CLEAN DEVELOPMENT MECHANISM

TOOL16

Methodological tool

Project and leakage emissions from biomass

Version 05.0

United Nations
Framework Convention on
Climate Change

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1. Introduction

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

2. Scope, applicability, and entry into force

2.1. Scope

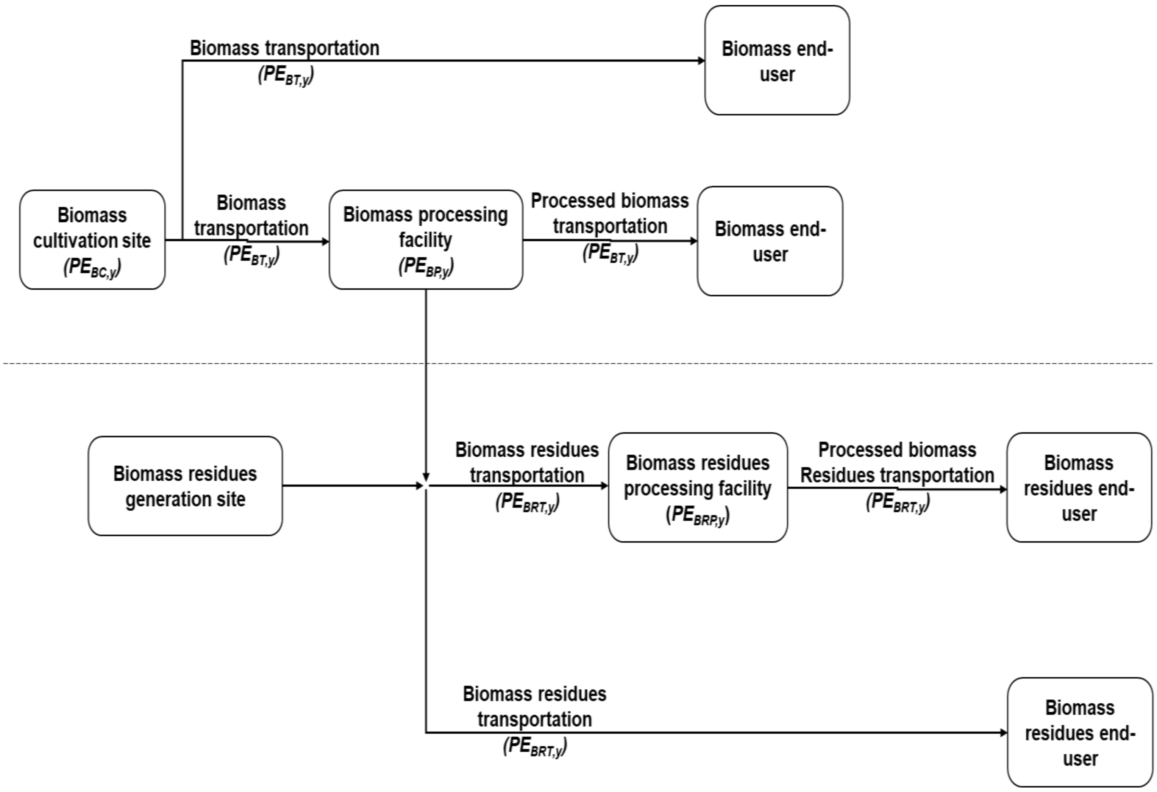
2. The tool provides methods for estimating emissions along the value chain of biomass and biomass residues and includes the following project emissions and leakage sources:

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)
$PE_{BT,y}$	tCO_2e	Project emissions resulting from transportation of biomass in year *y* (Section 5.2)
$PE_{BRT,y}$	tCO_2e	Project emissions resulting from transportation of biomass residues in year *y* (Section 5.2)
$PE_{BP,y}$	tCO_2e	Project emissions resulting from processing of biomass in year *y* (Section 5.3)
PE_{BRP}	tCO_2e	Project emissions resulting from processing of biomass residues in year *y* (Section 5.3)
$LE_{BC,y}$	tCO_2e	Leakage due to shift of pre-project activities resulting from cultivation of biomass in a dedicated plantation in year *y* (Section 6.1)
$LE_{BR,Div,y}$	tCO_2e	Leakage due to diversion of biomass residues from other applications in year *y* (Section 6.2)
$LE_{BRT,y}$	tCO_2e	Leakage due to the transportation of biomass residues outside of the project boundary in year *y* (section 6.3)
$LE_{BRP,y}$	tCO_2e	Leakage due to processing of biomass residues outside the project boundary in year *y* (Section 6.4)

