Draft revision to the approved baseline and monitoring methodology AM0047

"Production of biodiesel ~~based on waste oils and/or waste fats from biogenic origin~~ for use as fuel"

I. SOURCE AND APPLICABILITY

Source

This baseline and monitoring methodology is based on the following proposed new methodologies:

- NM0180 "BIOLUX Benji Biodiesel Beijing Project", proposed by BIOLUX Benji Energy and Recycling Co. Ltd, whose baseline and monitoring methodology and project design document were prepared by Clemens Plöchl Carbon Consulting;
- NM0228 "AGRENCO Biodiesel Project in Alta Araguaia", proposed by Agrenco do Brasil S/A, whose baseline and monitoring methodology and project design document were prepared by Factor Consulting + Management AG and Geoklock Consultoria e Engenharia Ambiental Ltd;
- NM0233 "Palm Methyl Ester – Biodiesel Fuel (PME-BDF) production and use for transportation in Thailand" whose baseline and monitoring methodology and project design document were prepared by Japan Transport Cooperation Association, Japan Weather Association and ALMEC Corporation.

The methodology also refers to the latest version of the following tools:[1]

- "Tool for the demonstration and assessment of additionality";
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "Tool to determine project emissions from flaring gases containing methane";
- A/R methodological Tool: "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities"

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

~~This methodology also refers to the latest version of ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" and AMS I.D "Grid connected renewable electricity generation."~~

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable".

[1] Please refer to: <http://cdm.unfccc.int/goto/MPappmeth>.

Definitions

For the purpose of this methodology, the following definitions apply:

Biodiesel is a diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters which is produced by esterification of vegetable oils and/or waste oil/fat with alcohols from biogenic and/or fossil origin.

Biodiesel production plant is the plant where waste oil/fat or vegetable oil is processed through esterification to biodiesel.

Biogenic means that the oils and/or fats originate from either vegetable or animal biomass, but not from mineral (fossil) sources**.**

Biomass. *Biomass* is non-fossilized and biodegradable organic material originating from plants, animals and microorganisms. This shall include products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes. Biomass also includes gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material.

Biomass residues. *Biomass residues* are defined as biomass that is a by-product, residue or waste stream from agriculture, forestry and related industries. This shall not include municipal waste or other wastes that contain fossilized and/or non-biodegradable material (however, small fractions of inert inorganic material like soil or sands may be included).

Blended biodiesel is defined as a blend of petrodiesel and biodiesel.

Dedicated plantations are plantations that are newly established as part of the project activity for the purpose of supplying oil seeds to the project plant. In case the dedicated plantation is an A/R CDM project, then the procedures of the approved A/R methodology apply.

Degraded or degrading lands are lands that can be identified as degraded or degrading as per the "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities"

Esterification denotes the formation of an ester compound from carbonic acid and alcohol. Transesterification denotes the exchange of one alcohol in an ester against another (for example glycerol against methanol). In this methodology, "esterification" is used to denote both esterification and transesterification for simplicity;

Oil production plant is a plant where oil seeds from plants are processed to vegetable oil.

Oil seeds: Seeds of plants from which oil can be derived.

Petrodiesel is 100% fossil fuel diesel**.**

Vegetable oil is oil of biogenic origin that is produced from oil seeds from plants.

Waste oil/fat is defined as a residue or waste stream of biogenic origin from restaurants, agro and food industry, slaughterhouses or related commercial sectors.

Applicability

The methodology is applicable to project activities that reduce emissions through the production, sale and consumption of blended biodiesel that is used as fuel, where the biodiesel is produced from:

(a) Waste oil/fat; and/or
(b) Vegetable oil that is produced with oil seeds from plants that are cultivated on dedicated plantations established on lands that are degraded or degrading at the start of the project activity.

The methodology ensures that the CERs can only be issued to the producer of the biodiesel and not to the consumer.

The following conditions apply to the methodology:

Feedstock inputs

(a) If the biodiesel in the project plant is only **partly** produced from the two sources (a) and (b) as specified above, any volumes of biodiesel that are also produced in the project biodiesel production plant but from other feedstock sources, are not included in the quantity of biofuel for which emission reductions are claimed;
(b) The alcohol used for esterification is methanol from **fossil fuel origin**. Volumes of biodiesel produced with alcohols other than methanol (for example, ethanol) are not included in the quantity of biodiesel for which emission reductions are claimed.[2]

Dedicated plantations (the following applicability conditions have to be met **only if** the feedstock is vegetable oil from oil seeds produced in dedicated plantations)

(a) The project activity does not lead to a shift of pre-project activities outside the project boundary, i.e. the land under the proposed project activity can continue to provide at least the same amount of goods and services as in the absence of the project;
(b) The plantations are established:
    (i) On land which was, at the start of the project implementation, classified as degraded or degrading as per the "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities"; OR
    (ii) On a land area that is included in the project boundary of one or several registered CDM A/R project activities.
(c) The land area of the dedicated plantations will be planted by direct planting and/or seeding;
(d) After harvest, regeneration will occur either by direct planting, seeding or natural sprouting.

[2] Only methanol from fossil fuel origin is included because the methodology does not provide procedures for estimating emissions associated with the use of other alcohols than methanol from fossil fuel origin. Project proponents are invited to propose procedures to estimate the emissions associated with the production of other alcohols that could be used foresterification, such as ethanol or methanol from renewable sources, as a revision to this methodology.

Biodiesel plant and products

(a) The petrodiesel, the biodiesel and the blended biodiesel comply with national regulations (if existent) or with suitable international standards such as ASTM D6751, EN14214, or ANP42;
(c) The project activity involves construction and operation of a biodiesel production plant;
(d) ~~If waste water anaerobic treatment does not capture and combust the methane generated, methane emissions should be accounted as project emissions per this methodology;~~
(e) The by-product glycerol is not disposed of or left to decay. It should be either incinerated or used as raw material for industrial consumption;
(f) If biomass or biofuels are used at the site of the biodiesel production plant or the oil production plant(s) for fuel combustion (e.g. for heat or electricity generation), , then at least 95% of the biomass and biofuel used in these plants should be either biomass residues from the dedicated plantations established under the project activity or biodiesel generated in the project activity biodiesel production plant. The amount of biodiesel used should not be included in the quantity of biodiesel for which emission reductions are claimed.

Consumption of biodiesel

(a) The (blended) biodiesel is supplied to consumers within the host country who use the (blended) biodiesel for fuel combustion in existing stationary installations (e.g. diesel generators) and/or in vehicles; ~~that actually combust the blend, are included in the project boundary.~~
(b) The consumer and the producer of the (blended) biodiesel are bound by a contract that allows the producer to monitor the consumption of (blended) biodiesel and that states that the consumer shall not claim CERs resulting from its consumption;
(c) No modifications in the consumer stationary installations or in the vehicles engines are necessary to consume/combust the (blended) biodiesel. In case of stationary installations, biodiesel or blended biodiesel with any blending fraction between 0 and 100% can be used. In case of vehicles, only blended biodiesel can be used and the blending proportion must be low enough to ensure that the technical performance characteristics of the blended biodiesel do not differ significantly from those of petrodiesel. This condition is assumed to be met if the blending proportion is 20% by volume (B20)[3]. If the project participants use a blending proportion of more than 20%, they shall demonstrate in the CDM-PDD that the technical performance characteristics of the blended biodiesel do not differ significantly from those of petrodiesel and comply with all local regulations. Blending is done by the producer, the consumer or a third party who is contractually bound to the producer to ensure that blending proportions and amounts are monitored and meet all regulatory requirements;
(d) In case of vehicles, the consumer (end-user) of the blended biodiesel is a captive fleet of vehicles;
(e) Only biodiesel consumed in excess of mandatory regulations is eligible for the purpose of the project activity. [4]

~~**Activities for which CERs are claimed**~~

~~a) Project participants claim CERs only for the CO_2 emissions from petrodiesel displaced by the biodiesel.~~

- ~~Project participants **do not** claim CERs for the following: (i) Reductions in life-cycle emissions associated with the production of displaced petrodiesel; (ii) Biodiesel consumed for non-energy~~

[3] 2004 Biodiesel Handling and Use Guidelines, U.S. Department of Energy.

[4] Regulations that have been implemented since the adoption by the COP of the CDM M&P (decision 17/CP.7, 11 November 2001) need not be taken into account.

~~purposes; (iii) Utilization of by-products such as glycerol; (iv) Avoidance of methane emissions from waste water treatment due to the reduction of waste oil in waste water~~

II. BASELINE METHODOLOGY

Project boundary

The spatial extent of the project boundary encompasses:

- Where applicable, transportation of:

  (a) Oil seeds and/or biomass residues from the field(s) to the oil production plant(s);
  (b) Vegetable oil and/or waste oil/fats to the biodiesel production plant; and
  (c) The biodiesel to the site where it is blended with petrodiesel.

- The biodiesel production plant at the project site, comprising the esterification unit plus other installations on the site (e.g. storage, refining, blending, etc.);
- If the feedstock is vegetable oil: the vegetable oil production plant(s) (on-site or off-site);
- If blended biodiesel is produced: Facility where the biodiesel is blended with petrodiesel (regardless of the ownership of the blending facility);
- ~~Transportation of the blended biodiesel to the final consumer (end-user);~~
- Vehicles and existing stationary combustion installations where the (blended) biodiesel is consumed.
- If the feedstock is vegetable oil from plants produced in dedicated plantations: the geographic boundaries of the dedicated plantations.

