METHODOLOGICAL TOOL

BM-T-AR-0002

Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R ICM project activity

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Version 1.0

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1. Introduction

1. This tool offers a systematic method to determine the baseline scenario while concurrently demonstrating additionality.

2. Scope & Applicability

2.1. Scope

2. This tool can be used for the estimation of non-CO2 GHG emissions resulting from burning of biomass and forest fires.

2.2. Applicability

3. The tool is applicable to all occurrences of fire within the project boundary.

4. Non-CO2 GHG emissions resulting from any occurrence of fire within the project boundary shall be accounted for each incidence of fire which affects an area greater than the minimum threshold area reported by the host Party for the purpose of defining forest, provided that the accumulated area affected by such fires in a given year is ≥5% of the project area.

2.3. Assumptions

5. This tool applies the following assumptions:

   a. Aboveground biomass of living trees shall be considered not to result in significant

   non-CO2 GHG emission in case of fire, when

         i. A forest fire burns through the understory but does not climb into the tree canopy; or

         ii. A forest fire singes trees but does not cause mortality such that leaf regeneration can be observed within six months (this may be demonstrated in remote sensing imagery)

   b. 60% of the dead organic matter is entirely burnt in all fires.

2.4. Parameters

6. This tool provides steps to estimate the parameter(s) given in Table 1.

Table 1: Parameters determined by the tool

Parameter	Unit	Description
$GHG_{E,t}$	t CO_2-e	Emission of non-CO2 GHGs resulting from burning of biomass and forest fires within the project boundary, in year t

2.5. Methodological Tool Approval Date

7. The date of adoption of this document shall be effective from 27 March 2025.

3. Methodology:

3.1. Estimation of Emissions of Greenhouse Gases

8. Emission of non-CO_2 GHGs resulting from burning of biomass and forest fires within the project boundary in year t is estimated as follows:

$$GHG_{E,t} = GHG_{SPF,t} + GHG_{FMF,t} + GHG_{FF,t} \tag{1}$$

Where:

$GHG_{E,t}$	Emission of non-CO2 GHGs resulting from burning of biomass and forest fires within the project boundary in year t; t CO2-e
$GHG_{SPF,t}$	Emission of non-CO2 GHGs resulting from use of fire in site preparation in year t; t CO2-e
$GHG_{FMF,t}$	Emission of non-CO2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management, in year t; t CO2-e
$GHG_{FF,t}$	Emission of non-CO2 GHGs resulting from fire in year t; t CO2-e
t	1, 2, 3, . years counted from the start of the A/R ICM project activity

3.2. Emission resulting from use of fire in site preparation

9. Emission of non-CO_2 GHGs resulting from use of fire in site preparation in year t is estimated as follows:

a. For all areas of land where: (i) Slash-and-burn is a common practice in the baseline, and (ii) Fire has been used in the area at least once during the period of ten years preceding the start of the A/R ICM project activity:

$$GHG_{SPF,t} = 0 \tag{2}$$

b. For all areas of land where the condition (a) above is not satisfied:

$$GHG_{SPF,t} = 0.07 * \sum_{i=1}^{M}(A_{SPF,t,i} * 44/12 * (CF_{TREE} * b_{TREE,i,t} + BDR_{SF} * CF_{SHRUB} * CC_{SHRUB,i,t} * B_{FOREST}) \tag{3}$$

where

CF_{SHRUB}	Carbon fraction of shrub biomass; t C (t d.m.)-1

	The IPCC default value of 0.50 is used
$A_{SPF\,t}$	Area of land in which fire is used in site preparation in stratum i in year t; ha
BDR_{SF}	Ratio of shrub biomass per unit area in land having a shrub crown cover of 1.0 and the default above-ground biomass content in forest in the region/country where the A/R ICM project is located; dimensionless
	A default value of 0.10 is used unless transparent and verifiable information can be provided to justify a different value
B_{FOREST}	Default above-ground biomass content in forest in the region/country where the A/R ICM project is located; t d.m. ha-1 The value of this parameter is selected according to the guidance provided in the relevant entry in the tables at the end of this tool
$CC_{SHRUB\,i\,t}$	Crown cover of shrubs in an area of land within the project boundary at the start of the project in which fire is used for site preparation in stratum i in year t; dimensionless
$GHG_{SPF,t}$	Emission of non-CO2 GHGs resulting from use of fire in site preparation in year t; t CO2-e
0.07	The ratio of non-CO2 GHG emissions to CO2 emissions resulting from burning of biomass; dimensionless
	The value of this ratio has been adapted from Table 2.5 of the *2006 IPCC Guidelines for National GHG Inventories*, taking into account methane (CH4) and nitrous oxide (N2O) emissions only
$b_{TREE,i,t}$	Mean tree biomass per hectare within stratum i in the project boundary at the start of the project; t d.m. ha-1
	Estimated using the tool .Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R ICM project activities. Where pre-project living trees are not burned during site preparation, bTREE,i shall be set equal to zero
CF_{TREE}	Carbon fraction of biomass; t C (t d.m)-1. The IPCC default value of 0.50 is used
t	*1, 2, 3, .* years counted from the start of the A/R ICM project activity
i	Stratum within the baseline

