CLEAN DEVELOPMENT MECHANISM

CDM-MP87-A05

Draft Methodological tool

TOOL16: Project and leakage emissions from biomass

Version 06.0

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board), at its 110th meeting, considered the draft revised “Glossary: CDM terms” that contained revised definition of "renewable biomass" and introduced definitions of new terms associated with market penetration of technology/measure, and requested the Methodologies Panel (MP) to analyze the existing approved methodologies and methodological tools with regard to the consistency in the use of these terms and related guidance, and to recommend revision to the methodologies and tools, as appropriate, based on the analysis.

2. The Methodologies Panel, at its 86th meeting, proposed a draft revised version of the “TOOL16: Project and leakage emissions from biomass” considering the impacts of the revised definition of biomass, and launched a call for public inputs. No comments were received.

2. Purpose

3. The purpose is to update the methodological tool “TOOL16: Project and leakage emissions form biomass” to include a comprehensive approach to determine project emissions form the utilization of biomass. With that done, individual methodologies could draw on the elements of the tool by citing the tool (e.g. including some sources of emissions but not all, depending on the end use and technology/measure).

3. Key issues and proposed solutions

4. In the current version of the tool, project emissions are determined based on emissions associated with the cultivation of biomass (land use and transportation) and use of biomass residues (energy consumption to process the biomass residues and transportation), including guidance and equations. In the proposed revision, the emission sources are further elaborated by means of streamlining the requirements, adding missing emission sources, adding additional guidance and equations and making consistent reference to parameters that are common to other methodologies and tools. Non-binding best practice examples were also added for better understanding of the requirements.

5. The proposed revision also includes alternative approaches to determine emissions from the transportation of biomass, from the transportation of biomass residues and approaches and options to determine emissions due to the use of aditives in the processing of biomass residues.

6. The calculation of some parameters was revised taking into account updated default values from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gases Inventories.

4. Impacts

7. The revision of the methodological tool, if approved, will provide clarity to stakeholders on the emission sources that may need to be included in the calculation of project emissions from projects involving the use of biomass or biomass residues for large-scale, small-scale and micro-scale CDM project activities.

5. Subsequent work and timelines

8. The MP, at its 87th meeting, agreed to seek public inputs on the draft revised methodological tool. Inputs received, if any, will be discussed with the MP and forwarded to the Board for its consideration together with this document. No further work is envisaged.

6. Recommendations to the Board

9. The MP recommends that the Board approve the revision of the tool, to be made effective at the time of the Board’s approval.

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1. Introduction

1. This tool provides procedures to calculate project and leakage emissions relevant for project activities which utilise biomass cultivated in dedicated plantations and/or biomass residues. The biomass and/or biomass residues~~. The biomass~~ may be used as either fuel or feedstock in the project activity~~. The biomass may be biomass residues or cultivated in a dedicated plantation~~.

Table 1. Parameters determined

Parameter	Unit	Description
$PE_{BC,y}$	tCO_2e	Project emissions resulting from cultivation of biomass in a dedicated plantation~~,~~ in year *y* (Section 5.1)
$PE_{BP,y}$	tCO_2e	Project emissions resulting from processing of biomass from a dedicated plantation in year *y* (Section 5.3)
$PE_{BT,y}$	tCO_2e	Project emissions resulting from transportation of biomass in year *y* (Section 5.2)
PE_{BRP}~~$PE_{BR,y}$~~	tCO_2e	Project emissions resulting from processing~~utilization~~ of biomass residues~~,~~ in year *y* (Section 5.3~~6~~)
$PE_{BRT,y}$	tCO_2e	Project emissions resulting from transportation of biomass residues in year *y* (Section 5.2)
$LE_{BC,y}$	tCO_2e	Leakage emissions due to shift of pre-project activities resulting from cultivation of biomass in a dedicated plantation~~,~~ in year *y* (Section 6.1~~7~~)
$LE_{BR,Div,y}$	tCO_2e	Leakage emissions due to diversion of biomass residues from other applications~~,~~ in year *y* (Section 6.2~~8~~)
$LE_{BRP,y}$	tCO_2e	Leakage emissions due to processing and transportation of biomass residues outside the project boundary in year *y* (Section 6.3)

2. Scope, applicability, and entry into force

2.1. Scope

2. This tool can be used for estimation of the following project emission sources (also illustrated in indicated in Figure 1):

(a) Project ~~and leakage~~ emissions resulting from the cultivation of biomass in a dedicated plantation of a CDM project activity that uses biomass ($PE_{BC,y}$);~~.~~

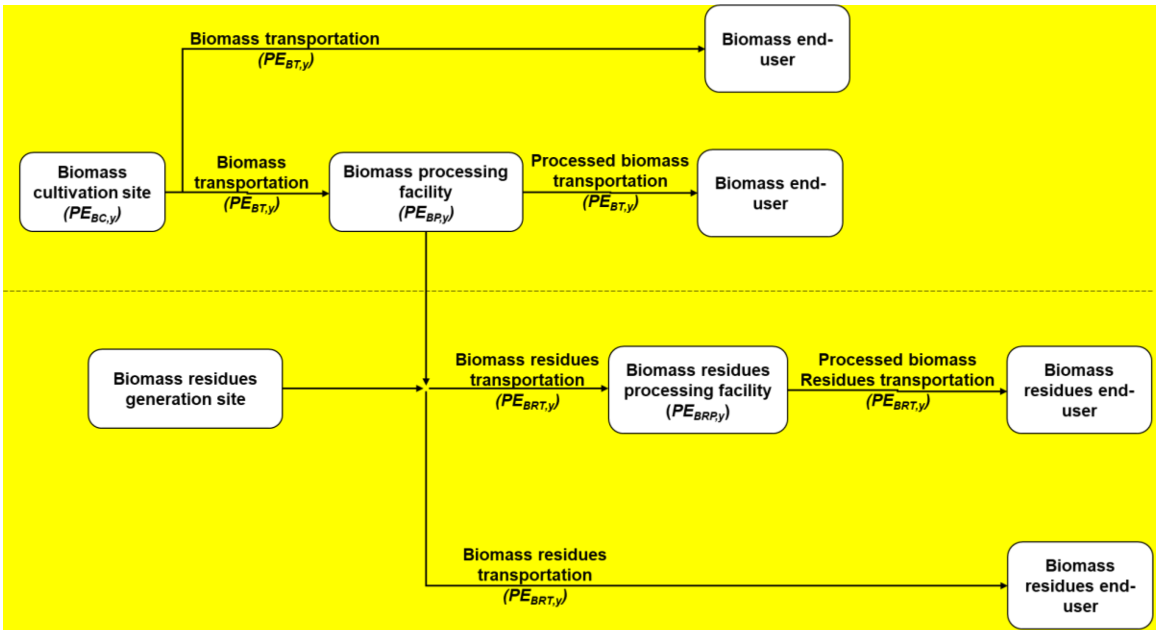
(b) ~~This tool also includes approaches for identifying and estimating project and leakage~~ Project emissions resulting from the transportation of biomass ($PE_{BT,y}$);

(c) Project emissions resulting from the processing of biomass ($PE_{BP,y}$);

(d) Project emissions resulting from the transportation of~~project activities that utilise~~ biomass residues ($PE_{BRT,y}$);~~.~~

(e) Project emissions resulting from the processing of biomass residues ($PE_{BRP,y}$);

Figure 1. Illustration of project emission sources included in the tool



3. The tool provides methods for estimating emissions along the value chain of biomass and biomass residues. The methodology applied to the project activity shall indicate which of the emission sources listed above are to be included or omitted in the calculation of project emissions.

Box 1. Non-binding best practice example 1: consideration of project emission sources from a project involving the use of wood briquettes to produce power

A project activity consumes wood briquette to generate power. In order to determine which project emission sources shall be included, the project participant shall determine how the wood briquettes are produced.

By conducting a due diligence of the wood briquette manufacturing process, the project participants identify that:

(a) The wood briquettes are produced in a briquette production facility that consumes sawmill dust as raw-material;

(b) The sawmill dust is a by-product, or a residue, from a wood board manufacturing facility, and the wood boards produced are transported to a construction materials retailer;

(c) The wood board manufacturing facility consumes wood from a specific and dedicated plantation;

(d) The wood board manufacturing facility provided the transportation route to wood cultivation site → wood board manufacturing facility (for the transportation of wood);

(e) The briquette production facility provided the following transportation routes: wood board manufacturing facility → briquette production facility (for the transportation of the sawmill dust);

Briquette production facility → Project plant (for the transportation of the wood briquettes)

Based on the findings from the due diligence, the following definitions from Figure 1 were applied:

- Biomass = wood;
- Biomass processing facility = wood board manufacturing facility;
- Processed biomass = wood boards;
- Processed biomass final users = construction material retailer;
- Biomass residues = sawmill dust;
- Biomass residues processing facility = wood briquette production facility;
- Processed biomass residues = wood briquette;
- Processed biomass residues end-user = project plant

Therefore, project participants shall account for the following emissions sources:

- $PE_{BC,y}$;
- $PE_{BT,y}$ for the transportation route biomass cultivation site → biomass processing facility;
- $PE_{BP,y}$ for the processing biomass (wood into wood boards);
- $PE_{BRT,y}$ for the transportation routes biomass processing facility → biomass residues processing facility → biomass residues end-user;
- $PE_{BRP,y}$ for the processing of biomass residues (sawmill dust into wood briquettes).

Box 2. Non-binding best practice example 2: consideration of project emission sources from a project involving the use of sugar-cane bagasse

A project activity consumes sugar-cane bagasse to generate power. In order to determine which project emission sources shall be included, the project participant shall determine how the bagasse is produced.

By conducting a due diligence of the bagasse production process, the project participants identify that:

(a) The bagasse is produced in the sugar-cane mill and is a by-product, or a residue, from the grinding of sugar-cane in a sugar mill;

(b) The sugar-cane is cultivated in a specific and dedicated plantation;

(c) The sugar mill provided the transportation route sugar-cane cultivation site → sugar mill (for the transportation of sugar cane);

(d) The bagasse is utilized to generate power inside the sugar mill as it is produced, meaning it does not have to be further transported nor processed.