~~Relevant emission sources within this boundary include the following (see table below for details):~~

- ~~Emissions from combustion of petrodiesel and biodiesel, taking into account the fossil carbon contained in methanol used in biodiesel production;~~
- ~~Emissions from fuel and electricity consumed in the production of biodiesel;~~
- ~~Emissions from the transport of waste oil/fat to the biodiesel plant;~~
- ~~Emissions from the transport of biodiesel to the facility where the biodiesel is blended with petrodiesel. These emissions are to be added to the project emissions only if the current distribution of the petrodiesel being displaced does not involve similar transport of fuel to a blend/distribution location.~~

If the feedstock is vegetable oils and/or fats from plants produced in dedicated plantations and the complete land area of the dedicated plantations is included in the project boundary of one or several registered A/R CDM project activities, no further emission sources related to the cultivation of the oil seeds need to be included in the project boundary.[5] Otherwise project emission sources related to the cultivation of the oil seeds shall be considered.

[5] The CDM Executive Board, at its 25th meeting, agreed that the emissions associated with an A/R activity should be accounted for in the A/R CDM project activity. In general, all project activities using biomass for energy should account for emissions associated with production of biomass. However, in the case that it can be demonstrated that for a project activity using biomass for energy, which uses biomass originating from a registered A/R project activity (i.e. through contractual agreement for procurement of biomass) it need not account for emissions related to biomass production.

Note: Production of petrodiesel leads to emissions, which would occur in the absence of project activity. These emissions are considered in the leakage section, as the production of the petrodiesel is not included in the project boundary. Similarly, emissions associated with the production of methanol used for esterification are excluded from the project boundary, but are accounted for as leakage.

Table 1: Summary of gases and sources included in the project boundary, and justification / explanation where gases and sources are not included

	Source	Gas	Included?	Justification / Explanation
Baseline	Vehicles and stationary combustion installations consuming petrodiesel	CO_2	Yes	Main source of baseline emissions
		CH_4	No	Excluded for simplification. CH_4 and N_2O emissions are assumed to be very small. No systematic difference to project activity
		N_2O	No	
Project Activity	On site energy consumption at biodiesel production plant and, if applicable, the oil production plant(s)	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Combustion of fossil fuel derived methanol in the biodiesel ester	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Transportation of oil seeds, vegetable oils and or oil/fat wastes	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Transportation of biodiesel to blending facility	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small.
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	~~Vehicles and stationary combustion installations consuming blended~~	~~CO_2~~	~~Yes~~	~~Fossil carbon contained in methanol used for esterification iThis is a significant source of emissions. The remaining carbon in the biodiesel is climate neutral.~~
		~~CH_4~~	~~No~~	~~Excluded for simplification. CH_4 and N_2O emissions are assumed to be very small. No systematic difference to baseline scenario~~
		~~N_2O~~	~~No~~	~~Excluded for simplification. N_2O emissions are assumed to be very small.~~
	Anaerobic wastewater	CO_2	No	Excluded for simplification. CO_2 emissions are assumed to be very small

	Source	Gas	Included?	Justification / Explanation
	treatment in crude vegetable oil production.	CH_4	Yes	May be a significant emissions source
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Cultivation of land to produce oil seeds (if the feedstock is vegetable oils and / or fats from plants produced in dedicated plantations)[6]	CO_2	Yes	May be a significant emissions source
		CH_4	Yes	May be a significant emissions source
		N_2O	Yes	May be a significant emissions source

Procedure for the selection of the most plausible baseline scenario

The baseline scenario should be separately determined for the following elements:

- **Production of fuels (P)**: What would have happened at the production level in the absence of the CDM project activity?
- **Consumption (C):** Which fuel would have been consumed in the absence of the CDM project activity?

If the biodiesel is produced from waste oil/fat the following element should be taken into account:

- **Material (M)**: What would have happened to the material used as input for production of biofuel in the absence of the CDM project activity?

If the biodiesel is produced from oil seeds cultivated in dedicated plantations on degraded or degrading lands the following element should be taken into account:

- **Land used for plantations (L):** What would be the land use in the absence of the CDM project activity?

For the **fuel production (P)**, project participants shall identify the most likely baseline scenario among all realistic and credible alternative(s), applying steps of the latest approved version of the “Tool for the demonstration and assessment of additionality”. Step 3 should be used to assess which of these alternatives is to be excluded from further consideration (i.e. alternatives where barriers are prohibitive or which are clearly economically unattractive) and Step 2 should be applied for all remaining alternatives. In case project proponent is a company already producing fuels other than biodiesel then only Step 2 should be applied for all options identified (barrier analysis is not allowed). Include a sensitivity analysis applying Sub-step 2d of the latest version of the “Tool for the demonstration and assessment of additionality”. If the

6 This emission source does not need to be included in the project boundary, if the complete land area of the dedicated plantation is included in the project boundary of one or several registered CDM A/R project activities. See footnote 6 for explanation.

sensitivity analysis is conclusive (for a realistic range of assumptions), then the most cost effective scenario is the baseline scenario. In case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with least emissions among the alternatives that are the most economically attractive according to the investment analysis and the sensitivity analysis. ~~Where more than one credible and plausible alternative scenario remains, project participants shall, as a conservative assumption, adopt the alternative that results in the lowest baseline emissions as the most likely baseline scenario.~~

At the production level the realistic and credible alternative(s) may include, *inter alia*:

P1: Continuation of current practices with no investment in biodiesel production capacity;
P2: The project activity implemented without the CDM; and
P3: Investment in any other alternative fuel replacing partially or totally the baseline fuel.

For the **consumption of fuel (C)**, the baseline should be determined as follows:

Step 1*: *Identify all realistic and credible alternatives for the fuel used by end consumers.

Project participants should at least consider the following alternatives with respect to the intended consumer of blended biodiesel:

C1: Continuation of petroleum diesel consumption;
C2: Consumption of biodiesel from other producers;
C3: Consumption of other single alternative fuel such as CNG or LPG, etc;
C4: Consumption of a mix of above alternative fuels;
C5: Consumption of biodiesel from the proposed project plant.

Step 2*: *Eliminate alternatives that are not complying with applicable laws and regulations

Eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements. Apply Sub-step 1b of the latest version of the “Tool for the demonstration and assessment of additionality”.

Step 3*: *Eliminate alternatives that face prohibitive barriers

Scenarios that face prohibitive barriers (e.g technical barrier) should be eliminated by applying Step 3 of the latest version of the “Tool for the demonstration and assessment of additionality”.

Step 4*: *Compare economic attractiveness of remaining alternatives

Compare the economic attractiveness for all the remaining alternatives by applying Step 2 of the latest version of the “Tool for the demonstration and assessment of additionality”. Provide all the assumptions in the CDM-PDD.

Include a sensitivity analysis applying Sub-step 2d of the latest version of the “Tool for the demonstration and assessment of additionality”. If the sensitivity analysis is conclusive (for a realistic range of assumptions), then the most cost effective scenario is the baseline scenario. In case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with least emissions among the alternatives that are the most economically attractive according to the investment analysis and the sensitivity analysis.

For the **material (M)** level, the previous steps 1 through 4 shall be taken. Project participants should at least consider the following alternatives.

M1: Use of material for production of biofuels (by the project proponent or by others);
M2: Use for material production of substances other than fuel;
M3: Incineration of material for the purpose of energy recovery;
M4: Incineration of material without energy recovery;
M5: Disposal of material in an anaerobic or aerobic manner.

For the **land use where the dedicated plantations are established (L)**, the baseline scenario should be determined as follows:

Step 1*: *Identify all realistic and credible alternatives for the land use

Project participants should at least consider the following alternatives with respect to the baseline scenario for the use of the land where the dedicated plantations are established:

L1: Continuation of current land use, i.e. continued absence of agricultural and forestry activities on degraded or degrading lands;
L2: Conversion to plantations of the oil plant without CDM;
L3: Conversion to another plantation (annual or perennial).

***Steps 2 – 4*:** Eliminate scenarios which are not in legal compliance or face prohibitive barriers or are not economically attractive, as described above for the fuel consumption scenarios.

The project participants should demonstrate that the most plausible scenario is continuation of current land use (L1), by assessing the attractiveness of the plausible alternative land uses in terms of benefits to the project participants, consulting with stakeholders for existing and future land use, and identifying barriers for alternative land uses. This can be done by demonstrating that similar lands in the vicinity are not planned to be used for alternative land uses other than L1. Show that apparent financial and/or other barriers, which prevent alternative land uses can be identified.

If the biodiesel is produced from waste oil/fat, this methodology is applicable for the baseline scenario which combines P1, C1, and any one of the M scenarios. For material scenarios M1, M2 and M3, possible leakage from the displacement of existing uses of waste oil/fat needs to be assessed, as stated in the leakage section.

If the biodiesel is produced from oil seeds, this methodology is applicable for the baseline scenario which combines P1, C1 and L1.

Additionality

The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board, and available on the UNFCCC CDM web site.

~~Additionality is assessed only for the project activity (i.e. the construction and operation of the biodiesel plant). Additionality is established ex-ante for the duration of the crediting period, i.e. the relevant~~

~~parameters are not subject to monitoring, and only need to be revalidated at the renewal of the crediting period.~~

Where Step 2 of the "Tool for the demonstration and assessment of additionality" (Investment Analysis) is used, the investment analysis shall include a sensitivity analysis of the biodiesel sales price, the feedstock costs and fuel costs.

