THE GBEP COMMON METHODOLOGICAL FRAMEWORK FOR GHG LIFECYCLE ANALYSIS OF BIOENERGY

VERSION ZERO

GBEP
Global Bioenergy Partnership

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Version Zero

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Dear Colleagues,

Biofuels have the potential to make a host of highly significant contributions to sustainable development around the world. One reason for pursuing increased use of biofuels worldwide is their potential to reduce greenhouse gas (GHG) emissions compared to the fossil fuels they would replace. Numerous studies have been performed worldwide on biofuels looking at this issue with differing results, strongly depending on the assumptions made for the calculations. In order to improve the acceptance of the results and foster transparency, GBEP's Task Force on GHG Methodologies developed the present "Version Zero" of a common methodological framework that could be applied to the lifecycle analysis (LCA) of bioenergy production and use as compared to the full lifecycle of its fossil fuel equivalent.

It is a flexible "checklist" framework intended to provide a reference of pertinent questions for countries and institutions to compare the various existing methodologies dedicated to assessing GHG emissions of bioenergy systems in a transparent way. This in turn will indicate where discrepancies in reported GHG emissions could have arisen from methodological differences and hence a fair comparison is not possible. The framework has been developed for several potential applications including governments that have implemented GHG emissions standards for biofuels and could thus present their methods in a manner that is transparent and intelligible to all stakeholders. The framework can also be applied by biofuels producers and manufacturers of products that use biofuels in order to support claims of GHG reductions relative to fossil fuels. Non-government organizations and roundtables can also make use of it to evaluate GHG reductions included in their sustainability analyses of biofuels.

Nevertheless we fully expect that the present "Version Zero" will be informed and improved by user experience. We encourage biofuels producers, industry groups, and regulatory bodies to utilize the framework in reporting biofuels LCA and to provide comments and feedbacks on points requiring clarification or modification.

We are confident that a common methodological framework for bioenergy GHG LCA will be a useful tool, as it will allow for more effective communication of results of GHG studies by providing transparency regarding the assumptions that have gone into the calculations. This is fundamental for the assessment of bioenergy's contribution to climate change mitigation and related policy decisions and regulations.

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Acknowledgements

In October 2007, the Global Bioenergy Partnership (GBEP) established the GBEP Task Force on GHG Methodologies under the joint leadership of the United States of America and the UN Foundation to develop a common methodological framework to assist policymakers and stakeholders when assessing GHG emissions associated with bioenergy and to make GHG lifecycle analyses more transparent.

The lead authors of this Report are Melinda Kimble, Drew Nelson and Ben Zaitchik as Task Force leaders, with valuable contribution of the Task Force sub-group leaders - Jan Lewandrowski (USA), Ewout Deurwaarder (European Commission), Horst Fehrenbach (Germany) and José Domingos Gonzalez Miguez (Brazil) - and support of the GBEP Secretariat (Maria Michela Morese, Roberta Ianna, Jonathan Reeves and Alessandro Flammini).

GBEP would also like to express its appreciation to all the experts that actively and generously contributed to the creation of this methodological framework that aims to become an effective tool for defining and analyzing all the factors to be taken into consideration when assessing GHG emissions associated with bioenergy production, conversion and use as compared with use of fossil fuels.

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Acronyms

BAU Business-as-usual

CHP Combined Heat and Power

EC European Commission

EEA European Environment Agency

EUBIA European Biomass Industry Association

FAO Food and Agriculture Organization of the United Nations

GBEP Global Bioenergy Partnership

GHG Greenhouse Gas

IEA International Energy Agency

IFAD International Fund for Agricultural Development

IPCC SAR Intergovernmental Panel on Climate Change - Second Assessment Report

LCA Lifecycle Analysis

R,D&D Research, Development and Demonstration

UNDESA United Nations Department of Economic and Social Affairs

UNDP United Nations Development Programme

UNEP United Nations Environment Programme

UNCTAD United Nations Conference on Trade and Development

UNIDO United Nations Industrial Development Organization

WBCSD World Business Council on Sustainable Development

WCRE World Council for Renewable Energy

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The GBEP Task Force on GHG Methodologies

Background

The Global Bioenergy Partnership (GBEP) builds its activities upon three strategic areas: Sustainable Development, Climate Change, and Food and Energy Security. It is a forum where national governments and organizations seek to facilitate effective policy frameworks and suggest rules and tools to promote sustainable bioenergy development through voluntary cooperation.