Based on the findings from the due diligence, the following definitions from Figure 1 were applied:

- Biomass = sugar-cane;
- Biomass processing facility = sugar-mill;
- Processed biomass = sugar;
- Biomass residues = bagasse;
- Biomass residues processing facility = N/A (no processing of bagasse takes place);
- Processed biomass residues = N/A (no processing of bagasse takes place);
- Processed biomass residues end-user = project plant

Therefore, project participants shall account for the following emissions sources:

- $PE_{BC,y}$;
- $PE_{BT,y}$ for the transportation route biomass cultivation site → biomass processing facility;
- $PE_{BP,y}$ for the processing biomass (wood into wood boards);

4. This tool can also be used to account for the leakage sources listed below:

(a) Leakage due to diversion of biomass residues from other applications, if biomass residues utilized by the project are diverted from another utilization such as fuel or feedstock ($LE_{BR,Div,y}$);

(b) Leakage due to the shift of land-use activities prior to the implementation of the project activity ($LE_{BC,y}$);

(c) Leakage due to the transportation of biomass residues, if they are not included in the project boundary ($LE_{BRT,y}$);

(d) Leakage due to the processing of biomass residues, if they are not included in the project boundary ($LE_{BRP,y}$).

5. Unless the methodology's procedures allow it, only positive leakage, i.e. increased emissions outside the project boundary are allowed by this tool. If the biomass production or utilization results in any reduction of greenhouse gas (GHG) emissions outside the project boundary, they will not be accounted for.

~~6. The tool does not calculate methane emissions from anaerobic decomposition of biomass, for example in stockpiles or wastewater.~~

2.2. Applicability

7. This tool shall be applied in conjunction with the methodology applied to the CDM project activity that allows the application of the tool.

~~8.~~ For CDM project activities which include biomass cultivation, project participant shall demonstrate that the~~:~~

9. ~~The~~ Land in which biomass is cultivated:

(a) Does not contain wetlands,~~;~~

(b) Does not contain organic soils as defined in paragraph 16(b),~~);~~

(c) Is not subject~~subjected~~ to flood irrigation;~~.~~

~~(d) The land in which biomass is cultivated:~~

~~(e)~~ Does not contain forest nor contained forest since 31 December 1989, otherwise~~; or~~

~~(f) Contains a forest plantation that before the start of the project will be harvested and the land would be neither reforested nor will regenerate on its own into a forest in the absence of the project activity.~~

~~(g) Desalination is not a substantial source of water in the host country.~~

(h) ~~In case the land contains a forest plantation,~~ the project ~~proponent~~ shall demonstrate and document transparently in the CDM-PDD that:

(i) Any existing forest plantation will be harvested before the start of the project activity, and the land would~~plantation will~~ be neither reforested nor regenerated~~finally harvested and regeneration~~ to forestland (according to the respective national definition) on its own in the absence of~~will not take place. In doing so,~~ the project activity;~~proponent shall:~~

10. To demonstrate the compliance with the sub-paragraph above, the project participants shall:

(a) Identify~~Identify~~ realistic and credible alternatives with regard to the possible land use scenarios that would occur in the absence of the project activity, including but not limited to (i) ~~The~~ the forest plantation continues under the current management practice, (ii) ~~The~~ the forest plantation is harvested and the land is replanted, (iii) ~~The~~ the forest plantation is harvested and the land is abandoned.

(b) Assess the economic attractiveness of the existing forest plantation by applying Step 2 of the latest approved version of the "TOOL01: Tool for the demonstration and assessment of additionality";

(c) Confirm, based on the plantation management practices in the region for the considered species, that the situation referred to in paragraph 6 (b) (ii) is the common practice; and

(d) Use relevant credible evidence, including but not limited to official land use maps, satellite images/aerial photographs, cadastral information, official land use records.

11. In addition, project participants shall demonstrate that desalination is not a substantial source of water in the host country.

12. The tool is also applicable if biomass residues are consumed in a CDM project activity, and the biomass residues can be utilized after processing or without processing. These could be:

(a) Procured by the project proponents; or

(b) The result of an agro-industrial process under the control of the project proponents.

2.3. Entry into force

13. The date of entry into force is the date of the publication of the EB XX meeting report on DD Month YYYY.

3. Normative references

14. This tool refers to the following documents:

(a) “TOOL01: Tool for the demonstration and assessment of additionality” (hereinafter referred as “TOOL01”);

(b) “TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (hereinafter referred as “TOOL03”);~~”;~~

(c) “TOOL04: Emissions from solid waste disposal site” (hereinafter referred as “TOOL04”)

(d) “TOOL05: ~~“~~Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (hereinafter referred as “TOOL05”);~~”;~~

(e) “TOOL08: Determining the baseline efficiency of thermal or electric energy generation systems" (hereinafter referred as “TOOL08”);

(f) “TOOL12: Project and leakage emissions from transportation of freight” (hereinafter referred as “TOOL12”);~~”.~~

(g) “TOOL13: Project and leakage emissions from composting” (hereinafter referred as “TOOL13”);

(h) “TOOL14: Project and leakage emissions from anaerobic digesters” (hereinafter referred as “TOOL14”).

4. Definitions

15. The definitions contained in the Glossary of CDM terms shall apply.

16. For the purpose of this tool, the following definitions apply:

(a) **Indirect land use change** - is land-use change that may be induced on land areas not included in the project boundary as a result of shifting of pre-project activities;

(b) **Organic soil**[1] - soils are organic if they satisfy the requirements (i) and (ii), or (i) and (iii) below:

(i) Thickness of 10 cm or more. A horizon less than 20 cm thick must have 12 per cent or more organic carbon when mixed to a depth of 20 cm;

(ii) If the soil is never saturated with water for more than a few days, and contains more than 20 per cent (by weight) organic carbon (about 35 per cent organic matter);

(iii) If the soil is subject to water saturation episodes and has either:

a. At least 12 per cent (by weight) organic carbon (about 20 per cent organic matter) if it has no clay; or

b. At least 18 per cent (by weight) organic carbon (about 30 per cent organic matter) if it has 60 per cent or more clay; or

c. An intermediate, proportional amount of organic carbon for intermediate amounts of clay;

(c) **Pre-project activities** - the land use prior to the implementation of the project activity, considering both land use practices and the primary and final products of the practices. This includes, for example, grazing, cultivation of crops, agroforestry, collection of biomass;

(d) **Project region** – area within a radius of 250km around the project activity;

(e) **Stratum** - area of land with uniform properties;

(f) **Wetland**[2] - this category includes land that is covered or saturated by water for all or part of the year (e.g. peatland) and that does not fall into the forest land, cropland, grassland or settlements categories. This category can be subdivided into managed and unmanaged according to national definitions. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions;

5. Project emissions

17. Project emissions involve emissions associated with the cultivation of biomass, transportation of biomass, processing of biomass, transportation of biomass residues and processing of biomass residues.

[1] As defined in “Annex A: Glossary” of the 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry.

[2] As defined in “Annex A: Glossary” of the 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry.

5.1. Project emissions from cultivation of biomass ($PE_{BC,y}$)

18. Project emissions resulting from cultivation of biomass in a dedicated plantation are estimated as follows:

$$PE_{BC,y} = PE_{SOC,y} + PE_{SM,y} + PE_{BSH,EC,y} PE_{EC,y} + PE_{BB,y} + PE_{TR,y}$$ Equation (1)

Where:

$PE_{SOC,y}$	=	Emissions resulting from loss of soil organic carbon, in year y (tCO_2et CO2e)
$PE_{SM,y}$	=	Emissions resulting from soil management, in year *y* (tCO_2et CO2e)
$PE_{BSH,EC,y}$ $PE_{EC,y}$	=	Emissions resulting from energy consumption (electricity and fuel) for biomass seeding and harvesting, in year *y* ($t\ CO_2e$)
PE_{BBy}	=	Emissions resulting from clearance or burning of biomass, in year *y* ($t\ CO_2e$)
$PE_{TR,y}$	=	Emissions resulting from transport of biomass, in year y (t CO2e)

19. Biomass originating from land areas included in registered afforestation/reforestation (A/R) project activities may be considered to have no project emissions, provided that the emission reductions from the A/R project activity have been verified and issued for the time period in which the biomass was harvested.

5.1.1. Emissions resulting from loss of soil organic carbon

20. To estimate emissions resulting from loss of soil organic carbon, the areas of land are stratified according to:

(a) Climate region and soil types given in Table 1 in appendix 1;

(b) Land-use and land management activities on croplands given in Tables 2 and 3 in appendix 1; and

(c) Land-use and land management activities on grasslands given in Table 4 in appendix 1. These apply also to abandoned land.

21. For each stratum of the areas of land which is subjected to soil disturbance attributable to project activity and for which the total area disturbed is less than 10% of the area of the stratum, emissions resulting from loss of soil organic carbon may be accounted as zero.

22. Subject to the provision of the paragraph 16 21 above, emissions resulting from loss of soil organic carbon are estimated as follows:

$$PE_{SOC,y} = \max\left(\frac{44}{12} \times \frac{1.156179}{T} \times \sum_i \Delta SOC_i , 0\right)$$ Equation (2)

Where:

$PE_{SOC,y}$	=	Emissions resulting from loss of soil organic carbon, in year *y* ($t\ CO_2e$)
T	=	Length of the first crediting period of the project in years (7 or 10)

ΔSOC_i	=	Loss of soil organic carbon in land stratum *i*, (t C)
$\frac{44}{12}$	=	Factor for converting units from t C to t CO_2e; dimensionless
1.~~156~~179	=	Factor to account for soil N_2O emissions associated with loss of soil organic carbon,[3] dimensionless
i	=	Strata of areas of land

23. Loss of soil organic carbon in a stratum is estimated as follows:

$$\Delta SOC_i = 1.21 \times A_{SOC,i} \times SOC_{REF,i} \times (f_{LUB,i} \times f_{MGB,i} \times f_{INB,i} - f_{LUP,i} \times f_{MGP,i} \times f_{INP,i})$$ Equation (3)

Where:

ΔSOC_i	=	Loss of soil organic carbon in land stratum *i*, (t C)
$A_{SOC,i}$	=	Area of land stratum *i*; (ha)
$SOC_{REF,i}$	=	Reference SOC stock applicable to land stratum *i*, (t C/ha)
$f_{LUB,i}$	=	Relative stock change factor for land-use in the baseline in stratum *i*
$f_{MGB,i}$	=	Relative stock change factor for land management in the baseline in stratum *i*
$f_{INB,i}$	=	Relative stock change factor for input in the baseline in stratum *i*
$f_{LUP,i}$	=	Relative stock change factor for land-use in the project in stratum *i*
$f_{MGP,i}$	=	Relative stock change factor for land management in the project in stratum *i*
$f_{INP,i}$	=	Relative stock change factor for input in the project in stratum *i*
i	=	Strata of areas of land
1.21	=	Conservativeness factor accounting for the uncertainties in the values in Tables 2-4 in appendix 1[4]

24. The values of relative stock change factors shall be determined according to Tables 2–4 in appendix 1 of this tool.[5]

25. After the first crediting period of the project, the value of $PE_{SOC,y}$ shall be 0.

[3] Based on the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For details, see appendix 3.

