport system involves liquified natural gas (Y or N)
  - 9f. Emissions from the regasification plant are accounted for (Y or N)
  
10. Refinery emissions are accounted for (Y or N)
  - 10a. Describe assumptions on refinery characteristics (e.g., existing, typical, local average)
  - 10b. Describe method for calculating direct refinery emissions
  - 10c. Emissions embodied in chemicals (catalysts, solvents, etc.) are accounted for (Y or N)
    - If yes, describe method.
  - 10d. Fugitive emissions accounted for (Y or N)
    - If yes, describe method.
  - 10e. Emissions for hydrogen production are accounted for (Y or N)
    - If yes, specify the production process.
  - 10f. Emissions for purchased and generated electricity are accounted for (Y or N)
    - If yes, specify electricity mix of the purchased electricity
  - 10g. Emissions from wastes and leakages are accounted for (Y or N)
    - If yes, describe method
  - 10h. Emissions for refinery by-products and co-products are accounted for (Y or N)
    - 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)

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)

(please consider consistency with Step 9)

If no:

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

If yes:

12b: Please explain how equivalency with the biofuel system is defined.

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

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

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

12d: Tailpipe gas is addressed (Y or N). If yes, describe methodology.

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)

8b: What type of fossil fuel is assumed to be replaced by the biofuel system?

Explain the assumption.

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.