It also aims to identify ways and means to support investments, to contribute to remove barriers to collaborative project development and implementation, and to foster bioenergy related RD&D activities and commercial bioenergy activities.

GBEP was established to implement the commitments taken by the G8 in the 2005 Gleneagles Plan of Action to support "biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent." The G8 Hokkaido Toyako Summit invited GBEP to "work with other relevant stakeholders to develop science-based benchmarks and indicators for biofuel production and use". (G8 Summit Declaration - Hokkaido Toyako, 8 July 2008).

GBEP Partners now include the following countries and organizations: Brazil, Canada, China, Fiji Islands, France, Germany, Italy, Japan, Mexico, Netherlands, Russian Federation, Spain, Sudan, Sweden, Switzerland, Tanzania, United Kingdom, United States of America, FAO, IEA, UNCTAD, UN/DESA, UNDP, UNEP, UNIDO, UN Foundation, World Council for Renewable Energy (WCRE) and European Biomass Industry Association (EUBIA).

Angola, Argentina, Austria, Colombia, Gambia, Ghana, India, Indonesia, Israel, Kenya, Madagascar, Malaysia, Mauritania, Morocco, Mozambique, Norway, Peru, Rwanda, South Africa, Tunisia, European Commission, European Environment Agency (EEA), International Fund for Agricultural Development (IFAD), the World Bank and the World Business Council on Sustainable Development (WBCSD) are participating as Observers. The Partnership is currently chaired by Corrado Clini, Director General, Ministry for the Environment Land and Sea, Italy and co- chaired by André Aranha Corrêa do Lago, Director, Ministry of External Relations, Brazil.

In line with GBEP's Terms of Reference and the state of the international debate on bioenergy, a Task Force on GHG Methodologies was established under the leadership of the United States of America, co-chaired by United Nations Foundation, to analyse the full lifecycle of transport biofuels and solid biomass, and to develop a harmonized methodological framework for the use of policy makers and stakeholders when assessing GHG impacts by which the methodologies of GHG lifecycle assessments could be compared on an equivalent and consistent basis.

Four subgroups were formed to address components of the methodological framework that the Task Force recognized needed further discussion, which are: Land Use Change and Feedstock Production (subgroup led by United States of America), Biomass Processing (subgroup led by the European Commission (EC), Fuel Transportation and Use (subgroup led by Germany) and Biofuel Usage Compared to Fossil Fuels (subgroup led by Brazil).

The goal of the methodological framework is to provide a reference of pertinent questions for countries/institutions to ask when seeking to develop a methodology. Although the answers may differ, the Task Force recognized that having a commonly agreed set of questions will increase transparency and facilitate comparison amongst methodologies. The need to incorporate solid biomass fuel concerns into the framework was also recognized.

The GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy

Introduction

A key benefit of bioenergy for transport and for stationary heat and electricity generation is its potential to reduce greenhouse gas (GHG) emissions relative to replaced fossil fuels. This reduction can be difficult to calculate, given the diverse and complex production and use systems for bioenergy and for the fossil fuels they replace. In order to facilitate emissions comparisons between different bioenergy production systems relative to fossil fuels, the Task Force on GHG Methodologies of the Global Bioenergy Partnership has produced a draft methodological framework intended to be appropriate for use in the lifecycle analysis (LCA) of bioenergy production and use. The framework is intended to provide a template for LCA that is transparent and that can be applied to a wide range of bioenergy systems. It does not set data standards and does not specify particular emissions models. The goal of the framework is to ensure that countries and organizations can evaluate GHG emissions associated with bioenergy in a consistent manner, using methods appropriate to their circumstances, conditions and systems of production. Furthermore, the framework enables a multi-tiered approach to be taken to the analysis of GHG emissions depending on the level of sophistication employed in the production of the biofuel and the data available.