[4] According to FCCC/SBSTA/2003/10/Add.2/6. For details, see appendix 3.

[5] Project proponents are encouraged to suggest revisions for this tool with alternative procedures (e.g. monitoring) to determine the relative stock change. Where the land contains a forest plantation in its last rotation in the baseline, or contains a forest plantation in the project activity, the relative stock change factors for land-use, land management and inputs each shall be assumed as 1.00, i.e. forest plantation is a reference scenario for the purpose of soil organic carbon.

5.1.2. Emissions resulting from soil management

26. Emissions resulting from soil management are estimated as follows:

$$PE_{SM,y} = PE_{SF,y} + PE_{SA,y}$$ Equation (4)

Where:

$PE_{SM,y}$	=	Emissions resulting from soil management, in year *y* (t CO_2e)
$PE_{SF,y}$	=	Emissions resulting from of soil fertilization and management, in year *y* (t CO_2e)
$PE_{SA,y}$	=	Emissions resulting from soil amendment, in year *y* (t CO_2e)

5.1.2.1. Emissions resulting from soil fertilization and management

27. Emissions resulting from soil fertilisation and management are estimated as follows:

$$PE_{SF,y} = q_{N,y} \times A_{FTM,y} \times EF_{FT}$$ Equation (5)

Where:

$PE_{SF,y}$	=	Emissions resulting from soil fertilization and management, in year *y* (t CO_2e)
$q_{N,y}$	=	Rate of nitrogen applied, in year *y* (t N/ha)
$A_{FTM,y}$	=	Area of land subjected to soil fertilization and management, in year *y* (ha)
EF_{FT}	=	Aggregate emission factor for N_2O and CO_2 emissions resulting from production and application of nitrogen (t CO_2e/(t N)). A default value of ~~13.3~~ 11.29 t CO_2e/(t N)[6] shall be used

5.1.2.2. Emissions resulting from soil amendment

28. Emissions resulting from soil amendment (liming) are estimated as follows:

$$PE_{SA,y} = \sum_{i} q_{SA,i,y} \times A_{SA,i,y} \times EF_{SA,i,y}$$ Equation (6)

Where:

$PE_{SA,y}$	=	Emissions resulting from soil amendment by liming, application of dolomite, urea or other carbon containing agent, in year *y* (t CO_2e)
$q_{SA.i,y}$	=	Rate of application of soil amendment agent type *i*, in year *y* (t/ha)
$A_{SA,i,y}$	=	Area of land in which soil amendment agent type *i* is applied, in year *y* (ha)

[6] Based on 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For details, see appendix 3.

$EF_{SA,i}$	=	Emission factor for CO_2 emissions from application of soil amendment agent type *i* (t CO_2e/t). Default values for limestone (0.12 t CO_2e/t)[7], dolomite (0.13 t CO_2e/t)[8] and urea (0.20 t CO_2e/t)[9] shall be used.

5.1.3. Emissions resulting from energy consumption for biomass seeding and harvesting

29. Emissions resulting from fuel and electricity consumption for biomass seeding and harvesting (e.g. fuel consumed by tractors and harvesters, and electricity consumed for irrigation water pumping) ~~energy consumption~~ are estimated, unless otherwise required in the relevant methodology, by the equation below:

$$PE_{BSH,EC,y} = PE_{BSH,electricity,y} + PE_{BSH,fuel,y} \qquad \text{Equation (7)}$$

Where:

$PE_{BSH,electricity,y}$	=	Project emissions from the consumption of electricity for biomass seeding and harvesting in year *y* (tCO_2e)
$PE_{BSH,fuel,y}$	=	Project emissions from the consumption of fossil fuels for biomass seeding and harvesting in year y (tCO_2e)

30. $PE_{BSH,electricity,y}$ and $PE_{BSH,fuel,y}$ are determined based on the provisions of the TOOL05 and TOOL03, respectively, where:

(a) The parameter $PE_{BSH,electricity,y}$ corresponds~~in the "Tool~~ to the parameter $PE_{EC,y}$ from the TOOL05;

(b) ~~calculate project or leakage CO2 emissions from fossil fuel combustion" and the tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". These emissions include emissions due~~ The parameter $PE_{BSH,fuel,y}$ corresponds to the parameter $PE_{FC,j,y}$ from the TOOL03.~~:~~

~~31. Biomass cultivation practices; and~~

~~32. Thermal and mechanical processing of the biomass.~~

33. Small scale project activities may, unless otherwise required by the methodology, neglect emissions from energy consumption associated with seeding and harvesting~~cultivation~~ of biomass.

5.1.4. Emissions resulting from clearance or burning of biomass

34. Emissions resulting from clearance or burning of biomass are estimated as follows:

$$PE_{BB,y} = \frac{44}{12} \times 0.47 \times \sum_{i} A_{FR,i,z} \times b_i \times (\sout{1.07}1.06 + R_i) \qquad \text{Equation (8)}$$

[7] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol 4, Ch 11, Eq 11.12.

[8] Ibid.

[9] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol 4, Ch 11, Eq 11.13.

Where:

$PE_{BB,y}$	=	Emissions resulting from clearance or burning of biomass, in year *y* (t CO_2e)
$\frac{44}{12}$	=	Factor for converting units from t C to t CO_2e; dimensionless
0.47	=	Default value of carbon fraction of biomass burnt;[10] dimensionless
~~1.07~~1.06	=	Factor to account for non-CO_2 emissions from biomass clearance or burning;[11] dimensionless. If biomass is cleared without using open fire, then this factor is set equal to 1 (one)
$A_{FR,i,y}$	=	Area of stratum *i* of land subjected to clearance or fire in year *y* (ha)
b_i	=	Fuel biomass consumption per hectare in stratum *i* of land subjected to clearance or fire (t dry matter/ha)
R_i	=	Root-shoot ratio (i.e. ratio of below-ground biomass to above-ground biomass) for stratum *i* of land subjected to clearance or fire; dimensionless
i	=	Strata of areas of land

5.2. Emissions resulting from transport of biomass ($PE_{BT,y}$) and biomass residues ($PE_{BRT,y}$)

35. Unless otherwise required in the relevant methodology, emissions resulting from transport of biomass and biomass residues are determined separately by following the provisions from the TOOL12, taking into account the following transport routes:

(a) For biomass:

(i) If the biomass produced is utilized without further processing, the route shall include only the transport of the biomass between the biomass production site and the biomass utilization facility;

(ii) If the biomass is processed before being utilized, the routes shall include the transport between (i) the biomass production site and the biomass processing facility, and (ii) the biomass processing facility and the biomass utilization facility;

(b) For biomass residues:

(i) If the biomass residues are consumed without further processing, the route shall include only the transport of the biomass residues between (i) the biomass processing facility or the biomass generation site and (ii) the biomass residues utilization facility;

(ii) If the biomass residues are processed before being utilized, the routes shall include the transport between (i) the biomass processing facility or the

[10] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol 4, Ch 4 Table 4.3.

[11] Based on the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. For details, see appendix 3.

biomass generation site and the biomass residues processing facility, and (ii) the biomass residues processing facility and the biomass residues utilization facility.

36. As an alternative to the monitoring of the parameters needed to calculate the emissions from the transportation, project proponents may apply the following options:

(a) For microscale project activities, these sources of emissions may be considered immaterial;

(b) For small-scale project activities these sources of emissions may be neglected if the transportation distance is less than 200 km;

(c) For large-scale project activities, apply a net-to-gross adjustment of 10%[12], i.e. multiply the emission reductions determined based on the applied methodology by 0.9 to determine the final amount of emission reductions that can be claimed.

~~37. Small scale project activities may, unless otherwise required by the methodology, may neglect this source of emissions if the transportation distance is less than 200 km. Micro scale project activities may, unless otherwise required by the methodology, consider this emission source inmaterial.~~

[12] Determined as the ratio between (i) the emissions to transport 1 ton of biomass and (ii) the emission reductions from the electricity generated by 1 ton of biomass, based on the following assumptions of a hypothetical project:

(a) The biomass is sourced from a distance of 200 km and the transport is made using heavy duty vehicles. These assumptions are conservative since:

(i) 100 km is observed in monitoring reports of registered CDM project activities as a typical distance of transport;

(ii) The transport of biomass is made using heavy duty vehicles, which is the vehicle type with the higher specific emission factor of the Data/Parameter table 1 from the TOOL12 (129 gCO_2/tkm);

(b) The type of biomass consumed is black liquor, the electricity is generated by a technology with 35% efficiency and is exported to a grid with an emission factor of 0.5 tCO_2/MWh. These assumptions are also conservative since:

(i) Black liquor is the type of biomass that has the lowest value of NCV among the types included in Table 1.2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (5.9 TJ/Gg);

(ii) The technology with a 35% efficiency is the one with the lowest value between the biomass technologies listed in Table 2 from the appendix of the TOOL08 (35%);

(iii) The the grid emission factors in non-Annex I countries currently reported is typically above 0.69 tCO_2/MWh (e.g.as observed from the IGES Database);

The emissions to transport 1 ton of biomass are determined by multiplying the distance travelled (200 km) by the emission factor of the heavy duty vehicles to transport 1 ton of biomass (129 gCO_2/tkm, or 129 x 10^{-6} tCO_2/tkm), which is equal to 0.0258 $tCO_2/t_{biomass}$.