3.3. Non-CO2 emissions resulting from use of fire to clear the land of harvest residue prior to replanting of the land

10. Emissions of non-CO2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land is estimated on the basis of the ratio of the biomass left at site to the biomass harvested. In the case of fuelwood harvest this ratio is likely to be smaller than in the case of timber harvest. It is, therefore, conservative to apply the ratio in the case of timber harvest to the case of fuelwood and other harvests.

When the data on biomass of the harvest removed are available

11. *If the* data on biomass of the harvest removed are available, the emission of non-CO2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land is estimated as follows:

$$GHG_{FMF\,t} = 0.07*44/12 * B_{HARVEST\,t} * f_{BL} * CF_{TREE} \qquad (4)$$

where:

$GHG_{FMF\,t}$	Emission of non-CO2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land, in year t; t CO2-e
$B_{HARVEST\,t}$	Biomass harvested from area subjected to use of fire to clear the land of harvest residue prior to replanting of the land in year t; t d.m.
f_{BL}	The fraction of aboveground tree biomass out of total harvest left on-site; dimensionless A value of 0.10 for temperate forests and 0.25 for tropical forests is used. These values of the parameter have been conservatively adapted from Table 3A.1.11 of the IPCC GPG LULUCF 2003, or the latest available version
CF_{TREE}	Carbon fraction of biomass of trees harvested; t C (t d.m)-1. IPCC default value of 0.50 t C (t d.m)-1 is used
t	1, 2, 3, . years counted from the start of the A/R ICM project activity

When the data on biomass of the harvest removed are not available

12. *If the data on biomass of the harvest removed are not available, the biomass of harvest removed is estimated as follows:*

$$B_{HARVEST\,t} = B_{FOREST} / BEF_2 * A_{FMF\,t.} \qquad (5)$$

where

$B_{HARVEST\,t}$	Biomass harvested from area subjected to use of fire to clear the land of harvest residue prior to replanting of the land in year t; t d.m.
B_{FOREST}	Default above-ground biomass content in forest in the region/country where the A/R ICM project is located; t d.m. ha- The value of this parameter is selected according to the guidance provided in the relevant entry in the tables at the end of this tool
BEF_2	The biomass expansion factor for trees harvested; dimensionless A value of 1.25 is used
$A_{FMF\,t.}$	Area of land subjected to use of fire to clear the land of harvest residue prior to replanting of the land in year t; ha
T	1, 2, 3, . years counted from the start of the A/R ICM project activity

3.4. Non-CO2 emissions resulting from forest fires

13. Emission of GHGs resulting from the burning of aboveground project tree biomass in fire that is not site preparation or burning of harvest residue (defined from this point forward as forest fire) is calculated using the aboveground biomass in trees and dead wood of relevant strata in last verification.

$$GHG_{FF\,t} = GHG_{FF\,TREE\,t} + GHG_{FF\,DOM\,t} \qquad (6)$$

where:

$GHG_{FF,t}$ — Emission of non-CO_2 GHGs resulting from forest fire, in year t; t CO_2-e

$GHG_{FF\_TREE,t}$ — Emission of non-COtrees due to forest fire, in year 2 GHGs resulting from the loss of aboveground biomass of t; t CO2-e

$GHG_{FF\_DOM,t}$ — to forest fire, in year Emission of non-CO2$_{t;\,t\,CO}$ GHGs resulting from the loss of dead organic matter due $_{2\text{-e}}$