The framework consists of 10 “Steps” of analysis. Steps 1 and 2 are simple checkboxes in which the user identifies the GHGs included in the LCA and the source of the biomass feedstock. In cases that the feedstock is waste material, further explanation is requested. Steps 3-9 walk through a full LCA appropriate for bioenergy production and use, including emissions due to land use change, biomass feedstock production, co-products and by-products, transport of biomass, processing into fuel, transport of fuel, and fuel use. For each Step the framework presents a series of yes/no questions and checkboxes, with requests for further explanation where appropriate. Step 10 is the comparison with replaced fuel. In this Step the framework includes options for reporting LCA of fossil transport fuels and LCA of stationary heat and electricity production systems.

The methodological framework is intended to be a practical product for the end user. For this reason it was necessary to strike a balance between inclusive detail and ease of application. At each stage participating authors worked to maximize clarity and flexibility. That said, we fully expect that the framework will be informed and improved by user experience. We encourage biofuels producers, industry groups, and regulatory bodies to utilize the framework in reporting biofuels LCA and to provide comment on points requiring clarification or modification. We are confident that a common framework for bioenergy LCA is useful in principle, as it will allow for more effective communication of LCA results. The utility of the common framework presented in this report, however, depends entirely on the degree to which prospective users adopt it and inform further development.

Rationale for a Common Methodological Framework

In approaching the challenge of LCA for bioenergy, the GBEP Task Force on GHG Methodologies considered a number of options. At its first meeting, the Task Force heard presentations from a number of LCA experts on the merits, opportunities, and limitations of various LCA models and data analysis techniques. These presentations clearly demonstrated that the biofuels community utilizes a wide range of LCA techniques, and that these techniques evolve in response to new data and new bioenergy technologies. While there is considerable overlap in guiding principles and in some methodologies, the diversity of bioenergy production systems and the range of policy opinions on what constitutes a "complete" LCA preclude the possibility of applying a single technique to all bioenergy systems, world-wide.

Recognizing this fact, the Task Force determined that GBEP's most useful contribution to biofuels LCA would be to provide a common framework for LCA reporting, rather than developing a common methodology. The framework allows for a comparison of existing LCA employed by independent scientists, industrial groups, and technical agencies, and provides a reference for the development of future analyses. The trade-off for this flexibility is that the framework is not, in itself, an LCA model. It is expected that the user will draw on the various LCA techniques most appropriate for their specific application and then use the GBEP framework to communicate the details of their technique in a consistent manner. By facilitating this communication, the framework fills an essential role for all stakeholders interested in transparent evaluation of GHG emissions associated with bioenergy.

The framework has many potential applications. For example, it could be used by governments that have implemented GHG emissions standards for biofuels, in order to present their methods in a manner that is transparent and intelligible to all stakeholders. The framework can also be applied by biofuels producers and manufacturers of products that use biofuels in order to support claims of GHG reductions relative to fossil fuels. Non-government organizations and roundtables can also make use of the framework to evaluate GHG reductions included in their voluntary sustainability analyses of biofuels.

Scope of the Framework

In developing the common methodological framework, the Task Force on GHG Methodologies decided that the framework should be designed to apply to all bioenergy systems, and not just the liquid transport fuels that presently dominate renewable fuels standards in developed countries. This decision complicated the work of the Task Force to some degree, given the diversity of bioenergy production and use and the variety of fossil energy sources that this bioenergy displaces. Nonetheless, the present-day use of bioenergy for heat and power production, along with the considerable potential to expand these stationary uses of bioenergy in both the developing and the developed world, argued for their inclusion in the framework.

A second important scope question arose with regard to the treatment of emissions due to land use change. There is a range of opinions on the matter of including land use change emissions in LCA of bioenergy systems. Some scientists and policy makers feel that it is necessary to count emissions due to both direct and indirect land use change attributable to bioenergy production. Within this paradigm, some argue that indirect land use calculations should include market-based models that estimate international indirect land use change, while others prefer to constrain the analysis to domestic land use change. At the same time, a number of experts feel that models linking bioenergy production to indirect land use change are too uncertain for policy applications, that they tend to over-estimate land use change due to bioenergy, or that there is a risk of double-counting land use change when both direct and indirect effects are included. Given the state of discussion on the topic of land use change, it was decided that the framework should include options for reporting direct land use change or indirect land use change or a combination of both, and that within indirect land use change, domestic and international methodologies would be reported in separate sections. This approach is consistent with the effort to maximize completeness and transparency in the framework without specifying methodology.