The emission reductions from the electricity generated by 1 ton of biomass is determined as the product between the energy released when burning one ton of black liquor (5.9 TJ/Gg, or 1.64 MWh/ton), the efficiency of the technology consuming biomass (35%) and the grid emission factor (0.5 tCO_2/MWh), resulting in 0.287 $tCO_2/t_{biomass}$. This is further discounted by the emissions due to transport 1 ton of biomass determined above (0.0258 $tCO_2/t_{biomass}$) and the final result is equal to 0.261 $tCO_2/t_{biomass}$.

The ratio is, therefore, equals to 0.0258 / 0.261, which is approximately 10%.

~~38. Emissions resulting from transport of biomass to the processing/utilisation facility are estimated, unless otherwise required in the relevant methodology, by following the provisions in the methodological tool "Project and leakage emissions from transportation of freight".~~

Box 3. Non-binding best practice example 2: Emissions from transportation of the biomass

A project activity involves the use of biomass from a dedicated plantation and bagasse from a nearby industry, which are located 25 km and 10 km away from the project plant, respectively.

The project participants opted to use the conservative default values provided by the TOOL12 and, therefore monitor:

- the quantity of each type of biomass transported, e.g. 1,000 tons of biomass and 2,000 tons of bagasse (biomass residue);
- the return distance from the dedicated plantation (50 km) and nearby industry (20 km); and
- the type of vehicle used, in order to select the appropriate emission factor, e.g heavy vehicles with an emission factor equals to 129 g CO_2/tkm;

Project emissions are calculated separately for biomass (PE_{BT}) and biomas residues (PE_{BRT}) based on equation (1) from the TOOL12:

$\boldsymbol{PE_{TR,m}} = \sum_f \boldsymbol{D_{f,m}} \times \boldsymbol{FR_{f,m}} \times \boldsymbol{EF_{CO2,f}} \times \boldsymbol{10^{-6}}$, where:

- $D_{f,m}$ = Return trip distance between the origin and destination of freight transportation activity *f* in monitoring period *m* (km). For biomass, this parameter is equal to 50 km; for bagasse, this parameter is equal to 20 km;

- $FR_{f,m}$ = Total mass of freight transported in freight transportation activity *f* in monitoring period *m* (t). For biomass, this parameter is equal to 1,000 tons; for bagasse, this parameter is equal to 2,000 tons;

- $EF_{CO2,f}$ = Default CO_2 emission factor for freight transportation activity *f* (gCO_2/tkm). For transportation using heavy duty vehicles, this parameter is equal to 129 gCO_2/tkm.

Therefore:

$\boldsymbol{PE_{BT}} = \mathbf{50}\ \text{km} \times \mathbf{1,000}\ \text{tons} \times \mathbf{129}\ \text{gCO}_2/\text{tkm} \times \mathbf{10^{-6}} = \mathbf{6.45}\ \text{tCO}_2$

$\boldsymbol{PE_{BRT}} = \mathbf{20}\ \text{km} \times \mathbf{2,000}\ \text{tons} \times \mathbf{129}\ \text{gCO}_2/\text{tkm} \times \mathbf{10^{-6}} = \mathbf{5.16}\ \text{tCO}_2$,

5.3. Project emissions from processing of biomass ($PE_{BP,y}$) and biomass residues ($PE_{BRP,y}$)

39. Emissions resulting from processing of biomass and biomass residues are determined as based on the equations below:

$$PE_{BP,y} = PE_{BP,electricity,y} + PE_{BP,fuel,y} + PE_{BP,CH4,y} + PE_{BP,COMP,y} + PE_{BP,AD,y} + PE_{BP,ww,y} + PE_{BP,additives,y} \quad \text{Equation (9)}$$

$$PE_{BRP,y} = PE_{BRP,electricity,y} + PE_{BRP,fuel,y} + PE_{BRP,CH4,y} + PE_{BRP,COMP,y} + PE_{BRP,AD,y} + PE_{BRP,ww,y} + PE_{BP,additives,y} \quad \text{Equation (10)}$$

Where:

$PE_{BP,electricity,y}$	=	Project emissions from the consumption of electricity due to thermo-chemical, biological and mechanical processing of the biomass in year *y* (tCO2e)
$PE_{BP,fuel,y}$	=	Project emissions from the consumption of fossil fuels for thermo-chemical, biological and mechanical processing of the biomass in year y (tCO_2e)
$PE_{BP,CH4,y}$	=	Project methane emissions from the decay of biomass under anaerobic conditions as a result of thermo-chemical, biological and mechanical processing in year *y* (tCO_2e)
$PE_{BP,COMP,y}$	=	Project emissions from composting due to thermo-chemical, biological and mechanical processing of the biomass in year *y* (tCO2e)
$PE_{BP,AD,y}$	=	Project emissions from the anaerobic digester due to thermo-chemical, biological and mechanical processing of the biomass in year *y* (tCO_2e)
$PE_{BP,ww,y}$	=	Project emissions from wastewater treatment due to thermo-chemical, biological and mechanical processing of the biomass in year *y* (tCO_2e)
$PE_{BP,additives,y}$	=	Project emissions from the use of additives to process the biomass in year *y* (tCO_2e)
$PE_{BRP,electricity,y}$	=	Project emissions from the consumption of electricity for thermo-chemical, biological and mechanical processing of the biomass residues in year y (tCO_2e)
$PE_{BRP,fuel,y}$	=	Project emissions from the consumption of fossil fuels for thermo-chemical, biological and mechanical processing of the biomass residues in year y (tCO_2e)
$PE_{BRP,CH4,y}$	=	Project methane missions generated from the decay of biomass under anaerobic conditions due to thermo-chemical, biological and mechanical processing during a time period ending in year *y* (tCO_2e)
$PE_{BRP,COMP,y}$	=	Project emissions associated with composting due to thermo-chemical, biological and mechanical processing of the biomass residues in year *y* (tCO_2e)
$PE_{BRP,AD,y}$	=	Project emissions associated with the anaerobic digester due to thermo-chemical, biological and mechanical processing of the biomass residues in year *y* (tCO_2e)
$PE_{BRP,ww,y}$	=	Project emissions from wastewater treatment due to thermo-chemical, biological and mechanical processing of the biomass residues in year *y* (tCO_2e)
$PE_{BRP,additives,y}$	=	Project emissions from the use of additives to process the biomass residues in year *y* (tCO_2e)

5.3.1. Emissions resulting from the electricity consumed due to thermo-chemical, biological and mechanical processing of biomass ($PE_{BP,electricity,y}$) and biomass residues ($PE_{BRP,electricity,y}$)

40. Emissions resulting from the electricity consumed due to thermo-chemical, biological and mechanical processing of the biomass are determined based on the provisions of the TOOL05, where the parameters $PE_{BP,electricity,y}$ and $PE_{BRP,electricity,y}$ corresponds to $PE_{EC,y}$ from the tool.

5.3.2. Emissions resulting from the fuel consumed due to thermo-chemical, biological and mechanical processing of biomass ($PE_{BP,fuel,y}$) and biomass residues ($PE_{BRP,fuel,y}$)

41. Emissions resulting from the fuel consumed due to thermo-chemical, biological and mechanical processing of the biomass are determined based on the provisions of the TOOL03, where the parameters $PE_{BP,fuel,y}$ and $PE_{BRP,fuel,y}$ correspond to $PE_{FC,j,y}$ from the tool.

5.3.3. Methane emissions from the decay of biomass ($PE_{BP,CH4,y}$) and of biomass residues ($PE_{BRP,CH4,y}$) under anaerobic conditions as a result of thermo-chemical, biological and mechanical processing

42. Emissions of methane from the decay of biomass under anaerobic conditions as a result of thermo-chemical, biological and mechanical processing of the biomass are determined based on the provisions of the TOOL04, where the parameters $PE_{BP,CH4,y}$ and $PE_{BRP,CH4,y}$ correspond to $PE_{CH4,SWDS,y}$ from the tool.

5.3.4. Emissions from composting due to thermo-chemical, biological and mechanical processing of biomass ($PE_{BP,COMP,y}$) and biomass residues ($PE_{BRP,COMP,y}$)

43. Emissions of methane from the composting as a result of thermo-chemical, biological and mechanical processing of the biomass are determined based on the provisions of the TOOL13, where the parameters $PE_{BP,COMP,y}$ and $PE_{BRP,COMP,y}$ correspond to $PE_{COMP,y}$ from the tool.

5.3.5. Emissions from the anaerobic digester due to thermo-chemical, biological and mechanical processing of biomass ($PE_{BP,AD,y}$) and biomass residues ($PE_{BRP,AD,y}$)

44. Emissions from the anaerobic digester due to thermo-chemical, biological and mechanical processing of the biomass are determined based on the provisions of the TOOL14, where the parameters $PE_{BP,AD,y}$ and $PE_{BRP,AD,y}$ correspond to $PE_{AD,y}$ from the tool.