14. Emission of non-CO_2 GHGs resulting from the loss of aboveground tree biomass due fire is calculated using the above ground biomass in trees of relevant strata in last verification and a combustion factor. For the first verification, emission of non-CO_2 GHGs resulting from the loss of trees due to natural or anthropogenic forest fire is assumed to be zero.

$$GHG_{FF\_TREE,t} = 0.001 * \sum A_{BURN,i,t} * b_{TREE,i,t_L} * COMF_i * \left(EF_{CH\,4,i} * GWP_{CH\,4} + EF_{N\,2O,i} * GWP_{N\,2O} \right) \qquad (7)$$

where:

$GHG_{FF\_TREE,t}$ — trees due to fire, in year Emission of non-CO2 gases resulting from the loss of aboveground biomass of $_{t;\,t\,CO2\text{-e}}$

$A_{BURN,i,t}$ — Area burnt in stratum i in year t; ha

b_{TREE,i,t_L} — Mean aboveground tree biomass per hectare in stratum i in year t_L which is the year in which last verification was carried out before occurrence of the fire; t d.m. ha^{-1}
Where aboveground biomass of living trees is not burnt by fire, b_{TREE,i,t_L} may be set equal to zero

$COMF_i$	Combustion factor for stratum i; dimensionless
$EF_{CH4,i}$	Emission factor for CH_4 in stratum i; g CH_4 (kg dry matter burnt)$^{-1}$
GWP_{CH4}	Global warming potential for CH_4; dimensionless. Default value of 21 is used
$EF_{N2O,i}$	Emission factor for N_2O in stratum i; g N_2O (kg dry matter burnt)$^{-1}$
GWP_{N2O}	Global warming potential for N_2O; dimensionless Default value of 310 is used
I	1, 2, 3 M strata
T	1, 2, 3, years elapsed since the start of the project activity

15. Emission of non-CO_2 GHGs resulting from the loss of dead organic matter due to fire is calculated using the dead organic matter stock at the last verification. Where PPs elected at validation not to account for dead organic matter pool, the dead organic matter stock is considered zero and non-CO_2 GHG emissions from fire are not accounted. Where dead organic matter is accounted, for the first verification period emission of non-CO_2 GHGs resulting from the loss of dead organic matter due to fire is assumed to be zero, and for subsequent verification periods emission of non-CO_2 GHGs is estimated as follows:

$$GHG_{FF\_DOM,t} = 0.07 * \sum_{i=1}^{M} A_{BURN,i,t} * \left(C_{DW,i,t_L} + C_{LI,i,t_L} \right) \qquad (8)$$

where

$GHG_{FF\_DOM,t}$ Emission of GHGs resulting from the loss of dead organic matter due to fire, in year t; t CO2-e

$A_{BURN,i,t}$ Area burnt in stratum i in year t; ha

C_{LI,i,t_L} Carbon stock in litter in stratum i in year t_L which is the year in which last verification was carried out before occurrence of the fire, as estimated using the Tool for estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R ICM project activities ; t CO_2-e

C_{DW,i,t_L} Carbon stock in dead wood in stratum i in year t_L which is the year in which last verification was carried out before occurrence of the fire, as estimated using the Tool for estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R ICM project activities ; t CO_2-e

I 1, 2, 3 M strata

T	years elapsed since the start of the project activity

5.   DATA AND PARAMETERS USED IN THE TOOL

14.   The following tables describe the data and parameters used in this tool. The guidelines contained in these tables regarding selection of data sources, and procedures to be followed in measurement, where applicable, should be treated as an integral part of this tool.

Data and parameters obtained from existing sources

Data / Parameter:	BDR_{SF}
Data unit:	Dimensionless
Used in equations:	3
Description	Ratio of shrub biomass per unit area in land having a shrub crown cover of 1.0 and the default above-ground biomass content in forest in the region/country where the A/R ICM project is located
Source of data:	A default value of 0.10 should be used unless transparent and verifiable information can be provided to justify a different value

Data / Parameter:	B_{FOREST}
Data unit:	t d.m. ha^{-1}
Used in equations:	3, 5
Description:	Default above-ground biomass content in forest in the region/country where the A/R ICM project is located
Source of data:	The source of data shall be selected, in order of preference, from the following: (a) Regional/national inventories e.g. national forest inventory, national GHG inventory; (b) Inventory from neighbouring countries with similar conditions; (c) Globally available data applicable to the project site or to the region/country where the site is located (e.g. latest data from FAO); (d) Default values from the latest IPCC GPG-LULUCF