Guidance for the Barriers Analysis when the dedicated plantation (or part of) is covered under an A/R CDM project activity

- If the A/R CDM activity and the activity covering the production, sale and consumption of blended biodiesel are two independent project activities (which may imply also that project proponents are different) then:
  - A barrier related to the implementation of the plantation cannot be used for the project activity covering the production, sale and consumption of blended biodiesel;
- If the A/R CDM project activity and the project activity covering the production, sale and consumption of blended biodiesel are part of an integrated development project (which means that the same project proponents are to be involved in the two CDM activities) then:
  - A barrier related to the implementation of the plantation can also be used by the production, sale and consumption of blended biodiesel activity.

Investment in the establishment of dedicated plantations must be considered, whether or not the establishment of such plantations is part of an A/R CDM project activity, if there is no market for the oil seeds. By definition, tCERs from A/R CDM activities, whose plantations are part of the biodiesel project, implemented under this methodology and CERs accruing from CDM project activities under this methodology must not be included in the investment analysis performed in order to identify the baseline scenario.

Baseline emissions

Baseline emissions from displaced petrodiesel are determined as follows:

$$BE_y = BD_y \cdot NCV_{BD,y} \cdot EF_{CO2,PD,y} \qquad \textbf{(1)}$$

with

$$BD_y = \min(P_{BD,y}, f_{PJ,y} \times C_{BBD,y}) - P_{BD,on-site,y} - P_{BD,other,y} \qquad \textbf{(2)}$$

Where:

BE_y	=	Baseline emissions during the year *y* (tCO_2)
$NCV_{BD,y}$	=	Net calorific value of biodiesel produced for the year *y*
BD_y	=	Quantity of biodiesel eligible for crediting in year *y* (tons)
$P_{BD,y}$	=	Production of biodiesel in the project plant in year *y* (tonnes)
$P_{BD,on-site,y}$	=	Quantity of biodiesel consumed at the project biodiesel production plant and/or the oil production plant(s) in year *y* (tonnes)

$PD_{BD,other,y}$	=	Quantity of biodiesel that is either produced with other alcohols than methanol from fossil origin or that is produced using other oil seeds or waste oil(s)/fat(s) than those eligible under this methodology according to the applicability conditions
$C_{BBD,y}$	=	Consumption of (blended) biodiesel from the project plant by the captive consumer(s) in year *y* (tonnes)
$f_{PJ,y}$	=	Fraction of blending in year *y* (ratio)
CF_{PD}	=	Conversion factor from biodiesel to petrodiesel (tonnes petrodiesel/tonnes biodiesel)
$EF_{CO2,PD}$	=	Carbon dioxide emissions factor for petrodiesel (tCO_2/GJ)
NCV_{PD}	=	Net calorific value of petrodiesel (GJ/tonne)

BD_y is determined in equation (2) as the lowest value between (a) the production of biodiesel in year *y* ($P_{BD,y}$), and (b) the consumption of biodiesel by the captive consumers in year y ($C_{BD,y}$). In the case of blended biodiesel, the consumption of eligible biodiesel is calculated by the multiplying the consumption of eligible blended biodiesel by the blending fraction ($C_{BBD,y}*f_{PJ,y}$). Only those (blended) biodiesel quantities shall be considered as eligible for which the applicability conditions are fulfilled and for which the baseline is the use of petrodiesel. Therefore, biodiesel quantities produced and consumed for the purpose of the project activity (self-consumption) and quantities which do not fulfill the applicability criteria are subtracted from the amount of biodiesel that is eligible for crediting.

~~In determining emission coefficients, emission factors or net calorific values in this methodology, guidance by the 2000 IPCC Good Practice Guidance[7] should be followed. Project participants may either conduct regular measurements or they may use accurate and reliable local or national data where available. Where such data is not available, IPCC default emission factors[8] (country-specific, if available) may be used if they are deemed to reasonably represent local circumstances. All values should be chosen in a conservative manner and the choices should be justified.~~

The conversion factor (CF_{PD}) shall be calculated based on the respective net calorific values of biodiesel and petrodiesel, as follows:

$$CF_{PD} = \frac{NCV_{BD}}{NCV_{PD}} \tag{3}$$

Where:

CF_{PD}	=	Conversion factor from biodiesel to petrodiesel (tonnes petrodiesel/tonnes biodiesel)
NCV_{BD}	=	Net calorific value of biodiesel (GJ/tonne)
NCV_{PD}	=	Net calorific value of petrodiesel (GJ/tonne)

~~[7] IPCC 2000, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.~~
~~[8] IPCC 2006, Revised 2006 Guidelines for National Grenhouse Gas Inventories, Reference Manual.~~

Project Emissions

Project activity emissions include four components:

- If the biodiesel is produced from oil seeds cultivated in dedicated plantations: project emissions from cultivation of oil seeds (this source shall not be included if the total area of dedicated plantation is registered as one or several A/R CDM project activities);
- Project emissions from transportation, where applicable. This includes:
    - Any transportation of oil seeds and/or biomass residues from the field(s) to the oil production plant(s);
    - Any transportation of vegetable oil and/or waste oil/fats to the biodiesel production plant, and;
    - Any transportation of the biodiesel to the site where it is blended with petrodiesel.
- Project emissions at the biodiesel production facility and, in case of vegetable oils, the oil production plant;
- CO_2 from combustion of fossil carbon contained in methanol that is chemically bound in the biodiesel during the esterification process, and released upon combustion;

These emission sources are only partly allocated to the production of biodiesel. Overall emissions are allocated between biodiesel and glycerol (expressed through the allocation factor $AF_{1,y}$ in equation 4) and, where applicable, project emissions associated with the cultivation of land are allocated between the different products produced from the plants expressed through the allocation factor $AF_{2,y}$ in equation 4).

Accordingly, project emissions are calculated as follows:

$$PE_y = AF_{1,y} \cdot (PE_{BPF,y} + PE_{MeOH,y} + PE_{Tr,y} + AF_{2,y} \cdot PE_{BC,y}) \quad \textbf{(4)}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2)
$PE_{BPF,y}$	=	Project emissions at the biodiesel production plant and, if applicable, the oil production plant(s) in year *y* (tCO_2)
$PE_{MeOH,y}$	=	Project emissions from fossil carbon in the biodiesel due to esterification with methanol of fossil origin in year *y* (tCO_2)
$PE_{Tr,y}$	=	Project emissions from transportation in year *y* (tCO_2)
$PE_{BC,y}$	=	Project emissions associated with the cultivation of land to produce oil seeds in year *y* (tCO_2)
$AF_{1,y}$	=	Allocation factor for the production of biodiesel in year *y* (fraction)
$AF_{2,y}$	=	Allocation factor for the oil seeds cultivation in year *y* (fraction)

1. Project emissions at the biodiesel production plant and oil production plant(s) ($PE_{BPF,y}$)

These emissions include fuel and electricity consumption that occurs at the site of the biodiesel production plant and, if applicable, emissions associated with the anaerobic treatment of wastewater in the oil production plant(s).

These emissions are estimated as follows:

$$PE_{BPF,y} = \sum_{j} PE_{FC,j,y} + PE_{EC,y} + PE_{W,y} \quad (5)$$

Where:

$PE_{BPF,y}$	=	Project emissions at the biodiesel production facility and the oil production plant(s) in year *y* (tCO_2)
$PE_{FC,j,y}$	=	Project emissions from combustion of fuel type *j* in the biodiesel production plant and oil production plant(s) in year *y* (tCO_2)
$PE_{EC,y}$	=	Project emissions from electricity consumption in the biodiesel production plant and the oil production plant(s) in year *y* (tCO_2)
$PE_{w,y}$	=	Project emissions from anearobic treatment of waste water in year *y* (tCO_2e)

Emissions from fossil fuel consumption ($PE_{FC,j,y}$)

This emission source should include CO_2 emissions from all fossil fuel consumption that occurs at the site of the biodiesel production plant and, if applicable, the oil production plant(s) and that is attributable to the project activity. This shall include, inter alia, fossil fuel combustion for heat and/or electricity generation. The project emissions from fossil fuel combustion ($PE_{FC,i,y}$) shall be calculated following the latest version of "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". For this purpose, the processes *j* in the tool correspond to all fossil fuel combustion sources at these plants..

Emissions from electricity consumption ($PE_{EC,,y}$)

Emissions from electricity consumption includes electricity delivered from the grid to the biodiesel production plant and, if applicable, the oil production plant(s). Electricity generated on-site should not be included here.[9]

The project emissions from electricity consumption ($PE_{EC,y}$) will be calculated following the latest version of "Tool to calculate project emissions from electricity consumption". In this particular case, the tool can also be applied if captive renewable power generation technologies are installed to provide electricity; however, only the electricity purchased from the grid should be included in $EC_{PJ,j,y}$ and scenario A of the tool should be applied respectively.

Project emissions from waste water treatment ($PE_{w,y}$)

Emissions associated with the anaerobic treatment of wastewater in the oil production plant(s) should be estimated where applicable.