5.3.6. Emissions from the wastewater treatment anaerobic digester due to thermo-chemical, biological and mechanical processing of the biomass ($PE_{BP,ww,y}$) and biomass residues ($PE_{BRP,ww,y}$)

45. This emission source shall be estimated in cases where waste water originating from the processing of the biomass and biomass residues is (partly) treated under anaerobic conditions and where methane from the waste water is not captured and flared or combusted. Project emissions from waste water are estimated as follows:

$$PE_{BP,ww,y} = GWP_{CH4} \times V_{BP,ww,y} \times COD_{BP,ww,y} \times B_{o,WW} \times MCF_{BP,ww} \quad \text{Equation (11)}$$

$$PE_{BRP,ww,y} = GWP_{CH4} \times V_{BRP,ww,y} \times COD_{BRP,ww,y} \times B_{o,WW} \times MCF_{BRP,ww} \quad \text{Equation (12)}$$

Where:

$PE_{BP,ww,y}$	=	CH_4 emissions from waste water generated from the treatment of biomass in year *y* (tCO_{2e})
GWP_{CH4}	=	Global Warming Potential for methane valid for the relevant commitment period (tCO_2/tCH_4)

$V_{BP,ww,y}$	=	Quantity of waste water generated from the processing of biomass in year *y* (m^3)
$COD_{BP,ww,y}$	=	Average chemical oxygen demand of the waste water in year *y* (t_{COD}/m^3)
$B_{o,WW}$	=	Methane generation potential of the waste water (t CH_4/t_{COD})
$MCF_{BP,ww}$	=	Methane correction factor for the waste water (ratio)
$PE_{BRP,ww,y}$	=	CH_4 emissions from waste water generated from the treatment of biomass residues in year *y* (tCH_4)
GWP_{CH4}	=	Global Warming Potential for methane valid for the relevant commitment period (tCO_2/tCH_4)
$V_{BRP,WW,y}$	=	Quantity of waste water generated in year *y* (m^3)
$COD_{BRP,WW,y}$	=	Average chemical oxygen demand of the waste water in year *y* (t_{COD}/m^3)
$B_{o,WW}$	=	Methane generation potential of the waste water (t CH_4/t_{COD})
$MCF_{BRP,WW}$	=	Methane conversion factor for the waste water (ratio)

5.3.7. Emissions from the use of additives to process the biomass (*$PE_{BP,additives,y}$*) and biomass residues (*$PE_{BRP,additives,y}$*)

$$PE_{BP,additives,y} = PE_{BP,additives,transport,y} + PE_{BP,additives,electricity,y} + PE_{BP,additives,FF,y}$$ Equation (13)

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$$PE_{BRP,additives,y} = PE_{BRP,additives,transport,y} + PE_{BRP,additives,electricity,y} + PE_{BRP,additives,FF,y}$$ Equation (14)

Where:

$PE_{BP,additives,transport}$	=	Emissions from the transportation of the additives from the production site to the biomass processing facility (tCO_2)
$PE_{BP,additives,electricity,y}$	=	Emissions from the consumption of electricity to produce the additives used by the biomass processing facility (tCO_2)
$PE_{BP,additives,FF,y}$	=	Emissions from the consumption of fossil fuels to produce the additives used by the biomass processing facility (tCO_2)
$PE_{BRP,additives,transport}$	=	Emissions from the transportation of the additives from the production site to the biomass residues processing facility (tCO_2)
$PE_{BRP,additives,electricity,y}$	=	Emissions from the consumption of electricity to produce the additives used by the biomass residues processing facility (tCO_2)

$PE_{BRP,additives,FF,y}$	=	Emissions from the consumption of fossil fuels to produce the additives used by the biomass residues processing facility (tCO_2)

46. $PE_{BP,additives,transport,y}$ and $PE_{BRP,additives,transport,y}$ are determined following the provisions from the TOOL12. The simplifications contained in paragraph 36 also apply.

47. Emissions resulting from the electricity consumed to produce the additives are determined based on the provisions of the TOOL05, where the parameters $PE_{BP,additives,electricity,y}$ and $PE_{BRP,additives,electricity,y}$ corresponds to $PE_{EC,y}$ from the tool.

48. Emissions resulting from the fuel consumed due to produce the additives are determined are determined based on the provisions of the TOOL03, where the parameters $PE_{BP,additives,fuel,y}$ and $PE_{BRP,additives,fuel,y}$ corresponds to $PE_{FC,j,y}$ from the tool

49. As an alternative to the monitoring of the parameters needed to calculate these emissions sources, project proponents may apply the following options:

(a) If the ratio between the additive consumed and the biomass or biomass residue processed (mass or volume basis) is below or equal to 2%, these emission sources may be neglected;

(b) If the ratio between the additive consumed and the biomass or biomass residue processed (mass or volume basis) is above 2% and below or equal to 10%, only the emissions from the consumption of electricity and fuel to produce the additives may be accounted. Project proponents may determine these emission sources based on literature such as peer reviewed studies.

(c) If the ratio between the additive consumed and the biomass or biomass residue processed (mass or volume basis) is above 10%, emissions from both the consumption of electricity and fuel to produce the additives and to transport the additives shall be accounted. Project proponents may determine these emission sources based on literature such as peer reviewed studies.

~~6. Project emissions from utilization of biomass residues~~

~~50. Project emissions resulting from utilization of biomass residues are estimated as follows:~~

~~$PE_{BU,y} = PE_{EC,y} + PE_{TR,y}$~~ ~~Equation (15)~~

~~Where:~~

~~$PE_{BU,y}$~~	~~=~~	~~Emissions resulting from utilization of biomass residues, in year y (tCO_2e)~~
~~$PE_{EC,y}$~~	~~=~~	~~Emissions resulting from energy consumption, in year y (tCO_2e)~~
~~$PE_{TR,y}$~~	~~=~~	~~Emissions resulting from transport of biomass, in year y (tCO_2e)~~

~~6.1. Emissions resulting from energy consumption~~

~~51. Emissions resulting from energy consumption are estimated, unless otherwise required in the relevant methodology, by following the provisions in the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” and the tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”.~~

~~These emissions include emissions due to thermal and mechanical processing of the biomass residue.~~

~~52. Small scale project activities may, unless otherwise required by the methodology, neglect emissions from energy consumption associated with processing of biomass residue.~~

~~6.2. Emissions resulting from transport~~

~~53. Emissions resulting from transport of biomass residue to the processing/utilisation facility are estimated, unless otherwise required in the relevant methodology, by following the provisions in the methodological tool "Project and leakage emissions from transportation of freight".~~

~~54. Small scale project activities may, unless otherwise required by the methodology, neglect this source of emissions if the transportation distance is less than 200 km.~~

7. Leakage

55. Leakage may occur outside of the project boundary and may involve emissions due to shift of pre-project activities, diversion of biomass residues from other applications and due to collection, processing and transportation of biomass residues outside the project boundary.

7.1. Leakage due to shift of pre-project activities ($LE_{BC,y}$)

56. This section is applicable only if the project activity utilizes biomass cultivated in a dedicated plantation. Project proponents are advised to avoid pre-project activities from being shifted outside the project boundary, to avoid indirect land use changes as a result of the project activity. Rather, project proponents are encouraged to include in the project boundary the land in which the pre-project activities will take place after the project implementation.

57. No leakage due to shift of pre-project activities occurs if one of the following two conditions applies:

(a) The plantation area was or would have been abandoned land prior to the implementation of the project activity;

(b) The plantation area was used prior to the implementation of the project area but the pre-project land use of the plantation area will be accommodated for, providing at least the same level of service during the project activity, within the land area included in the project boundary. The project area may be expanded to accommodate for this condition. This could be achieved, inter alia, in the following ways:

(i) At least the same number of cattle as prior to the implementation of the project activity will continue being grazed during the project activity within the land area included in project boundary;

(ii) Due to more efficient farming practice, the pre-project crops can be grown on a smaller area, which is included in the land area included in the project boundary, to achieve the same level of annual production of crops, freeing land for the dedicated plantation;

(iii) Settlements are not removed from the land area included in the project boundary.

58. Project participants should assess the possibility of leakage from the displacement of activities or people by monitoring the following indicators:

(a) Percentage of families/households of the community involved in or affected by the project activity displaced (from within to outside of the project boundary) due to the project activity;

(b) Percentage of total production of the main product (e.g. meat, corn) within the project boundary displaced due to the cultivation of biomass.

59. For project activities which fall above the small-scale threshold, no shift of pre-project activities is allowed.

60. For project activities which fall below the small-scale threshold:

(a) If the value of both indicators is lower than 10 per cent, then leakage from this source is assumed to be zero;

(b) If the value of any of the two indicators is higher than 10 per cent and less than or equal to 50 per cent, then leakage shall be equal to 15 per cent of the difference between baseline emissions and project emissions;

(c) If the value of either of these two indicators is larger than 50 per cent, then this tool is not applicable and a new procedure must be submitted for the approval of the Board.

7.2. Leakage due to diversion of biomass residues from other applications ($LE_{BR,Div,y}$)

61. This section is applicable for project activities which utilise biomass residues. It quantifies leakage due to diversion of biomass residues to the project to be used as either fuel or feedstock. These biomass residues could have been used outside the project boundary in competing applications, and due to the implementation of the project activity these competing application might be forced to use inputs which are not carbon neutral.

7.2.1. Determination of the alternative scenario of the biomass residues in absence of the project activity

62. The alternative scenario for the “use”, in absence of the project activity, of biomass residues that will be used in the underlying CDM project activity shall include:

(a) B1: The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields;

(b) B2: The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to landfills which are deeper than five meters. This does not apply to biomass residues that are stock-piled or left to decay on fields;

(c) B3: The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes;

(d) B4: The biomass residues are used for energy or non-energy applications, or the primary source of the biomass residues and/or their fate cannot be clearly identified.[13]

63. Project proponents may choose to combine some or all relevant biomass types into one category when determining the fate of biomass residues, and treat the combined types as one, for instance in the biomass availability determination. These combinations shall be documented transparently in the CDM project design document (CDM-PDD) and remain consistent throughout the crediting period.

64. When defining plausible and credible alternative scenarios for the use of biomass residues, the guidance below shall be followed:

(a) If the biomass residues processing (drying, pelletization, shredding, briquetting, etc.) is not included in the project boundary, the processed biomass obtained from that plant should be considered as B4 above;

(b) The alternative scenario for the categories of biomass residues identified according to paragraphs 63 and 64 above should be separately identified, covering the whole amount of biomass residues supposed to be used in the project activity along the crediting period;

(c) A category of biomass residues is defined by three attributes: (1) its type or types (i.e. bagasse, rice husks, empty fruit bunches, etc.); (2) its source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, etc.); and (3) its alternative scenario in the absence of the project activity (Scenarios B1 to B4 above);

(d) Explain and document transparently in the CDM-PDD, using a table similar to Table 1 in Appendix 2, what quantities of which biomass residues categories are used in which installation(s) under the project activity and what is their alternative scenario;

(e) For biomass residues categories for which scenarios B1, B2 or B3 are deemed a plausible alternative scenario, the following procedures should be applied for the combined amount of biomass identified:

(i) Demonstrate that there is an abundant surplus of the biomass residue in the project region which is not utilized. For this purpose, demonstrate that the total quantity of that type of biomass residues annually available in the project region is at least 25 per cent larger than the quantity of biomass residues which is utilized annually in the project region (e.g. for energy generation or as feedstock), including the project facility;

(ii) Demonstrate for the sites from where biomass residues are sourced that the biomass residues have not been collected or utilized (e.g. as fuel, fertilizer or feedstock) but have been dumped and left to decay, land-filled, left in the field to decay after harvest,[14] or burnt without energy generation (e.g. field

[13] For example, this scenario can be used if biomass residues are purchased from a market, or biomass residues retailers, or if processed biomass is purchased from biomass processing plants which are not included in the project boundary.