3. Figure 1 below provides an overview of the project emission sources over the value chain of the biomass and biomass residues:

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



4. The methodology that refers to this tool shall indicate which of the emission sources listed in Table 1 above are to be included or omitted in the calculation of project emissions.

5. Unless allowed by the methodology, only positive leakage, i.e. increased emissions outside the project boundary, can be accounted under this tool. If the result of the lekage calculation is negative, assume a value equals to zero.

2.2. Applicability

6. This tool shall be applied in conjunction with the methodology that refers to this tool.

7. For project activities which include biomass cultivation:

(a) The land in which biomass is cultivated:

(i) Does not contain wetlands;

(ii) Does not contain organic soils as defined in paragraph 13(c);

(iii) Is not subjected to flood irrigation.

(b) The land in which biomass is cultivated:

(i) Does not contain forest nor contained forest since 31 December 1989; or

(ii) 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.

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

8. In case the land contains a forest plantation, the project participants shall demonstrate that before the start of the project activity the plantation will be finally harvested and regeneration to forestland (according to the respective national definition) will not take place. In doing so, the project proponent shall:

(a) 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 forest plantation continues under the current management practice;

(ii) The forest plantation is harvested and the land is replanted;

(iii) 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 "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 7(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.

9. 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

10. The date of entry into force is the date of the publication of the EB 113 meeting report on 11 March 2022.

3. Normative references

11. This tool refers to the the latest approved version of 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

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

13. 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 it satifies 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;

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

(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

14. Project emissions involve emissions resulting from the cultivation of biomass, transportation of biomass, processing of biomass, transportation of biomass residues and processing of biomass residues.

5.1. Project emissions resulting from cultivation of biomass in a dedicated plantation in year *y* ($PE_{BC,y}$)

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

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

Where:

$PE_{SOC,y}$	=	Project emissions resulting from loss of soil organic carbon in year y (tCO_2e)
$PE_{SM,y}$	=	Project emissions resulting from soil management in year *y* (tCO_2e)
$PE_{BSH,EC,y}$	=	Project emissions resulting from energy consumption (electricity and fuel) for biomass seeding and harvesting in year *y* ($t\ CO_2e$)
PE_{BBy}	=	Project emissions resulting from clearance or burning of biomass, in year *y* ($t\ CO_2e$)
	=	

16. 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. Project emissions resulting from loss of soil organic carbon in year y ($PE_{SOC,y}$)

17. 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 from Appendix 1;

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

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

(c) Land-use and land management activities on grasslands given in Table 4 from Appendix 1. This also applies to abandoned land.

18. 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.

19. Subject to the provision of the paragraph 18 above, emissions resulting from loss of soil organic carbon are estimated as follows:

$$PE_{SOC,y} = \max\left(\frac{44}{12} \times \frac{1.179}{T} \times \sum_{i} \Delta SOC_i , 0\right) \quad \text{Equation (2)}$$

Where:

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
1.179	=	Factor to account for soil N_2O emissions associated with loss of soil organic carbon[3]; dimensionless
i	=	Strata of areas of land

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

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

Where:

$A_{SOC,i}$	=	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;

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

1.21	=	Conservativeness factor accounting for the uncertainties in the values in Tables 2 to 4 from Appendix 1;[4]

21. The values of relative stock change factors shall be determined according to Tables 2 to4 from Appendix 1 of this tool.[5]

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

5.1.2. Project emissions resulting from soil management in year y ($PE_{SM,y}$)

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

$$PE_{SM,y} = PE_{SF,y} + PE_{SA,y}$$

Equation (4)

Where:

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

5.1.2.1. Project emissions resulting from soil fertilization and management in year y ($PE_{SF,y}$)

24. 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:

$q_{N,y}$	=	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 11.29 t CO_2e/(t N)[6] shall be used;

[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.