If the methane from anaerobic treatment of wastewater is vented to the atmosphere, then $PE_{w,y}$ is estimated as follows:

[9] On-site electricity generation with fossil fuels should be included in $PE_{FC,i,y}$. On-site electricity generation with biomass residues or biodiesel is accounted as zero emissions, as the use of biomass residues is not assumed to result in any emissions and emissions associated with the production of biodiesel are included in the emission sources accounted under this methodology.

$$PE_{w,y} = Q_{COD,y} \cdot P_{COD,y} \cdot B_0 \cdot MCF_p \cdot GWP_{CH4} \quad \textbf{(6)}$$

Where:

$PE_{w,y}$	=	Project emissions from anearobic treatment of waste water in year *y* (tCO_2e)
$Q_{COD,y}$	=	Amount of wastewaster treated anaerobically or released untreated from the crude vegetable oil production plant in year *y* (m^3/y)
$P_{COD,y}$	=	Chemical Oxygen Demand (COD) of wastewaster in year *y* ($tCOD/m^3$)
B_0	=	Maximum methane producing capacity (t CH_4/t COD)
MCF_p	=	Methane conversion factor (fraction)
GWP_{CH4}	=	Global warming potential valid for the relevant commitment period (tCO_2e/tCH_4)

If the methane from anaerobic treatment of waste water is flared, then the “Tool to determine project emissions from flaring gases containing methane” should be used to estimate project emissions from waste water treatment. In this case, $PE_{w,y}$ will be calculated ex-ante as per equation 5, and then monitored during the crediting period.

~~**Emissions from fossil fuel consumption**~~

~~Emissions from fuel consumption (i.e. for steam production) are calculated on the basis of measured consumption of heating fuel(s) on either the biodiesel production site or the site of an external supplier of steam as shown in equation (4).~~

$$\cancel{PE_{fuel,y} = \sum_i \left(FC_{BDP,i,y} \times NCV_i \times EF_{CO2,i}\right)} \quad \cancel{\textbf{(4)}}$$

~~Where:~~

~~$PE_{fuel,y}$~~	=	~~Project emissions from combustion of fuels (i.e. for required steam) in biodiesel production in year *y* (tCO_2)~~
~~$FC_{BDP,i,y}$~~	=	~~Fuel of type *i* consumed on-site for biodiesel production in year *y* (tonnes)~~
~~NCV_i~~	=	~~Net calorific value of fuel type *i* (GJ/tonne)~~
~~$EF_{CO2,i}$~~	=	~~Carbon dioxide emissions factor for fuel *i* (tCO_2/GJ)~~

~~**Emissions from electricity consumption**~~

~~Emissions from electricity consumption are calculated on the basis of measured electricity consumption at the biodiesel production site, as shown in equation (5).~~

$$\cancel{PE_{elec,y} = EC_y \times EF_{CO2,elec}} \quad \cancel{\textbf{(5)}}$$

~~Where:~~

~~$PE_{elec,y}$~~	=	~~Project emissions from electricity consumption in the biodiesel plant in year *y* (tCO_2)~~
~~EC_y~~	=	~~Electricity consumption at project site in year *y* (MWh)~~
~~$EF_{CO2,elec}$~~	=	~~Emissions factor for grid electricity (tCO_2/MWh)~~

~~The emission factor ($EF_{CO2,elec}$) shall be calculated in accordance with the latest version of the following approved methodologies:~~

- ~~ACM0002 shall be used if the consumption exceeds the CDM small scale thresholds as defined by the Executive Board.~~
- ~~AMS I.D may be used if the consumption does not exceed the CDM small scale thresholds as defined by the Executive Board.~~

2. Project emissions from fossil carbon in the biodiesel due to the use of methanol from fossil origin in the esterification process ($PE_{MeOH,y}$)

~~Methanol is normally produced from natural gas, hence the carbon is fossil fuel derived.~~

Under the current applicability of the methodology, methanol of fossil origin is used for the esterification of vegetable oil or waste oil/fats. In the esterification process, the carbon from the methanol remains in the esters. Thus, a fraction of the carbon in the biodiesel is of fossil origin and need to be accounted as project emissions. These emissions are estimated as follows:

$$PE_{MeOH,y} = MC_{MeOH,y} \times EF_{C,MeOH} \times \frac{44}{12} \quad \textbf{(7)}$$

Where:

$PE_{MeOH,y}$	=	Project emissions from fossil carbon in the biodiesel due to esterification with methanol of fossil origin in year *y* (tCO_2)
$MC_{MeOH,y}$	=	Quantity of methanol consumed in the biodiesel plant, including spills and evaporations in year *y* (tonnes)
$EF_{C,MeOH}$	=	Carbon emissions factor of methanol, based on molecular weight (tC/tMeOH) (= 12/32)
44/12	=	Molecular weight ratio to convert tonnes of carbon into tonnes of CO_2 (tCO_2/tC)

3. Project emissions from transportation ($PE_{Tr,y}$)

Project emissions from transportation only have to be accounted if distances of more than 50 km are covered.

Project emissions from transportation include the following sources, where applicable:

- Any transportation of oil seeds to the oil production plant(s);
- Any transportation of vegetable oil and/or waste oil/fats to the biodiesel production plant; and
- Any transportation of the biodiesel to the site where it is blended with petrodiesel.

~~Emissions from transport of biodiesel to the blending station are to be added to the project emissions only if the current distribution of the petrodiesel being displaced does not involve similar transport of fuel to a blend/distribution location.~~

Option 1:

Emissions are calculated on the basis of distance and the average truck load:

$$PE_{tr,y} = \sum_{m} \left(\frac{MT_{m,y}}{TL_m} \times AVD_m \times EF_{km} \right) \quad \textbf{(8)}$$

Where:

$PE_{tr,y}$	=	Project emissions from transportation in year *y* (tCO_2)
$MT_{m,y}$	=	Material *m* transported in year *y* (tonnes)
TL_m	=	Average truck load for vehicles transporting material *m* (tonnes)
AVD_m	=	Average distance travelled by vehicles transporting material *m* (km), including the return trip/s
EF_{km}	=	Carbon dioxide emissions factor for vehicles transporting material (tCO_2/km)
m	=	Material transported (e.g. oil seeds, vegetable oil and biodiesel)

Option 2:

Emissions are calculated based on the actual quantity of fossil fuel consumed for transportation.

$$PE_{tr,y} = \sum_{m} \sum_{i} \left(FC_{m,i,y} \times NCV_i \times EF_{CO2,i} \right) \quad \textbf{(9)}$$

Where:

$PE_{Tr,y}$	=	Project emissions from transportation in year *y* (tCO_2)
$FC_{m,i,y}$	=	Fuel consumption of type *i* for transporting material *m* in year *y* (tonnes)
NCV_i	=	Net calorific value of fuel type *i* (GJ/tonne)
$EF_{CO2,i}$	=	Carbon dioxide emissions factor for fuel type *i* (tCO_2/GJ)
m	=	Material transported (e.g. oil seeds, vegetable oil and biodiesel)

4. Project emissions associated with the cultivation of lands to produce oil seeds ($PE_{BC,y}$)

This step calculates emissions associated with the cultivation of lands to produce the oil seeds used in oil production plant(s) and is applicable if the biodiesel is produced from oil seeds cultivated in dedicated plantations.

If the oil seeds are sourced from a plantation area that is registered as one or several A/R CDM project activities, these emissions are not accounted as project emissions under this methodology.

Project participants may choose among two options to calculate this emission source:

- Option A provides a simple approach, using conservative **default values** for the emissions associated with the cultivation of lands, taking into account different geographical regions. This approach can only be used for oil seeds from **palm or jatropha**;
- Option B calculates the emissions based on actual data from the cultivation process and is more accurate than Option A but requires the collection of more data by the project participants.

Option A: Use of a default emission factor

$$PE_{BC,y} = \sum_{s} A_{s,y} \times EF_{s,y} \quad \textbf{(10)}$$

Where:

$PE_{BC,y}$	=	Project emissions associated with the cultivation of land to produce oil seeds in year *y* (tCO_2/year)
$A_{s,y}$	=	Area in which oil seed type *s* is cultivated for use in the project plant in year *y* (ha)
$EF_{s,y}$	=	Default emission factor for the GHG emissions associated with the cultivation of land to produce oil seed type s (tCO_2e/ha). See table 2 below for available values.

Table 2: Conservative default emission factors for the GHG emissions associated with the cultivation of land to produce oil seeds

Crop	**Climate Zone**[10]	**$EF_{s,y}$ (tCO_2e/ha)**
Palm Methyl Esther	Tropical Moist	1.87
Palm Methyl Esther	Tropical Wet	1.87
Jatropha Methyl Ester	Tropical Moist	1.76
Jatropha Methyl Ester	Tropical Wet	2.52

Option B: Use of project specific data

Project emissions associated with the cultivation of land vary between different project types. Table 3 explains in which cases which emission sources must be considered. The procedures to estimate these emissions are partly contained in Annex 1 and partly reference is made to tools. Project participants should clearly document and justify which emission sources are applicable to the project activity.

Table 3: Cases for which relevant emission sources from the cultivation of biomass should be taken into account

Emission Sources	# of Equations in Annex 1	Cases in which the emission sources should be considered
Fossil fuel consumption for agricultural operations	-	Should be estimated if fossil fuels are used for agricultural operations. This source should be calculated following the latest version of *"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"*
Electricity consumption for agricultural operations	-	Should be estimated of electricity is used for agricultural operations (e.g. irrigation). This source should be calculated following the latest version of *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*
N_2O emissions from the application of fertilizers.	1, 2, 3	Should be estimated if **synthetic fertilizers or organic fertilizers** (e.g., animal manure, compost, sewage sludge, rendering waste) are applied at the plantation
CO_2 emissions from urea application.	4	Should be estimated if **urea** is applied as a nitrogen source at the plantation
CO_2 emissions from application of limestone and dolomite.	5	Should be estimated if **limestone or dolomite** is applied to the plantation to reduce soil acidity and improve plant growth

[10] See Annex 2.