[14] Project proponents shall demonstrate the fraction of biomass which exceeds the function of refertilising the soil, as only this part of the biomass may be considered unutilised.

burning). This approach is only applicable to biomass residues categories for which project participants can clearly identify the site from where the biomass residues are sourced;

(iii) In case surplus of biomass residues in the project region cannot be demonstrated, the alternative use of the biomass shall be considered unknown (B4) and result in leakage emissions.

65. If during the crediting period, new categories of biomass residues of the type B1, B2 or B3 are used in the project activity which were not listed at the validation stage, for example due to new sources of biomass residues, the alternative scenario for those types of biomass residues should be assessed using the procedures outlined in this tool for each new category of biomass residues.

7.2.2. Calculation of Leakage due to diversion of biomass residues

66. The main potential source of leakage due to biomass residues is an increase in emissions from fossil fuel combustion or other sources due to diversion of biomass residues from other uses to the project plant as a result of the project activity. The alternative scenario for biomass residues for which this potential leakage is relevant is B4.

67. The actual leakage emissions in each of these cases may differ significantly and depend on the specific situation of each project activity. For that reason, a simplified approach is used in this tool: it is assumed that an equivalent amount of fossil fuels, on energy basis, would be used if biomass residues are diverted from other users, no matter what the use of biomass residues would be in the alternative scenario.

68. Therefore, for the categories of biomass residues whose alternative scenario has been identified as B4, project participants shall calculate leakage emissions as follows:

$$LE_{BR,y} = EF_{CO2,LE} \times \sum_{n} BR_{PJ,n,y} \times NCV_{n,y}$$ Equation (16)

Where:

$LE_{BR,Div,y}$	=	Leakage emissions due to the diversion of biomass in year *y* (t CO_2e)
$EF_{CO2,LE}$	=	CO_2 emission factor of the most carbon intensive fossil fuel used in the country (t CO_2/GJ)
$BR_{PJ,n,y}$	=	Quantity of biomass residues used in the project site and included in the project boundary in year *y* (tonnes on dry-basis)
$NCV_{n,y}$	=	Net calorific value of the biomass residues of category *n* in year *y* (GJ/tonne of dry matter)
n	=	Categories of biomass residues for which B4 has been identified as the alternative scenario

69. The determination of $BR_{PJ,n,y}$ shall be based on the monitored amounts of biomass residues used in facilities included in the project boundary.

7.3. Leakage due to collection, processing and transportation of biomass residues outside the project boundary ($LE_{BRP,y}$)

70. If collection, processing and transportation of biomass residues occur outside the project boundary, the requirements and equations in Section 5.2 shall be followed for estimation of leakage emissions, where:

(a) The parameter $PE_{BRP,electricity,y}$ corresponds to $LE_{EC,y}$ from the TOOL05;

(b) The parameter $PE_{BRP,fuel,y}$ corresponds to $PE_{FC,j,y}$ from the TOOL03;

(c) The parameter $PE_{BRP,CH4,y}$ corresponds to $LE_{CH4,SWDS,y}$ from the TOOL06;

(d) The parameter $PE_{BRP,COMP,y}$ corresponds to $LE_{COMP,y}$ from the TOOL13;

(e) The parameter $PE_{BRP,AD,y,}$ corresponds to $LE_{AD,y}$ from the TOOL14;

8. Monitoring methodology

8.1. Data and parameters not monitored

71. Data and parameters not monitored have been provided along with the relevant equation in the preceding section of the tool. Furthermore, for projects including biomass cultivation, the following parameter shall be known.

Data / Parameter table 1.

Data / Parameter:	**Pre-project land use**
Data unit:	variable
Description:	Service level of the pre-project land use
Source of data:	Land management records, records of the relevant local authority, stakeholders' interviews etc.
Measurement procedures (if any):	-
Any comment:	-

72. For projects including biomass residues, the following parameter shall be known.

Data / Parameter table 2.

Data / Parameter:	**Biomass residues categories and quantities used in the project activity**
Data unit:	(a) Type (i.e. bagasse, rice husks, empty fruit bunches, etc.); (b) Source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, etc.); (c) Fate in the absence of the project activity (Scenario B); (d) Use in the project scenario

Description:	Explain and document transparently in the CDM-PDD, using a table similar to table 1 in appendix 2 which quantities of which biomass residues categories are used in which installation(s) under the project activity and what is their alternative scenario. The last column of table 1 in appendix 2 corresponds to the quantity of each category of biomass residues (tonnes on dry-basis). These quantities should be updated every year of the crediting period so as to reflect the actual use of biomass residues in the project scenario. These updated values should be used for leakage calculations, if the determined alternative fate indicates associated leakage emissions. Along the crediting period, new categories of biomass residues (i.e. new types, new sources, with different fate) can be used in the project activity. In this case, a new line should be added to the table. If those new categories are of the type B1, B2 or B3, the alternative scenario for those types of biomass residues should be assessed using the procedures outlined in the guidance provided in the procedure for the determination of the alternative scenario
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_{4we}
Description:	GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2/tCH_4)
Source of data:	IPCC
Measurement procedures (if any):	Updated according to COP/MOP decisions.
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	**B_0**
Data unit:	t_{CH4}/t_{COD}
Description:	Maximum methane producing capacity, expressing the maximum amount of CH4 that can be produced from a given quantity of chemical oxygen demand (COD)
Source of data:	Table 6.8 from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Measurement procedures (if any):	No measurement procedures. The default IPCC values for B_0 from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories shall be properly justified.
Any comment:	-

8.2. Data and parameters monitored

73. Data and parameters relevant to projects including biomass cultivation are monitored as described in the following parameter tables.

Data / Parameter table 5.

Data / Parameter:	$\mathbf{A_{SOC,i}}$
Data unit:	ha
Description:	Area of land stratum *i*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party country are used
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	$\mathbf{q_{N,y}}$
Data unit:	t N/ha
Description:	Rate of nitrogen applied, in year *y*
Source of data:	Land management records maintained by project participants and fertiliser composition information from supplier, study or independent laboratory. Alternatively, the default conservative value of 0.20 t N/ha per year may be used
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts and inventory
Any comment:	Nitrogen applied through the following methods shall be added up to arrive at this value: (i) synthetic fertilisers; (ii) organic manure; (iii) return of the residues or cover crops

Data / Parameter table 7.

Data / Parameter:	$\mathbf{A_{FTM,y}}$
Data unit:	ha
Description:	Area of land subjected to soil fertilization and management, in year *y*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party are used
Any comment:	Areas receiving one or more of the following inputs shall be added up to arrive at this value: (i) synthetic fertilisers; (ii) organic manure; (iii) return of the residues or cover crops

Data / Parameter table 8.

Data / Parameter:	$\mathbf{q_{SA,i,y}}$
Data unit:	t/ha
Description:	Rate of application of oil amendment agent type *i*, in year *y*
Description:	
Source of data:	Land management records maintained by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts and inventory
Any comment:	-

Data / Parameter table 9.

Data / Parameter:	$\mathbf{A_{SA,i,y}}$
Data unit:	ha
Description:	Area of land in which oil amendment agent type *i* is applied, in year *y*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party are used
Any comment:	-

Data / Parameter table 10.

Data / Parameter:	$\mathbf{A}_{FR,i,y}$
Data unit:	ha
Description:	Area of stratum *i* of land subjected to fire in year *y*
Source of data:	Measurement by project participants
Measurement procedures (if any):	Standard land area measurement methods applicable in the host party
Monitoring frequency:	Annual
QA/QC procedures:	Check that standard land area measurement methods applicable in the host party are used
Any comment:	-

Data / Parameter table 11.

Data / Parameter:	$\mathbf{b}_i$
Data unit:	t dry matter/ha
Description:	Fuel biomass consumption per hectare in stratum *i* of land subjected to fire

Source of data:	Measurement by project participants. Alternatively, the default ‘average above-ground biomass content in forest’ values from Table 3A.1.4 of the Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC-GPG-LULUCF 2003)
Measurement procedures (if any):	Measurement may be carried out through sample plots
Monitoring frequency:	Annual
QA/QC procedures:	If sample plots are used, the estimated mean value should not have an uncertainty of greater than 10 per cent at 90 per cent confidence level
Any comment:	-

Data / Parameter table 12.

Data / Parameter:	$\mathbf{R_i}$
Data unit:	Dimensionless
Description:	Root-shoot ratio (i.e. ratio of below-ground biomass to above-ground biomass) for stratum *i* of land subjected to fire
Source of data:	Measurement by project participants. Alternatively, the default values from Table 4.4 of the 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories may be used
Measurement procedures (if any):	Measurement may be carried out through sample plots
Monitoring frequency:	Annual
QA/QC procedures:	If sample plots are used, the estimated mean value should not have an uncertainty of greater than 10% at 90% confidence level
Any comment:	-

Data / Parameter table 13.

Data / Parameter:	**Land use**
Data unit:	variable
Description:	Service level of the project land use
Source of data:	-
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	The service level of the project land use shall at least provide the pre-project service level, otherwise leakage shall be accounted for

74. For projects utilising biomass residues, in the absence of relevant data/parameter tables in the methodology, the following parameter tables shall be used.

Data / Parameter table 14.

Data / Parameter:	**$BR_{PJ,n,y}$**
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues of category *n* used in facilities which are located at the project site and included in the project boundary in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight meters. Adjust by the moisture content in order to determine the quantity of dry biomass
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	The biomass residue quantities used should be monitored separately for (a) each type of biomass residue (e.g.) and each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.). In case of missing data of up to 30 consecutive days within six consecutive months one of the following options may be used to estimate the quantity of biomass: 1. an annual mass balance that is based on purchased or collected quantities and stock changes; 2. calculated based on the carrying capacity of each truck delivering biomass (moisture content and density shall be known); 3. The highest value of the parameter for the same calendar period of the previous years. These options are applicable for project activities or PoAs, where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs)

Data / Parameter table 15.