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

5.1.2.2. Project emissions resulting from soil amendment in year y (*$PE_{SA,y}$*)

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

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

Where:

$q_{SA.i,y}$	=	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);
$EF_{SA,i}$	=	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. Project emissions resulting from energy consumption (electricity and fuel) for biomass seeding and harvesting in year *y* (*$PE_{BSH,EC,y}$*)

26. 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) 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)

27. $PE_{BSH,electricity,y}$ 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 to the parameter $PE_{EC,y}$ from the TOOL05;

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

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

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[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.

5.1.4. Project emissions resulting from clearance or burning of biomass in year *y* ($PE_{BB,y}$)

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

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

Where:

$\frac{44}{12}$	=	Factor for converting units from t C to t CO_2e; dimensionless
0.47	=	Default value of carbon fraction of biomass burnt;[10] dimensionless
1.06	=	Factor to account for non-CO_2 emissions from biomass clearance or burning[11]. 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;
i	=	Strata of areas of land.

5.2. Project emissions resulting from transportation of biomass in year *y* ($PE_{BT,y}$) and Project emissions resulting from transportation of biomass residues in year *y* ($PE_{BRT,y}$)

30. Unless otherwise required in the applied methodology, project 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 the biomass

[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.

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

31. 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 and small-scale project activities, apply a default emission factor of 0.0142 tCO_2/tonne of biomass[12];

(b) For large-scale project activities, apply a net-to-gross adjustment of 10%[13], 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.

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[12] Determined assuming that 1 tonne of biomass is transported using heavy duty vehicles (with an associated specific emission factor of 129 gCO_2/tkm according to the Data/Parameter table 1 from the TOOL12) through a round-trip distance of 110 km (average round-trip distance observed for a sample of registered CDM projects).

[13] Determined as the ratio between (i) the emissions to transport 1 tonne of biomass and (ii) the emission reductions from the electricity generated by 1 tonne 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) 110 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 tonne of biomass are determined by multiplying the distance travelled (200 km) by the emission factor of the heavy duty vehicles to transport 1 tonne 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 tonne of biomass is determined as the product between the energy released when burning one tonne of black liquor (5.9 TJ/Gg, or 1.64 MWh/tonne), 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 tonne 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%.

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

32. 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 resulting from the consumption of electricity due to thermo-chemical, biological and mechanical processing of the biomass in year *y* (tCO_2e)
$PE_{BP,fuel,y}$	=	Project emissions resulting 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 resulting 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 resulting from composting due to thermo-chemical, biological and mechanical processing of the biomass in year *y* (tCO_2e)
$PE_{BP,AD,y}$	=	Project emissions resulting 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 resulting 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 resulting from the use of additives to process the biomass in year *y* (tCO_2e)
$PE_{BRP,electricity,y}$	=	Project emissions resulting from the consumption of electricity due to thermo-chemical, biological and mechanical processing of the biomass residues in year y (tCO_2e)
$PE_{BRP,fuel,y}$	=	Project emissions resulting from the consumption of fossil fuels due to thermo-chemical, biological and mechanical processing of the biomass residues in year y (tCO_2e)
$PE_{BRP,CH4,y}$	=	Project methane missions resulting from the decay of biomass residues under anaerobic conditions due to thermo-chemical, biological and mechanical processing in year *y* (tCO_2e)
$PE_{BRP,COMP,y}$	=	Project emissions associated resulting from composting due to thermo-chemical, biological and mechanical processing of the biomass residues in year *y* (tCO_2e)

$PE_{BRP,AD,y}$	=	Project emissions resulting from 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 resulting 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 resulting from the use of additives to process the biomass residues in year *y* (tCO_2e)

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

33. Emissions resulting from the electricity consumed due to thermo-chemical, biological and mechanical processing of the biomass and biomass residues 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. Project emissions resulting from the fuel consumed due to thermo-chemical, biological and mechanical processing of biomass in year *y* ($PE_{BP,fuel,y}$) and Project emissions resulting from the fuel consumed due to thermo-chemical, biological and mechanical processing of biomass residues in year *y* ($PE_{BRP,fuel,y}$)