Emission Sources	# of Equations in Annex 1	Cases in which the emission sources should be considered
CH_4 and N_2O emissions from the field burning of biomass.	6	Should be estimated if biomass from the plantation is to be burnt regularly during the crediting period (e.g. after harvest)
Direct N_2O emissions from land management at the plantation	7, 8, 9	Should be estimated when relevant, for example, drainage/management of organic soils is only applicable in the case of organic soils
Emissions from the production of synthetic fertilizer that is used at the plantations	10	Should be estimated if synthetic fertilizers are applied at the plantation
CO_2 emissions resulting from changes in soil carbon stocks following land use changes or changes in the land management practices.	11, 12, 13, 14, 15	Should be estimated if land use change or change in land management practices is introduced with the cultivation of biomass under the project activity. If it can be demonstrated that at maturity of the acreage, the total stock in above ground and below ground biomass is higher in the project case than in the baseline this emissions don't need to be estimated. For this, the project proponents should: • Estimate the above and below ground biomass in the baseline; • Estimate the above and below ground biomass with the project when the acreage reaches maturity. This should be done using specific data for the project activity

Leakage

This methodology estimates the following sources of leakage:

- Emissions associated with the production of the methanol used for esterification;
- If the biodiesel is produced from waste oil/fat, displacement of existing uses of waste oil/fat that may result in increased demand for fossil fuels elsewhere;
- Positive leakage associated with the avoided production and transportation of petrodiesel.

$$LE_y = LE_{MeOH,y} + LE_{WOF,y} - LE_{PD,y} \quad \textbf{(11)}$$

Where:

LE_y = Leakage emissions in year *y* (tCO_2)

$LE_{MeOH,y}$ = Leakage emissions associated with production of methanol used in biodiesel production in year *y* (tCO_2)

$LE_{WOF,y}$ = Leakage emissions from displacement of existing utilization of waste oil/fat in year *y* (tCO_2). These emissions will only be estimated if the biodiesel is produced from waste oil/fat

$LE_{PD,y}$ = Leakage related to the avoided production of petrodiesel (tCO_2/yr)

Leakage from methanol production

Emissions from production of methanol that are used in the esterification process to produce the biodiesel are estimated as follows:

$$LE_{MeOH,y} = MC_{MeOH,y} \cdot EF_{MeOH,PC} \qquad \textbf{(12)}$$

Where:

$LE_{MeOH,y}$	=	Leakage emissions associated with production of methanol used in biodiesel production in year *y* (tCO_2)
$MC_{MeOH,y}$	=	Mass of methanol consumed in the biodiesel plant, including spills and evaporation on site, in year *y* (tonnes)
$EF_{MeOH,PC}$	=	Pre-combustion (i.e. upstream) emissions factor for methanol production (tCO_2/t MeOH)

Leakage from the displacement of existing uses of waste oil/fat

For material scenarios M1, M2 and M3, project participants shall demonstrate that the use of the waste oil/fat by the project activity does not result in increased fossil fuel consumption elsewhere. For this purpose, project participants shall monitor the total supply of waste oil/fat used in the project plant.

Project participants shall demonstrate that there is a surplus of waste oil/fat in the region of the project activity, which is not currently recovered or used for any purpose. For the purpose of this methodology, "surplus" is defined as the quantity of available waste oil/fat produced in the region being at least 25% larger than the quantity of waste oil/fat that is recovered (e.g. for energy generation or as feedstock), including the project plant.

Project participants shall clearly define the geographical boundary of the region and document it in the CDM-PDD. In defining the geographical boundary of the region, project participants should take into account the usual distances for waste oil/fat transport. In other words, if waste oil/fat is transported up to 50 km, the region may cover a radius of 50 km around the project activity. In any case, the region should cover a radius around the project activity of at least 20 km ~~but not more than 200 km~~. Once defined, the region should not be changed during the crediting period(s).

Where project participants cannot demonstrate that the total quantity of waste oil/fat used by the project activity does not result in increased fossil fuel use elsewhere, a leakage penalty shall be applied. The penalty is calculated as follows: For scenario M2, this applies where the most likely substitute, taking into account common practice of the region, is derived from fossil fuel.

$$LE_{WOF,y} = WOF_{L,y} \cdot NCV_{BD} \cdot EF_{CO2,L} \text{ (for scenario M1 and M3)} \qquad \textbf{(13)}$$

$$LE_{WOF,y} = COEF_{WOF,L} \cdot WOF_{L,y} \cdot NCV_{L} \cdot EF_{CO2,L}$$ (for scenario M2 where the substitute for substance is likely to be derived from fossil fuel) **(14)**

Where:

$LE_{WOF,y}$	=	Leakage emissions from displacement of existing utilization of waste oil/fat in year *y* (tCO_2)
$WOF_{L,y}$	=	Waste oil/fat that causes increased fossil fuel consumption elsewhere (tonnes)
NCV_{BD}	=	Net calorific value of biodiesel (GJ/tonne)
NCV_L	=	Net calorific value of the fossil fuel likely to substitute waste oil / fat (GJ/tonne)
$EF_{CO2,L}$	=	Carbon dioxide emissions factor of most carbon intensive fuel oil in the country (tCO_2/GJ)
$COEF_{WOF,l}$		Coefficient of substitution of fossil fuel to waste oil / fat to produce the substance previously produced by waste oil / fat

Determination of $WOF_{L,y}$

$$WOF_{L,y} = \begin{cases} \dfrac{(1.25 \times WOF_{D,y}) - WOF_{S,y}}{1.25} & if\ (1.25 \times WOF_{D,y}) > WOF_{S,y} \\ 0 & if\ (1.25 \times WOF_{D,y}) \leq WOF_{S,y} \end{cases} \tag{15}$$

with

$$WOF_{D,y} = WOF_{DS,y} + u_D$$
$$WOF_{S,y} = WOF_{SS,y} - u_S$$

Where:

$WOF_{L,y}$	=	Waste oil/fat that causes increased fossil fuel consumption elsewhere (tonnes)
$WOF_{D,y}$	=	Demand for waste oil/fat , including the project activity, in the defined region (tonnes), corrected for uncertainties associated with its determination
$WOF_{S,y}$	=	Supply of waste oil/fat in the defined region (tonnes), corrected for uncertainties associated with its determination
$WOF_{DS,y}$	=	Statistical mean value obtained from surveys or other sources for the demand for waste oil/fat , including the project activity, in the defined region (tonnes)
$WOF_{SS,y}$	=	Statistical mean value obtained from surveys or other sources for the supply of waste oil/fat in the defined region (tonnes)
u_D	=	Uncertainty for waste oil/fat demand (tonnes)
u_S	=	Uncertainty for waste oil/fat supply in the defined region (tonnes)

Methods to determine $WOF_{D,y}$, $WOF_{S,y}$ and the associated uncertainties are indicated in the monitoring methodology section below.

In the case that overall emission reductions from the project activity are negative in a given year because of the leakage penalty, CERs are not issued to project participants for the year concerned and in subsequent years, until emission reductions from subsequent years have compensated the quantity of negative emission reductions from the given year.

Leakage related to the avoided production of petrodiesel

The substitution of biodiesel for petrodiesel reduces indirect ("upstream") emissions associated with the production of petrodiesel. For the purpose of this methodology, these include the following emission sources:

(1) Production of crude oil. These include emissions from venting, flaring and energy uses;
(2) Oil refinery. These include emissions from energy uses, production of chemicals and catalysts, disposal of production wastes (including flaring) and direct emissions;
(3) Long distance transport.

Emissions related to infrastructure are not be taken into account either for the production of crude oil (e.g. drilling and maintenance of the oil wells) or for the oil refinery (e.g. construction of the refinery), to keep consistency with the estimation of project emissions from biodiesel production where these emission sources are also ignored.

Emissions from the distribution to filling stations are not be taken into account, as it is assumed that these emissions balance with the emissions of transport of the biodiesel to the blending facility.

$$LE_{PD,y} = LE_{PROD,y} + LE_{REF,y} + LE_{LDT,y} \qquad \textbf{(16)}$$

Where:

$LE_{PD,y}$	=	Leakage related to the avoided production of petrodiesel (tCO_2/yr)
$LE_{PROD,y}$	=	Leakage related to the production of crude oil (tCO_2/yr)
$LE_{LDT,y}$	=	Leakage related to the long distance transport (tCO_2/yr)
$LE_{REF,y}$	=	Leakage related to refining of crude oil (tCO_2/yr)

Leakage related to the production of crude oil ($LE_{PROD,y}$)

$$LE_{PROD,y} = BD_y \cdot \frac{NCV_{BD,y}}{NCV_{PD,y}} \cdot EF_{PROD} \qquad \textbf{(17)}$$

Where:

BD_y	=	Quantity of biodiesel eligible for crediting in year *y* (tons)
CF_{PD}	=	Conversion factor from biodiesel to petrodiesel (tonnes petrodiesel/tonnes biodiesel) calculated according to equation 3
EF_{PROD}	=	Emission factor for production of crude oil (tCO_2e/t petrodiesel)

Leakage related to oil refining ($LE_{REF,y}$)

$$LE_{REF,y} = BD_y \cdot CF_{PD} \cdot EF_{REF} \qquad \textbf{(18)}$$

Where:

BD_y = Quantity of biodiesel eligible for crediting in year *y* (tons)

CF_{PD} = Conversion factor from biodiesel to petrodiesel (tonnes petrodiesel/tonnes biodiesel) calculated according to equation 3

EF_{REF} = Emission factor related to oil refining (tCO_2e/tpetrodiesel)

Leakage related to the long distance transport ($LE_{LDT,y}$)

Emissions from international long distance transport (transport of crude oil to the refinery) will not be taken into account since the EB has clarified that CDM project activities can not claim emission reductions from reducing international bunker fuel consumption. EB25 report paragraph 58 states that "The Board agreed to confirm that the project activities/parts of project activities resulting in emission reductions from reduced consumption of bunker fuels (e.g. fuel saving on account of shortening of the shipping route on international waters) are not eligible under the CDM."