Data / Parameter:	$COMF_i$
Data unit:	dimensionless
Used in equations:	7

Description:	Combustion factor for stratum i (per vegetation type)
Source of data:	The source of data shall be selected, in order of preference, from the following: (a) Project-specific calculation, regional/national inventories e.g. national forest inventory, national GHG inventory; (b) Inventory from neighbouring countries with similar conditions; (c) Globally available data applicable to the project site or to the region/country where the site is located; (d) Default values as follows

Forest type	Mean age (years)	Default value
Tropical forest	3-5	0.46 6-10 0.67
	11-17	0.50
	18 and above	0.32
Boreal forest	All	0.40
Temperate forest	All	0.45

Data / Parameter:	EF_{CH4}
Data unit:	g kg^{-1} dry matter burnt
Used in equations:	7
Description:	Emission factor for CH_4 in stratum i
Source of data:	The source of data shall be selected, in order of preference, from the following: (a) Regional/national inventories e.g. national forest inventory, national GHG inventory; (b) Inventory from neighbouring countries with similar conditions; (c) Globally available data applicable to the project site or to the region/country where the site is located; (d) Default values as follows: (i) Tropical forest: 6.8 (ii) Other forest: 4.7

Data / Parameter:	EF_{N2O}
Data unit:	g kg^{-1} dry matter burnt
Used in equations:	7
Description:	Emission factor for N_2O in stratum i

Source of data:	The source of data shall be selected, in order of preference, from the following:
	(a) Regional/national inventories e.g. national forest inventory, national GHG inventory;
	(b) Inventory from neighbouring countries with similar conditions;
	(c) Globally available data applicable to the project site or to the region/country where the site is located; (d) Default values as follows:
	(i) Tropical forest: 0.20
	(ii) Other forest: 0.26

Data and parameters obtained from measurements

Data / Parameter:	$A_{SPF,t}$
Data unit:	ha
Used in equations:	3
Description:	Area of land in which fire is used for site preparation in year t
Measurement procedures:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In absence of these, SOPs from published handbooks, or from the latest *IPCC GPG LULUCF*, may be applied
Monitoring frequency:	This area is measured whenever fire is used in site preparation
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In absence of these, QA/QC procedures from published handbooks, or from the latest *IPCC GPG LULUCF*, may be applied

Data / Parameter:	$A_{FMF,t}$
Data unit:	ha
Used in equations:	5
Description:	Area of land subjected to use of fire to clear the land of harvest residue prior to replanting of the land in year t
Measurement procedures:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In the absence of these, SOPs from published handbooks, or from the latest *IPCC GPG LULUCF*, may be applied
Monitoring frequency:	This area is measured whenever fire is used to clear the land of harvest residue prior to replanting of the land
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the latest *IPCC GPG LULUCF*, may be applied

Data / Parameter:	$A_{BURN,i,t}$
Data unit:	ha
Used in equations:	7
Description:	Area of land subjected to use of fire to clear the land of harvest residue prior to replanting of the land in year t
Source of data:	Field measurement or remote sensing measurement
Measurement procedures:	The area shall be delineated either on the ground using GPS or from georeferenced remote sensing data
Monitoring frequency:	This area is measured whenever forest fire has occurred
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the latest IPCC GPG LULUCF, may be applied

Data / Parameter:	$CC_{SHRUB,t}$
Data unit:	Dimensionless
Used in equations:	3
Description:	Crown cover of shrubs in land where fire is used for site preparation in year t; dimensionless
Source of data:	Field measurement
Measurement procedures:	Ocular estimation of crown cover may be carried out or any other method such as the line transect method
Monitoring frequency:	This parameter is measured whenever fire is used in site preparation
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the latest *IPCC GPG LULUCF*, may be applied

IV. References

- IPCC. *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, Prepared by the National Greenhouse Gas Inventories Programme, Jim Penman, Michael Gytarsky, Taka Hiraishi, Thelma Krug, Dina Kruger, Riitta Pipatti, Leandro Buendia, Kyoko Miwa, Todd Ngaram(eds). Published: IGES, Japan.
URL: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Revision/Changes in the Document

Version	Date	Description
1.0	March 2025	Initial Adoption