34. Emissions resulting from the fuel consumed due to thermo-chemical, biological and mechanical processing of the biomass and biomass residues 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. Project methane emissions resulting from the decay of biomass under anaerobic conditions as a result of thermo-chemical, biological and mechanical processing in year *y* ($PE_{BP,CH4,y}$) and Project methane emissions resulting from the decay of biomass residues under anaerobic conditions as a result of thermo-chemical, biological and mechanical processing in year *y* ($PE_{BRP,CH4,y}$)

35. Emissions of methane from the decay of biomass under anaerobic conditions as a result of thermo-chemical, biological and mechanical processing of the biomass and biomass residues 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. Project emissions resulting from composting due to thermo-chemical, biological and mechanical processing of biomass in year *y* ($PE_{BP,COMP,y}$) and Project emissions resulting from composting due to thermo-chemical, biological and mechanical processing of biomass residues year *y* ($PE_{BRP,COMP,y}$)

36. Emissions of methane from the composting as a result of thermo-chemical, biological and mechanical processing of the biomass and biomass residues 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. Project emissions resulting from the anaerobic digester due to thermo-chemical, biological and mechanical processing of biomass in year *y* ($PE_{BP,AD,y}$) and Project emissions resulting from the anaerobic digester due to thermo-chemical, biological and mechanical processing of biomass residues in year *y* ($PE_{BRP,AD,y}$)

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

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

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

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

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

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

Where:

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

39. $PE_{BP,additives,transport,y}$ and $PE_{BRP,additives,transport,y}$ are determined following the provisions from the TOOL12. The simplifications contained in paragraph 31 also apply.

40. Project 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.

41. Project 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

42. As an alternative to the monitoring of the parameters needed to calculate $PE_{BP,additives,y}$ and $PE_{BRP,additives,y}$, 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. Leakage

43. 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 processing and transportation of biomass residues outside of the project boundary.

6.1. Leakage due to shift of pre-project activities resulting from cultivation of biomass in a dedicated plantation in year *y* ($LE_{BC,y}$)

44. 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.

45. 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.

46. 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.

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

48. 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.

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

49. 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.

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

50. 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.[14]

51. 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-PDD and remain consistent throughout the crediting period.

52. 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 50 and 51 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 as in paragraph 50 above);

(d) Explain and document transparently in the CDM-PDD, using a table similar to Table 1 from 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

[14] 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.

feedstock) but have been dumped and left to decay, land-filled, left in the field to decay after harvest,[15] or burnt without energy generation (e.g. field 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.

53. 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.

6.2.2. Calculation of leakage due to diversion of biomass residues

54. 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.

55. 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.

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

$$LE_{BR,Div,y} = EF_{CO2,LE} \times \sum_{n} BR_{PJ,n,y} \times NCV_{n,y}$$ Equation (15)

Where:

$LE_{BR,Div,y}$	=	Leakage emissions due to the diversion of biomass residues from other applications 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 of category *n* used in facilities which are located at 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)

[15] 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.

n = Categories of biomass residues for which B4 has been identified as the alternative scenario

57. 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.

6.3. Leakage due to the transportation of biomass residues outside of the project boundary in year *y* ($LE_{BRT,y}$)

58. If 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 the parameter $LE_{BRT,y}$ corresponds to $LE_{TR,m}$ from the TOOL12.

6.4. Leakage due to processing of biomass residues outside the project boundary in year *y* ($LE_{BRP,y}$)

59. If processing of biomass residues occur outside the project boundary, the requirements and equations in Section 5.3 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;

7. Monitoring methodology

7.1. Data and parameters not monitored

60. 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:	-

61. 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 from 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 from 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:	**$B_{0,ww}$**
Data unit:	t_{CH4}/t_{COD}
Description:	Maximum methane producing capacity, expressing the maximum amount of CH_4 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:	-

7.2. Data and parameters monitored

62. 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 soil 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 soil 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:	$\mathbf{A}_{\boldsymbol{FR,i,y}}$
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 clearance or 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:	$V_{BP,ww,y}$ / $V_{BRP,ww,y}$
Data unit:	m^3
Description:	$\mathbf{V_{BP,ww,y}}$: Quantity of wastewater generated from the processing of biomass in year y $\mathbf{V_{BRP,ww,y}}$: Quantity of wastewater 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 14.