If long distance transport occurs within the host country where the project activity takes place, these emissions will be accounted for as per the following equation:

$$LE_{LDT,y} = BD_y \cdot CF_{PD} \cdot EF_{LDT} \qquad \textbf{(19)}$$

Where:

BD_y = Quantity of biodiesel eligible for crediting in year *y* (tons)

CF_{PD} = Conversion factor from biodiesel to petrodiesel (tonnes petrodiesel/tonnes biodiesel) calculated according to equation 3.

EF_{LDT} = Emission factor related to long distance transportation (tCO_2e/tpetrodiesel)

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = \left(BE_y - PE_y - LE_y\right) \qquad \textbf{(20)}$$

Where:

ER_y = Emission reductions in year *y* (tCO_2/yr)

BE_y = Baseline emissions in year *y* (tCO_2/yr)

PE_y = Project emissions in year *y* (tCO_2/yr)

LE_y = Leakage emissions in year *y* (tCO_2/yr)

Changes required for methodology implementation in 2nd and 3rd crediting periods

~~Compliance with the applicability conditions, baseline scenario (i.e. baseline fuels) and additionality all need to be fully revalidated upon renewal of the crediting period.~~

Refer to the "Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period" (Annex 1 of the "Procedures for renewal of the crediting period of a registered CDM project activity").[11]

Data and parameters not monitored

Baseline Emissions

ID Number:	1
Parameter:	NCV_{PD}
Data unit:	GJ/tonne
Description:	Net calorific value of petrodiesel
Source of data:	2006 IPCC Guidelines for GHG Inventories
Measurement procedures (if any):	
Any comment:	

ID Number:	2
Parameter:	$EF_{CO2,PD}$
Data unit:	tCO_2/GJ
Description:	Carbon dioxide emissions factor for petrodiesel
Source of data:	Default value may be derived from 2006 IPCC Guidelines, or from national statistics, if available
Measurement procedures (if any):	
Any comment:	Local or national data should be preferred. Default values from the IPCC may be used alternatively

Project Emissions

ID Number:	3
Parameter:	MCF_p
Data unit:	%
Description:	Methane conversion factor
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	
Any comment:	Preferably local specific value should be used. In absence of local values, MCF_p default values can be obtained from table 6.3, chapter 6, volume 4 from IPCC 2006 guidelines

[11] <https://cdm.unfccc.int/Reference/Procedures/reg_proc04.pdf>.

ID Number:	4
Parameter:	B_0
Data unit:	t CH_4/t COD
Description:	Maximum methane producing capacity
Source of data:	IPCC 2006 guidelines specifies the value for B_0 as 0.25 kg CH_4/kg COD. Taking into account the uncertainty of this estimate, project participants should use a value of 0.265 kg CH_4/kg COD as a conservative assumption for Bo
Measurement procedures (if any):	
Any comment:	

Leakage

ID Number:	5
Parameter:	EF_{MeOH_PC}
Data unit:	tCO_2/t methanol
Description:	Specific emission per tonne of produced methanol
Source of data:	Apple 1998: <http://edj.net/sinor/SFR4-99art7.html> and 2006 IPCC Guidelines.
Measurement procedures (if any):	1.95 tCO_2/tonne produced methanol
Any comment:	Based on 30 GJ/tonne energy requirement and average of IPCC emissions factors for natural gas and diesel oil

ID Number:	6
Parameter:	NCV_L
Data unit:	GJ/tonne
Description:	Net calorific value of the fossil fuel likely to substitute waste oil / fat
Source of data:	2006 IPCC Guidelines for GHG Inventories
Measurement procedures (if any):	
Any comment:	Identification of the fossil fuel shall be made taking into account common practice

ID Number:	7
Parameter:	$EF_{CO2,L}$
Data unit:	tCO_2 /GJ
Description:	Carbon dioxide emission factor of the most carbon intensive fuel oil in the country
Source of data:	Reliable official data (e.g. official statistics and government publication publications)
Measurement procedures (if any):	
Monitoring frequency:	Annually
Any comment:	Local or national data should be preferred. Default values from the 2006 IPCC Guidelines may be used alternatively and should be chosen in a conservative manner

ID Number:	8
Data / Parameter:	$COEF_{WOF,l}$
Data unit:	Dimensionless
Description:	Coefficient of substitution of fossil fuel to waste oil / fat to produce the substance previously produced by waste oil / fat
Source of data:	Industry data
Measurement procedures (if any):	
Monitoring frequency:	Annually
Any comment:	Local or national data should be preferred. Identification of the fossil fuel shall be made taking into account common practice

ID Number:	9
Parameter:	EF_{PROD}
Data unit:	tCO_2e/t petrodiesel
Description:	Emission factor for production of crude oil
Source of data:	
Value to be applied:	The emission factor for the production of crude oil (EF_{PROD}) to be used in equation 18 is **0.073 tCO2e/t petrodiesel**[12]. A global value was calculated with the assumption that that upstream emissions with respect to crude oil production in Annex I countries is zero
Any comment:	

ID Number:	10
Parameter:	EF_{REF}
Data unit:	tCO_2e/t petrodiesel
Description:	Emission factor related to oil refinery
Source of data:	
Value to be applied:	The emission factor related to oil refinery (EF_{REF}) shall be one of the following: a) In the absence of a country-specific data, a global average figure of **0.233t-CO2**/t-petrodiesel can be used.[13] b) If refining occurs in the host country, reliable local emission factors from an official information source (e.g. national communications) may be used instead of the default emission factor
Any comment:	

[12] This value was calculated using data from World Bank GGFR (amount of flared gas) and BP statistical review (crude oil production) for the year 2005.

[13] This value was calculated using data from IEA for the year 2005 and NCV values from IPCC 2006 Guidelines.

ID Number:	11
Parameter:	EF_{LDT}
Data unit:	tCO_2e/t petrodiesel
Description:	Emission factor related to long distance transportation
Source of data:	
Value to be applied:	Reliable local emission factors from an official information source (e.g. national communications)
Any comment:	

III. MONITORING METHODOLOGY

Monitoring procedures

Describe and specify in the draft CDM-PDD all monitoring procedures, including the type of measurement instrumentation used, the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. All meters and instruments should be calibrated regularly as per industry practices.

Biodiesel production must apply national industry standards on QA/QC or, if there are no national QA/QC standards yet, apply industry standards from mature biodiesel production markets such as in Brazil, Europe or US.

Specific CDM related monitoring procedures

The quality manual necessary under the above mentioned QA/QC standards shall include a section describing the elements of the CDM related monitoring procedures and how to assure and control their quality. A quality management representative from the project participant shall ensure that the monitoring procedures are established and that they meet the requirements as specified in this methodology.

Monitoring the plant inputs and outputs required for calculating leakage, baseline and project emissions shall be based on a complete documented mass balance, adjusted for stock changes, covering:

- Amounts of waste oil/fat purchased and processed, if applicable;
- Amounts of feedstock from dedicated plantations purchased and processed; if applicable;
- Amounts of catalysts purchased, processed and recovered;
- Amounts of methanol purchased and processed;
- Amounts of glycerol produced and incinerated and/or sold for utilization;
- Amounts of blended biodiesel delivered to consumers and consumed.

This mass balance shall be based on a combination of purchase/sales records and records of measurements, in accordance with the measuring instruments available at the plant and stationary consumers or fuelling stations of the captive fleet owner in case of use in transport sector. The mass balance serves as a QA/QC instrument to crosscheck results of monitoring parameters as defined in the following section.

The following procedure shall be used to verify the actual amount of biodiesel from waste oil/fat that is consumed by the end user for displacement of petrodiesel and its correspondence with the produced amount of biodiesel from waste oil/fat:

- If the biodiesel is produced from waste oil/fat, the produced amount of biodiesel from waste oil/fat is recorded by a periodically calibrated metering system;
- If the biodiesel is produced from oil seeds cultivated in dedicated plantations from degraded or degrading lands, the produced amount of biodiesel from feedstock from dedicated plantations is recorded by a periodically calibrated metering system;
- The amount of biodiesel produced from waste oil/fat or from feedstock from dedicated plantations on degraded or degrading lands transported to the storage of the blender is recorded by a calibrated metering system at the point of filling the (road) tankers and at the point of delivery at the blender site;
- During the process of creating the biodiesel blend at the blending station, the blending operation shall be monitored to assure adequate mixing of the products in the specified proportions. This includes measuring and recording the volumes and blend levels as verified through bills of lading, meter printouts or other auditable records of both the biodiesel and diesel fuel, which comprise the blended biodiesel;
- Contractually the biodiesel producer has to monitor consumption by the consumer as follows:
    - The receiving amount of blended biodiesel in the gas station or final distributor has to be recorded by a calibrated metering system and the storage fill level is recorded by a calibrated filling level indicator;
    - The amount of the blended biodiesel filled into the installation or vehicle where combustion takes place must be recorded by a calibrated metering system;
    - If blending is done by a third party contractual arrangement shall be made, that the same monitoring procedure as described above can be applied.