Data / Parameter:	**$NCV_{n,y}$**
Data unit:	GJ/tonnes on dry-basis
Description:	Net calorific value of biomass residues of category *n* in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards. Measure the NCV on dry-basis
Monitoring frequency:	At least every six months, taking at least three samples for each measurement

QA/QC procedures:	Check the consistency of the measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Ensure that the NCV is determined on the basis of dry biomass
Any comment:	The proposed sampling plan shall ensure that samples are randomly selected and are representative of the population. In case of missing data, the following can be used for project activities or PoAs, where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs): • IPCC default values at the upper limit of the uncertainty at a 95 per cent confidence interval as provided in table 1.2 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories; or • The highest value from the previous monitoring periods of the same biomass type

Data / Parameter table 16.

Data / Parameter:	**Moisture content of the biomass residues**
Data unit:	% Water content in mass basis in wet biomass residues
Description:	Moisture content of each biomass residues type *n*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	The moisture content should be monitored for each batch of biomass of homogeneous quality. The weighted average should be calculated for each monitoring period and used in the calculations
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 17.

Data / Parameter:	**$EF_{CO2,LE}$**
Data unit:	t CO_2/GJ
Description:	CO_2 emission factor of the most carbon intensive fuel used in the country
Source of data:	Identify the most carbon intensive fuel type from the national communication, other literature sources (e.g. IEA). Possibly consult with the national agency responsible for the national communication/GHG inventory. If available, use national default values for the CO_2 emission factor. Otherwise, IPCC default values may be used
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 18.

Data / Parameter:	$V_{BP,y}$ / $V_{BRP,y}$
Data unit:	m^3
Description:	**$V_{BP,y}$:** Quantity of waste water generated from the processing of biomass in year y **$V_{BRP,y}$:** Quantity of waste water generated from the processing of biomass residues in year y
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 19.

Data / Parameter:	$COD_{BP,y}$ / $COD_{BRP,y}$
Data unit:	t_{COD}/m^3
Description:	**$COD_{BP,y}$:** Average chemical oxygen demand of the waste water generated from the processing of biomass in year y **$COD_{BRP,y}$:** Average chemical oxygen demand of the waste water generated from the processing of biomass residues in year y
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	At least every six months, taking at least three samples for each measurement
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 20.

Data / Parameter:	$MCF_{BP,y}$ / $MCF_{BRP,y}$
Data unit:	-
Description:	**$MCF_{BP,y}$:** Methane conversion factor for the treatment of waste water generated from the processing of biomass in year y **$MCF_{BRP,y}$:** Methane conversion factor for the treatment of waste water generated from the processing of biomass residues in year y
Source of data:	Table 6.8 from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Measurement procedures (if any):	No measurement procedures. The default IPCC values for B_0 from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories shall be properly justified.
Any comment:	-

Appendix 1. Default values for biomass cultivation

Table 1. Default reference SOC stocks (SOC_{REF}) for mineral soils (tC/ha in 0–30 cm depth)[1]

Climate region	HAC soils[2]	LAC soils[3]	Sandy soils[4]	Spodic soils[5]	Volcanic soils[6]	Wetland soils[7]
Polar Moist/Dry	59	N/A	27	NA	NA	NA
Boreal Moist/Dry	~~68~~ 63	NA	10	117	20	116
Cold temperate, dry	~~50~~ 43	33	~~34~~ 13	NA	20	87
Cold temperate, moist	~~95~~ 81	~~85~~ 76	~~71~~ 51	~~115~~ 128	~~130~~ 136	128
Warm temperate, dry	~~38~~ 24	~~24~~ 19	~~19~~ 10	NA	~~70~~ 84	74
Warm temperate, moist	~~88~~ 64	~~63~~ 55	~~34~~ 36	~~NA~~ 143	~~80~~ 138	135
Tropical, dry	~~38~~ 21	~~35~~ 19	~~31~~ 9	NA	50	22
Tropical, moist	~~65~~ 40	~~47~~ 38	~~39~~ 27	NA	70	68
Tropical, wet	~~44~~ 60	~~60~~ 52	~~66~~ 46	NA	~~130~~ 77	49
Tropical montane	~~88~~ 51	~~63~~ 44	~~34~~ 52	NA	~~80~~ 96	82

1 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 2.3 (updated).

2 Soils with high activity clay (HAC) minerals are lightly to moderately weathered soils, which are dominated by 2:1 silicate clay minerals (in the World Reference Base for Soil Resources (WRB) classification these include Leptosols, Vertisols, Kastanozems, Chernozems, Phaeozems, Luvisols, Alisols, Albeluvisols, Solonetz, Calcisols, Gypsisols, Umbrisols, Cambisols, Regosols; in USDA classification includes Mollisols, Vertisols, high-base status Alfisols, Aridisols, Inceptisols).

3 Soils with low activity clay (LAC) minerals are highly weathered soils, dominated by 1:1 clay minerals and amorphous iron and aluminium oxides (in WRB classification includes Acrisols, Lixisols, Nitisols, Ferralsols, Durisols; in USDA classification includes Ultisols, Oxisols, acidic Alfisols).

4 Includes all soils (regardless of taxonomic classification) having >70 per cent sand and <8 per cent clay, based on standard textural analyses (in WRB classification includes Arenosols; in USDA classification includes Psamments).

5 Soils exhibiting strong podzolization (in WRB classification includes Podzols; in USDA classification Spodosols).

6 Soils derived from volcanic ash with allophanic mineralogy (in WRB classification Andosols; in USDA classification Andisols).

7 Soils with restricted drainage leading to periodic flooding and anaerobic conditions (in WRB classification Gleysols; in USDA classification Aquic suborders).

Table 2. Relative stock change factors for different management activities on cropland[8]

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
Land use (f_{LU})	Long-term cultivated	Cool temperate/ Boreal	Dry	~~0.80~~ 0.77	Area has been continuously managed for crops for more than ~~20~~ 50 years
			Moist/~~Wet~~	~~0.69~~ 0.70	
		~~Tropical~~ Warm temperate	Dry	~~0.58~~ 0.76	
			Moist/~~Wet~~	~~0.48~~ 0.69	
		Tropical ~~montane~~	~~n/a~~ Dry	~~0.64~~ 0.92	
			Moist/Wet	0.83	
Land use (f_{LU})	Set aside (< 20 yrs) ~~Short-term cultivated (<20 years) or set aside (<5 years)~~	Temperate/ Boreal and Tropical	Dry	0.93	Represents temporary set aside of annually cropland (e.g., conservation reserves) or other idle cropland that has been revegetated with perennial grasses. ~~Area has been managed for crops for less than 20 years and/or the area is cropland that has been in a fallow state for less than five years at any point during the last 20 years~~
			Moist/Wet	0.82	
		Tropical montane	n/a	0.88	
Management (f_{MG})	Full tillage	All	Dry and Moist/Wet	1.00	Substantial soil disturbance with full inversion and/or frequent (within year) tillage operations. At planting time, little (e.g. <30%) of the surface is covered by residues
Management (f_{MG})	Reduced tillage	Cool Temperate/ Boreal	Dry	~~1.02~~ 0.98	Primary and/or secondary tillage but with reduced soil disturbance (usually shallow and without full soil inversion). Normally leaves surface with >30% coverage by residues at planting
			Moist	~~1.08~~ 1.04	
		Tropical	Dry	~~1.09~~ 0.99	
			Moist/Wet	~~1.15~~ 1.04	
		~~Tropical montane~~ Warm Temperate	~~n/a~~ Dry	~~1.09~~ 0.99	
			Moist/Wet	1.04	
	No-tillage		Dry	~~1.10~~ 1.03	

[8] Adapted from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Table 5.5 (updated).

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
Management (f_{MG})		Cool Temperate/ Boreal	Moist	~~1.15~~ 1.09	Direct seeding without primary tillage, with only minimal soil disturbance in the seeding zone. Herbicides are typically used for weed control
		Tropical	Dry	~~1.17~~ 1.04	
			Moist/Wet	~~1.22~~ 1.10	
		~~Tropical montane~~ Warm temperate	~~n/a~~ Dry	~~1.16~~ 1.04	
			Moist/Wet	1.10	

Table 3. Relative stock change factors for different levels of nutrient input on cropland[9]

Factor type	Level	Temperature regime	Moisture regime	Factor value	Description and criteria
Input (f_{IN})	Low	Temperate/ Boreal	Dry	0.95	There is removal of residues (via collection or burning), or frequent bare-fallowing, or production of crops yielding low residues (e.g. vegetables, tobacco, cotton), or no mineral fertilization or N-fixing crops
			Moist	0.92	
		Tropical	Dry	0.95	
			Moist/Wet	0.92	
		Tropical montane	n/a	0.94	
Input (f_{IN})	Medium	All	Dry and Moist/Wet	1.00	All crop residues are returned to the field. If residues are removed then supplemental organic matter (e.g. manure) is added. Additionally, mineral fertilization or N-fixing crop rotation is practised
Input (f_{IN})	High without manure	Temperate/ Boreal and Tropical	Dry	1.04	Represents significantly greater crop residue inputs over medium C input cropping systems due to additional practices, such as production of high residue yielding crops, use of green manures, cover crops, improved vegetated fallows, irrigation, frequent use of perennial grasses in annual crop rotations, but without manure applied
			Moist/Wet	1.11	
		Tropical Montane	n/a	1.08	
Input (f_{IN})	High with manure	Temperate/ Boreal and Tropical	Dry	1.37	Represents significantly higher C input over medium C input cropping systems due to an additional practice of regular addition of animal manure
		-	Moist/ Wet	1.44	
		Tropical Montane	n/a	1.41	

9 Ibid.

Table 4. Relative stock change factors (f_{LU}, f_{MG}, and f_{IN}) for grassland management[10]

Factor type	Level	Climate regime	Factor value	Description
Land use (f_{LU})	All	All	1.00	All permanent grassland is assigned a land-use factor of 1
Management (f_{MG})	Non-degraded grassland	All	1.00	Non-degraded and sustainably managed grassland, but without significant management improvements
Management (f_{MG})	High intensity grazing	All	0.90	High intensity grazing systems (or cutting and removal of vegetation) with shifts in vegetation composition and possibly productivity but is not severely degraded
~~Management (f_{MG})~~	~~Moderately degraded grassland~~	~~Temperate/ Boreal~~	~~0.95~~	~~Overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) and receiving no management inputs~~
		~~Tropical~~	~~0.97~~	
		~~Tropical Montane~~	~~0.96~~	
Management (f_{MG})	Severely degraded	All	0.70	Implies major long-term loss of productivity and vegetation cover, due to severe mechanical damage to the vegetation and/or severe soil erosion
Management (f_{MG})	Improved grasslands	Temperate/ Boreal	1.14	Represents grassland which is sustainably managed with moderate grazing pressure and that receive at least one improvement (e.g. fertilization, species improvement, irrigation)
		Tropical	1.17	
		Tropical Montane	1.16	
Input (f_{IN}) (applied only to improved grassland)	Medium	All	1.00	~~All grassland without input of fertilizers is assigned an input factor of 1~~ Improved grassland where no additional management inputs have been used.