Finally, members of the Task Force recognized that it would be impossible for the framework to anticipate all LCA methodologies or to specifically solicit full information on system boundaries. For this reason, users are invited to "clarify assumptions" for several Steps of the framework. These clarifications will provide needed information on methodologies and system boundaries. If it is found that certain critical clarifications appear repeatedly in framework applications then the framework can be updated to capture those assumptions more efficiently.

The full common methodological framework is presented in Section 2 of this report. Details on rationale and guidance are provided at the beginning of each Step of the framework.

Overview of the Framework

1. GHGs covered
2. Source of biomass
3. Land use changes due to bioenergy production
4. Biomass feedstock production on farms and in forests
5. Transport of biomass
6. Processing into fuel
7. By-products and co-products
8. Transport of fuel
9. Fuel Use
10. Comparison with replaced fuel

The Methodological Framework

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_2 ____

CH_4 ____

N_2O ____

HFCs ____

PFCs ____

SF_6 ____

Other __________

Please report global warming potential used for each GHG covered.

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 __

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: ____

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.

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 defendable 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)

___ Business-as-Usual (BAU) 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 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

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

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

Accounted for net changes of carbon stocks in:[1]

___ living biomass, ___ dead organic matter, ___ soils

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

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[1] 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.

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 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.

____ 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[2]:

___ 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)

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)

[2] 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.

- 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[3]:

___ 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)

[3] 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_2 emissions from lime/dolomite applications

___ N_2O emissions resulting from the application of nitrogen fertilizers:

__direct; __volatilization; __runoff/leaching

___ CH_4 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)[4]

___ Other (please specify)

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)

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)

[4] 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)

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).

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)

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

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): ____________________

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: ___

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 actual 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: ____________________________________

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

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. ___ 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 the processing plant to the use site is dedicated to this purpose. (Y or N)

    If Yes:

    3a. ___ 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.

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

    ___ 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_2 replacing fossil fuel and therefore fossil CO_2 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)

    1b. Electric efficiency of the use process ________

    1c. Thermal efficiency of the use process ________

    1d. Electricity sent to a general grid (Y or N)

    1e. In case of CHP, indicate method used to account for electricity and heat (i.e., allocation, substitution, etc.), as in LCA Step 7.

2. Specific emissions are addressed by the usage (Y or N)

    2a. Identify conversion/combustion technology

3. The technique specifically causes significant non-CO_2 emissions of:

    ___ N_2O (e.g. CFB-type boilers)

    ___ CH_4 (e.g. low level technique or small-scale)

    ___ 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)

    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)

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). If yes, describe methodology:

e.g.: CO_2 emissions associated with combustion source and feedstock sink are netted out; CH_4 and N_2O 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_2 ____

   CH_4 ____

   N_2O ____

   HFCs ____

   PFCs ____

   SF_6 ____

   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.

In line with GBEP's Terms of Reference and the state of the international debate on bioenergy, a Task Force on GHG Methodologies was established under the leadership of the United States of America, co-chaired by United Nations Foundation, to analyse the full lifecycle of transport biofuels and solid biomass, and to develop a common methodological framework for the use of policy makers and stakeholders when assessing GHG impacts by which the methodologies of GHG lifecycle assessments could be compared on an equivalent and consistent basis.

Four subgroups were formed to address components of the methodological framework that the Task Force recognized needed further discussion, which are: Land Use Change and Feedstock Production, Biomass Processing, Fuel Transportation and Use and Biofuel Usage Compared to Fossil Fuels.

The goal of the methodological framework is to provide a reference of pertinent questions for countries/institutions to ask when seeking to develop a methodology. Although the answers may differ, the Task Force recognized that having a commonly agreed set of questions will increase transparency and facilitate comparison amongst methodologies. The need to incorporate solid biomass fuel concerns into the framework was also recognized.

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