If the biodiesel is produced from oil seeds cultivated in dedicated plantations degraded or degrading lands, the following specific guidance should be taken into account:

- If feedstock is pre-processed off-site, the energy consumption of the corresponding facilities shall be included in the monitoring. This applies, for example, for crude vegetable oil production plant (oil mills) located in between the plantations and the biodiesel plant;
- Monitoring compliance with the applicability conditions.

Data Archiving

All data need to be archived electronically until two years after end of the crediting period.

Data and parameters monitored

Applicability Conditions

Data / Parameter:	$f_{PJ,y}$ and $f_{PJ,i,y}$
Data unit:	%
Description:	Fraction of biodiesel in the blended diesel in the project scenario in year *y* and fraction of biodiesel in the blended diesel from the project activity, with blending ratio i, in year *y*
Source of data:	Records from blending operations
Measurement procedures (if any):	Recording volumes or flows with calibrated meters
Monitoring frequency:	Every produced blend must be monitored
QA/QC procedures:	During the process of creating the blended biodiesel at the blending station, the blending operation shall be monitored to assure adequate mixing of the products in the correct proportions. For automotive purposes the blending ratio must not exceed 20%. This includes measuring and recording the volumes and blend levels as verified through bills of lading, meter printouts or other auditable records of both the biodiesel and diesel fuel, which comprise the blend.
Any comment:	See “BQ-9000 Quality Assurance Program Requirements for the Biodiesel industry” for further information

Data / Parameter:	$f_{reg,y}$
Data unit:	%
Description:	Fraction of biodiesel in the blended diesel bound by regulation in year *y*
Source of data:	Regulations in the Host Country
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / Parameter:	Various parameters; Compliance of biodiesel produced with national regulations
Data unit:	Various data units
Description:	Compliance of produced biodiesel with national regulation, biofuel properties
Source of data:	Various measurements based on national or international standards
Measurement procedures (if any):	Various methods of measurement and uncertainty analysis
Monitoring frequency:	According to national regulation, at least annually
QA/QC procedures:	According to national or international standards
Any comment:	

Data / Parameter:	$MP_{Glyc,y}$
Data unit:	Tonnes (t)
Description:	Amount of byproduct glycerol produced during plant operation
Source of data:	Measured (volumetric or weighed) values
Measurement procedures (if any):	Volumetric flow meter including a volume integrator or load cell to measure the weight of produced glycerol
Monitoring frequency:	All quantity of produced glycerol must be monitored
QA/QC procedures:	Volumetric flow meter and integrator calibrated periodically Load cell calibrated periodically. Measured amounts to be crosschecked against mass balance of the biodiesel production unit
Any comment:	

Data / Parameter:	$MU_{Glyc,y}$
Data unit:	Tonnes (t)
Description:	Amount of byproduct glycerol sold or used
Source of data:	Sales data and internal records in case of use inside the plant
Measurement procedures (if any):	---
Monitoring frequency:	All produced glycerol must be tracked via sales data or internal records or its mode of disposal checked by DOE (incl. visual inspection of facilities and record of incineration or disposal if any)
QA/QC procedures:	DOE to check the produced glycerol was marketed
Any comment:	

Baseline Emissions

Data / Parameter:	$P_{BD,y}$
Data unit:	Tonnes
Description:	Quantity of produced biodiesel from waste oil/fat or from the feedstock from dedicated plantations that is used by host country consumers to substitute for petrodiesel
Source of data:	Metering system at production site
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning
Monitoring frequency:	All produced biodiesel must be metered
QA/QC procedures:	Cross check production and consumption data with sales records
Any comment:	Measured for reference purposes to ensure consumption of biodiesel does not exceed production of biodiesel

Data / Parameter:	$C_{BD,y}$
Data unit:	Tonnes
Description:	Quantity of biodiesel from waste oil/fat or feedstock from dedicated plantations consumed by host country consumers to substitute for petrodiesel
Source of data:	Metering system at consumer site
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning
Monitoring frequency:	Continuous recording of filling consumers´ stationary combustion installations or vehicles
QA/QC procedures:	Cross check production and consumption data with sales records
Any comment:	Consumption of biodiesel will be determined as the consumption of blended biodiesel times the blending fraction of the respective blend

Data / Parameter:	$C_{BBD,y}$
Data unit:	Tonnes
Description:	Quantity of blended biodiesel from waste oil/fat or from feedstock from dedicated plantations consumed by host country consumers to substitute for petrodiesel
Source of data:	Metering system at fuelling stations
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning
Monitoring frequency:	Continuous recording of filling consumers´ stationary combustion installations or vehicles
QA/QC procedures:	Cross check production and consumption data with sales records
Any comment:	

Data / Parameter:	$NCV_{BD,y}$
Data unit:	GJ/tonne
Description:	Net calorific value of biodiesel for the year *y*
Source of data:	Laboratory analysis
Measurement procedures (if any):	Measured according to relevant national or international standards regulating determination of NCV by calibrated equipment
Monitoring frequency:	Annually
QA/QC procedures:	Check consistency of measurements and local / national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements
Any comment:	Analysis has to be carried out by accredited laboratory. A sample is representative if uncertainty of the NCV does not exceed ±5% at 95% confidence level

Project emissions

Data / Parameter:	$PE_{FC,j,y}$
Data unit:	tCO_{2e}
Description:	Project emissions from fossil fuel combustion in process *j* during the year *y*
Source of data:	Calculated as per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.
Measurement procedures (if any):	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”
Monitoring frequency:	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”
QA/QC procedures:	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”
Any comment:	-

Data / Parameter:	$PE_{EC,y}$
Data unit:	tCO_2
Description:	Emissions from consumption of electricity in the project case in year *y*
Source of data:	Calculated as per the “Tool to calculate project emissions from electricity consumption”. When using the tool $PE_{Elec,y} = PE_{EC,y}$
Measurement procedures (if any):	As per the “Tool to calculate project emissions from electricity consumption”
Monitoring frequency:	As per the “Tool to calculate project emissions from electricity consumption”
QA/QC procedures:	As per the “Tool to calculate project emissions from electricity consumption”
Any comment:	-

Data / Parameter:	$MC_{MeOH,y}$
Data unit:	Tonnes
Description:	Mass of methanol consumed in the biodiesel plant
Source of data:	Mass meters
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning. The methanol consumption should be net of any water content. Methanol spilled and evaporated on the project site should be considered as consumption for estimating the emissions
Monitoring frequency:	Continuously
QA/QC procedures:	Crosscheck against methanol purchase receipts and calculated stochiometric requirements
Any comment:	Adjust for stock changes when comparing purchase data with consumption data; also used for leakage calculations. Use most conservative values. Any spills on-site and evaporation are accounted as consumption. Please note that data should also report the source of methanol - from fossil fuel or non-fossil fuel sources. As per the applicability only biofuel produced using fossil fuel based methanol can be credited

Data / Parameter:	$MT_{m,y}$
Data unit:	Tonnes
Description:	Material *m* transported in year *y*
Source of data:	Plant record, Records of truck operators
Measurement procedures (if any):	Mass or volumetric (including quantity integrator) meters (e.g. load cell)
Monitoring frequency:	Every Material transported (e.g. oil seeds, vegetable oil and biodiesel) must be monitored
QA/QC procedures:	Crosscheck data provided by trucks delivering the material with measured feedstock inputs at plant. Use most conservative values
Any comment:	

Data / Parameter:	AVD_m
Data unit:	Km
Description:	Average distance travelled by vehicles transporting material m (km)
Source of data:	Records of truck operator
Measurement procedures (if any):	Vehicle odometer
Monitoring frequency:	Annually
QA/QC procedures:	Check consistency of distance records provided by the truck operators by comparing recorded distances with other information from other sources (e.g. maps)
Any comment:	If material *m* is supplied from different sites, this parameter should correspond to the mean value of km travelled by trucks that supply the biodiesel plant

Data / Parameter:	TL_m
Data unit:	Tonnes
Description:	Average truck load for vehicles transporting material *m*
Source of data:	Records of truck operator; plant records, vehicle manufacturer information
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Cross check against vehicle manufacturer's capacity rating
Any comment:	

Data / Parameter:	EF_{km}
Data unit:	tCO_2 /km
Description:	Carbon dioxide emission factor for vehicles transporting material *m* and biodiesel.
Source of data:	Measurements or local / national data should be preferred. Default values from the IPCC may be used alternatively.
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Check consistency of measurements and local / national data with default values from IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements.

Any comment:	Local or national data should be preferred. Default values from the IPCC may be used alternatively and should be chosen in a conservative manner.