[10] Adapted from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Table 6.2 (updated).

Factor type	Level	Climate regime	Factor value	Description
	High	All	1.11	~~Grasslands with direct application of fertilizers (organic or inorganic) beyond what is required to be classified as improved grassland~~ Improved grassland where one or more additional management inputs/improvements have been used (beyond that required to be classified as improved grassland)

Appendix 2. Example identification of alternative uses

1. Consider a project activity which includes the installation of a new biomass-only power plant, and the retrofit of an existing co-fired biomass-fossil-fuel power plant, which has historically used rice husks, produced on-site. Suppose that the project activity will use two types of biomass residues, rice husks (historical use plus an additional amount) and diverse agricultural residues (as additional biomass residues compared to the historical situation). Further consider that the rice husks used in the project would come from two different sources, on-site production and off-site supply from an identified rice mill. Presumably, the rice husks produced on-site would have been partly used on-site for electricity generation and partly be dumped in the determined alternative scenario. The rice husks procured off-site would have been dumped in the determined alternative scenario. The diverse agricultural residues are purchased from a biomass retailer. For this example, four categories of biomass residues should be considered in the subsequent analysis, as illustrated in Table 1.

2. The last column of Table 1 corresponds to the quantity of each category of biomass residues (tonnes). For the determination of the alternative scenario, at the validation stage, an ex ante estimation of these quantities should be provided. These quantities should be updated every year of the crediting period as part of the monitoring plan so as to reflect the actual use of biomass residues in the project scenario. These updated values should be used for emissions reductions calculations. Along the crediting period, new categories of biomass residues (i.e. new types, new sources, with different fate) can be used in the project activity. In this case, a new line should be added to the table.

Table 1. Table for biomass residues categories

Biomass residues category (*k*)	Biomass residues type	Biomass residues source	Biomass residues fate in the absence of the project activity	Biomass residues use in project scenario	Biomass residues quantity (tonnes)
1	Rice husks	On-site production	Electricity generation on-site (B4)	Electricity generation on-site (biomass-only boiler)	See comments above
2	Rice husks	On-site production	Dumped (B1)	Electricity generation on-site (biomass-only boiler)	See comments above
3	Rice husks	Off-site from an identified rice mill	Dumped (B1)	Electricity generation on-site (biomass-only boiler)	See comments above
4	Agricultural residues	Off-site from a biomass residues retailer	Unidentified (B4)	Electricity generation on-site (co-fired boiler)	See comments above

Appendix 3. Explanation of factors used

1. In equation (2), the factor to account for soil N_2O emissions associated with loss of soil organic carbon is calculated following volume 4 chapters 3 and 11 of the 2019 IPCC Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories. Loss of SOC leads to associated mineralisation of N in the soil, leading to N_2O emissions:

    (a) The mineralised *N* can be calculated using equation (11.1) and (11.10), with EF_1= 0.01, EF_5 = ~~0.0075~~ 0.011 and $Frac_{LEACH}$ = ~~0.3~~ 0.24, results in total ~~0.01225~~ 0.01264 tN-N_2O/tN[1];

    (b) Using equation (11.8) of the IPCC guidelines, in which *R* is set to ~~10~~ 8 tSOC/tN, results in ~~0.001225~~ 0.00158 tN-N_2O/tSOC;

    (c) Converting to t CO_2e/tSOC by multiplying with ~~298~~ 265 (GWP_{N2O}) and dividing by 28/44 (Weight of *N* in N_2O) results in ~~0.574~~ 0.658 t CO_2e/tSOC;

    (d) Dividing by 44/12 (mass ratio of CO_2 and C) to convert to t CO_2e/t CO_2 (dimensionless factor) results in ~~0.156~~ 0.179 tCO_2e released in N_2O for each t CO_2 released from SOC.

2. In equation (3), the factor to account for the IPCC default factor was derived from evaluating worse-case scenario, i.e. worse uncertainties, in the used factors:

    (a) Reviewing the IPCC data, SOC_{REF} has error estimate of 90% (2019 IPCC refinement, table 2.3, table note), whereas the various *f* factors have error estimate of up to 50 per cent (IPCC tables 5.4 and 6.2). These are two sigma estimates, equivalent to 95 per cent confidence interval;

    (b) Converting them to 90 per cent confidence interval (equivalent to 1.282 sigma), which is deemed appropriate for the tool, by multiplying with 1.282/2, results in SOC_{REF} uncertainty of 58 per cent, and the various *f* factors in uncertainties of 32 per cent;

    (c) Adding the root-mean-square of these error estimates result in total 70 per cent error (Note the *f* uncertainties have each half the weight of the SOC_{REF} error estimate, due to the addition in the equation);

    (d) As SOC_{REF} always has error estimate of 58 per cent, total error estimate has range of 58–70 per cent;

    (e) The error estimates being in the uncertainty band of 50-100 per cent, result in a corrective factor of 1.21 according to FCCC/SBSTA/2003/10/Add.2/6.

3. In equation (5), the default value of the aggregate emission factor for N_2O and CO_2 emissions resulting from production and application of nitrogen, is calculated following volume 4 chapters 3 and 11 of 2006 IPCC Guidelines for National Greenhouse Gas

[1] (EF_5 x $Frac_{LEACH}$)+ EF_1

Inventories, as well as based on Wood and Cowie (2004) and Swaminathan (2004). The calculation is for ammonium nitrate, which is considered conservative:[2]

(a) Direct and indirect N_2O emissions (emissions associated to the fertiliser application on the soil) calculated, using IPCC equations (11.1), (11.9) and (11.10), with $EF_1 = 0.01$, $EF_4 = 0.01$ EF_5 = ~~0.0075~~ 0.011, $Frac_{GASF}$ = 0.11 and $Frac_{LEACH}$ = ~~0.3~~ 0.24, results in total ~~0.01325~~ 0.01374 tN-N_2O/tN. This is converted, by multiplying with ~~298~~ 265 (GWP_{N2O}) dividing by 28/44 (Weight of *N* in N_2O), to ~~6.20~~ 4.19 t CO_2e/tN[3];

(b) Emissions from synthetic fertiliser production, including fuel, feedstocks and emissions during production, calculated based on Wood and Cowie (2004) and Swaminathan (2004), taken for ammonium nitrate, a conservative fertiliser, is 7.1 t CO_2e/tN;

(c) Adding the above emissions results in ~~13.3~~ 11.29 t CO_2e/tN.

4. In equation (~~7~~8), the factor to account for non-CO_2 emissions from biomass clearance or burning was calculated using the values in table 2.5, volume 4 chapter 2 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories:

(a) Taking the values for savannah and grassland, which are most conservative;

(b) (1613 g CO_2 + 2.3 g CH_4 x ~~25~~ 21 (GWP_{CH4}) + 0.21 g N_2O x ~~298~~ 265 (GWP_{N2O}))/1613 g CO_2 = ~~1.07~~ 1.06.

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[2] ~~As a comparison, the calculation is repeated for organic fertiliser:~~

~~(a) Direct and indirect N_2O emissions calculated similarly to ammonium nitrate, but with $Frac_{GASM}$=0.2 resulting in 6.67 t CO_2e/tN;~~

~~(b) No emissions from fertiliser production are considered, resulting in total 6.67 t CO_2e/tN. As an additional comparison, the calculation is also repeated for synthetic urea:~~

~~(c) Direct and indirect N_2O identical to ammonium nitrate equals 6.20 t CO_2e/tN;~~

~~(d) Emissions from urea production, from the same source as ammonium nitrate, is 1.70 t CO_2e/tN;~~

~~(e) Emissions from urea applications (carbon released from the urea decomposition) calculated as 0.429 tC/tN, which is the C/N mass ratio in urea. This is converted, by dividing by 12/44 (Weight of *C* in CO_2), to 1.57 t CO_2e/tN;~~

~~(f) Adding the above emissions results in 9.5 t CO_2e/tN.~~

[3] $[(EF_4 \times Frac_{GASF}) + (EF_5 \times Frac_{LEACH}) + EF_1] \times GWP_{N2O} / (28/44)$

Document information

Version	*Date*	*Description*
06.0	21 February 2022	MP 87, Annex 5 To be considered by the Board at EB 113. A call for public input will be issued for this draft document. Any input will be discussed with the MP and forwarded to the Board for its consideration together with this document. Revision to: • Provide clarity on the approach in determine project emissions from the utilization of biomass or biomass residues; • Update the tables and default factors based on the 2019 refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
05.0	1 October 2021	MP 86, Annex 3 A call for public input will be issued for this draft document. Any input will be considered at MP87 when the MP prepares the revision and recommendation to the Board. Revision to: • Provide clarity on the approach in determine project emissions from the utilization of biomass or biomass residues; • Update the tables and default factors based on the 2019 refinement to the 200 IPCC Guidelines for National Greenhouse Gas Inventories.
04.0	22 September 2017	EB 96, Annex 8 Revision to provide flexible and objective requirements and best practice examples for missing data management.
03.0	4 November 2016	EB 92, Annex 6 Revision to provide clarity on eligible types of land and to broaden its applicability to cover biomass cultivation in forest that is at its last rotation of forest plantation.
02.0	16 April 2015	EB 83, Annex 8 Revision to: • Simplify and streamline the requirements for accounting for leakage emissions from use of biomass residues or biomass from cultivation; • Introduce leakage calculation due to use of biomass residues; • Expand simplified approaches to include both small-scale and large-scale methodologies; • Includes project emissions due to biomass processing and biomass transport; • Change the title from "Project emissions from cultivation of biomass" to "Project and leakage emissions from biomass".
01.0	4 October 2013	EB 75, Annex 11

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