Data / Parameter:	***$COD_{BP,ww,y}$ / $COD_{BRP,ww,y}$***
Data unit:	t_{COD}/m^3
Description:	**$COD_{BP,ww,y}$:** Average chemical oxygen demand of the wastewater generated from the processing of biomass in year y **$COD_{BRP,ww,y}$:** Average chemical oxygen demand of the wastewater 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 15.

Data / Parameter:	***$MCF_{BP,ww,y}$ / $MCF_{BRP,ww,y}$***
Data unit:	-
Description:	**$MCF_{BP,ww,y}$:** Methane conversion factor for the treatment of wastewater generated from the processing of biomass in year y **$MCF_{BRP,ww,y}$:** Methane conversion factor for the treatment of wastewater 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:	-

Data / Parameter table 16.

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

63. 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 17.

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 18.

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 19.

Data / Parameter:	**Moisture content of the biomass residues**
Data unit:	Percentage of 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 20.

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:	-

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	63	NA	10	117	20	116
Cold temperate, dry	43	33	13	NA	20	87
Cold temperate, moist	81	76	51	128	136	128
Warm temperate, dry	24	19	10	NA	84	74
Warm temperate, moist	64	55	36	143	138	135
Tropical, dry	21	19	9	NA	50	22
Tropical, moist	40	38	27	NA	70	68
Tropical, wet	60	52	46	NA	77	49
Tropical montane	51	44	52	NA	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	0.77	Area has been continuously managed for crops for more than 50 years
			Moist	0.70	
		Warm temperate	Dry	0.76	
			Moist	0.69	
		Tropical	Dry	0.92	
			Moist/Wet	0.83	
Land use (f_{LU})	Set aside (< 20 yrs)	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.
			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	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	1.04	
		Tropical	Dry	0.99	
			Moist/Wet	1.04	
		Warm Temperate	Dry	0.99	
			Moist/Wet	1.04	
Management (f_{MG})	No-tillage	Cool Temperate/ Boreal	Dry	1.03	Direct seeding without primary tillage, with only minimal soil disturbance in the seeding zone. Herbicides are typically used for weed control
			Moist	1.09	
		Tropical	Dry	1.04	
			Moist/Wet	1.10	
		Warm temperate	Dry	1.04	
			Moist/Wet	1.10	

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

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})	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	Improved grassland where no additional management inputs have been used.
	High	All	1.11	Improved grassland where one or more additional management inputs/improvements have been used (beyond that required to be classified as improved grassland)

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

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 $EF_1 = 0.01$, $EF_5 = 0.011$ *and* $Frac_{LEACH} = 0.24$, results in total 0.01264 tN-N_2O/tN[1];

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

    (c) Converting to t CO_2e/tSOC by multiplying with 265 (GWP_{N2O}) and dividing by 28/44 (Weight of *N* in N_2O) results in 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 0.179 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:

(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 $EF_1 = 0.01$, $EF_4 = 0.01$ $EF_5 = 0.011$, $Frac_{GASF} = 0.11$ and $Frac_{LEACH} =$ 0.24, results in total 0.01374 tN-N_2O/tN. This is converted, by multiplying with 265 (GWP_{N2O}) dividing by 28/44 (Weight of *N* in N_2O), to 4.19 t CO_2e/tN[2];

(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 11.29 t CO_2e/tN.

4. In equation (8) from the tool, 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 21 (GWP_{CH4}) + 0.21 g N_2O x 265 (GWP_{N2O}))/1613 g CO_2 = 1.06.

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2 $[(EF_4 \times Frac_{GASF}) + (EF_5 \times Frac_{LEACH}) + EF_1] \times GWP_{N2O} / (28/44)$

Document information

Version	*Date*	*Description*
05.0	11 March 2022	EB 113, Annex 11 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.
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 Initial adoption.

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