Data / Parameter:	$FC_{m,i,y}$
Data unit:	Tonnes
Description:	Fuel consumption of type *i* for transporting material *m* in year *y*
Source of data:	Truck operator records
Measurement procedures (if any):	
Monitoring frequency:	All consumed fuel must be metered.
QA/QC procedures:	Crosscheck fuel purchase data with average consumption for the type of vehicle provided by the manufacturer
Any comment:	Fuel purchase data must be adjusted for stock changes. Subscript i denotes different fuel types

Data / Parameter:	$Q_{COD,y}$
Data unit:	m^3/yr
Description:	Amount of wastewaster treated anaerobically or released untreated from the the crude vegetable oil production plant in year *y*
Source of data:	Measured value by flow meter
Measurement procedures (if any):	-
Monitoring frequency:	Monthly aggregated annually
QA/QC procedures:	The monitoring instruments will be subject to regular maintenance and testing to ensure accuracy
Any comment:	If the wastewater is treated aerobically, emissions are assumed to be zero, and hence this parameter does not need to be monitored

Data / Parameter:	$P_{COD,y}$
Data unit:	$tCOD/m^3$
Description:	Chemical Oxygen Demand (COD) of wastewaster
Source of data:	Measured value by purity meter
Measurement procedures (if any):	-
Monitoring frequency:	Monthly and averaged annually
QA/QC procedures:	The monitoring instruments will be subject to regular maintenance and testing to ensure accuracy
Any comment:	If the wastewater is treated aerobically, emissions are assumed to be zero, and hence this parameter does not need to be monitored

Data / Parameter:	$AF_{1,y}$
Data unit:	Fraction
Description:	Allocation factor for the production of biodiesel in year *y*
Source of data:	
Measurement procedures (if any):	Estimated as per the “Guidance on apportioning of emissions to co-products and by-products”
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / Parameter:	$AF_{2,y}$
Data unit:	Fraction
Description:	Allocation factor for the oil seeds cultivation in year *y*
Source of data:	
Measurement procedures (if any):	Estimated as per the “Guidance on apportioning of emissions to co-products and by-products”
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Leakage

Data / Parameter:	$WOF_{DS,y}$
Data unit:	Tonnes
Description:	Formal and informal market demand for waste oil/fat , including the project activity, in the defined region. Statistical mean value obtained from surveys or other sources for the demand for waste oil/fat , including the project activity, in the defined region (tonnes)
Source of data:	Demand by the project activity is known. Other demand can be determined by: reliable official data from authorities; scientific publications; market data from waste collection companies and companies utilizing waste oil/fat ; third party statistically representative surveys that shall include a list of potential uses of waste oil/fats, interviews with collection companies or companies using waste oil/fats, etc
Measurement procedures (if any):	--
Monitoring frequency:	Annually
QA/QC procedures:	The calculated demand for waste oil/fat shall be based on at least 2 of the above mentioned data sources and associated uncertainties. The most conservative result considering the most conservative uncertainty limit should be adopted
Any comment:	

Data / Parameter:	$WOF_{SS,y}$
Data unit:	Tonnes
Description:	Supply for waste oil/fat in the defined region. Statistical mean value obtained from surveys or other sources for the supply of waste oil/fat in the defined region (tonnes)
Source of data:	Reliable official data from authorities; scientific publications; market data from waste collection companies; third party statistically representative survey that shall include oil consumption data, information about fat absorption data of cooked food, etc; compare with data from other countries
Measurement procedures (if any):	--
Monitoring frequency:	Annually
QA/QC procedures:	The calculated supply for waste oil/fat shall be based on at least 2 of the above mentioned data sources and associated uncertainties. The most conservative result considering the most conservative uncertainty limit should be adopted
Any comment:	

Data / Parameter:	u_D
Data unit:	Tonnes
Description:	Uncertainty for waste oil/fat demand
Source of data:	Demand by the project activity is known. Other demand can be determined by: reliable official data from authorities; scientific publications; market data from waste collection companies and companies utilizing waste oil/fat ; third party statistically representative surveys that shall include a list of potential uses of waste oil/fats, interviews with collection companies or companies using waste oil/fats, etc
Measurement procedures (if any):	--
Monitoring frequency:	Annually
QA/QC procedures:	The calculated demand for waste oil/fat shall be based on at least 2 of the above mentioned data sources and associated uncertainties. The most conservative result considering the most conservative uncertainty limit should be adopted.
Any comment:	Surveys must be realized with a 95% confidence interval. This confidence interval corresponds to the guidelines issued by the EB in its 22nd meeting Annex 2 (EB 22 report Annex 2, D, page 3): “Methodologies employing sampling to derive parameters in estimating emissions reductions shall quantify these parameter uncertainties at the 95% confidence level”

Data / Parameter:	u_S
Data unit:	Tonnes
Description:	Uncertainty for waste oil/fat demand.
Source of data:	Supply of waste oil/fat in the region defined by the project can be determined by: reliable official data from authorities; scientific publications; market data from waste collection companies and companies utilizing waste oil/fat ; third party statistically representative surveys that shall include a list of potential uses of waste oil/fats, interviews with collection companies or companies using waste oil/fats, etc
Measurement procedures (if any):	--
Monitoring frequency:	Annually
QA/QC procedures:	The calculated supply for waste oil/fat shall be based on at least 2 of the above mentioned data sources and associated uncertainties. The most conservative result considering the most conservative uncertainty limit should be adopted.
Any comment:	Surveys must be realized with a 95% confidence interval. This confidence interval corresponds to the guidelines issued by the EB in its 22nd meeting Annex 2 (EB 22 report Annex 2, D, page 3): “Methodologies employing sampling to derive parameters in estimating emissions reductions shall quantify these parameter uncertainties at the 95% confidence level”

Annex 1: Project emissions associated with the cultivation of lands to produce oil seeds

Definitions

Project area. The total land area where biomass is cultivated under the CDM project activity.

N_2O emissions from the application of fertilizers

$$PE_{N2O-N,Fer,y} = F_{N,y} \times EF_{N2O-N,dir} \times GWP_{N2O} \times \frac{44}{28} \quad \textbf{(1)}$$

Where:

$PE_{N2O-N,Fer,y}$	=	Direct N_2O-N emissions from land management at the plantation in year *y* (tCO_2e/yr)
$F_{N,y}$	=	Amount of synthetic fertilizer nitrogen and organic fertilizer nitrogen from animal manure, sewage, compost or other organic amendments applied at the plantation in year *y* (t N/yr). Where $F_{N,y} = F_{ON,y} + F_{SN,y}$
$EF_{N2O-N,dir}$	=	Emission factor for direct nitrous oxide emissions from N inputs (Default Value 0.01 t N_2O-N/t N)

The amount of organic fertilizer N applied at the plantation ($F_{ON,y}$) is calculated based on the quantity of organic fertilizer applied and the N content in the organic fertilizer, as follows:

$$F_{ON,y} = \sum_p M_{OF,p,y} \times w_{N,p,y} \quad \textbf{(2)}$$

Where:

$F_{ON,y}$	=	Amount of organic fertilizer nitrogen from animal manure, sewage, compost or other organic amendments applied at the plantation in year *y* (t N/yr)
$M_{OF,p,y}$	=	Amount of organic fertilizer *p* applied at the plantation in year *y* (tonnes)
$w_{N,p,y}$	=	Weight fraction of nitrogen in organic fertilizer type *p* (t N / t organic fertilizer)
p	=	Organic fertilizer types (animal manure, sewage, compost or other organic amendments) applied at the plantation in year *y*

The amount of synthetic fertilizer N applied at the plantation ($F_{SN,y}$) is calculated based on the quantity of synthetic fertilizer applied and the N content in the synthetic fertilizer, as follows:

$$F_{SN,y} = \sum_q M_{SF,q,y} \times w_{N,q,y} \quad \textbf{(3)}$$

Where:

$F_{SN,y}$	=	Amount of synthetic fertilizer nitrogen applied at the plantation in year *y* (t N/yr)
$M_{SF,q,y}$	=	Amount of synthetic fertilizer *q* applied at the plantation in year *y* (t synthetic fertilizer/yr)
$w_{N,q,y}$	=	Weight fraction of nitrogen in synthetic fertilizer type *q* (t N /t synthetic fertilizer)
q	=	Synthetic fertilizer types applied at the plantation in year *y*

Data and parameters not monitored

Parameter:	$EF_{N2O-N,dir}$
Data unit:	kg N_2O-N/kg N input
Description:	Emissions factor for direct N_2O emissions from N inputs
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 11. Table 11.1
Value to be applied:	0.01
Any comment:	

Parameter:	GWP_{N2O}
Data unit:	tCO_2e/tN_2O
Description:	Global Warming Potential of nitrous oxide valid for the commitment period
Source of data:	IPCC 1996
Value to be applied:	310 for the first commitment period
Any comment:	

Data and parameters monitored

Data / Parameter:	$M_{OF,p,y}$
Data unit:	tonnes of organic fertilizer / year
Description:	Amount of organic fertilizer *p* applied at the plantation in year *y* where *p* are the organic fertilizer types (animal manure, sewage, compost or other organic amendments) applied at the plantation in year *y*
Source of data:	On-site records and measurements
Measurement procedures (if any):	Measure the quantities of any animal manure, sewage, compost or other organic amendments applied as fertilizers to the plantation
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / Parameter:	$w_{N,p,y}$
Data unit:	tN/t organic fertilizer
Description:	Weight fraction of nitrogen in organic fertilizer type *p* where *p* are the organic fertilizer types (animal manure, sewage, compost or other organic amendments) applied at the plantation in year *y*
Source of data:	Sample measurements by project participants
Measurement procedures (if any):	Where applicable, measure the quantities and nitrogen content of any animal manure, sewage, compost or other organic amendments applied as fertilizers to the dedicated plantation.
Monitoring frequency:	Regularly
QA/QC procedures:	
Any comment:	

Data / Parameter:	$M_{SF,q,y}$
Data unit:	tonnes of synthetic fertilizer / year
Description:	Amount of synthetic fertilizer *q* applied at the plantation in year *y* where *q* are the synthetic fertilizer types applied at the plantation in year *y*
Source of data:	On-site records by project participants
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts
Any comment:	

Data / Parameter:	$w_{N,q,y}$
Data unit:	tN/t synthetic fertilizer
Description:	Weight fraction of nitrogen in synthetic fertilizer type *q* where *q* are the synthetic fertilizer types applied at the plantation in year *y*
Source of data:	Specifications by the fertilizer manufacturer
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

CO_2 emissions from urea application

Adding urea to soils leads to a loss of CO_2 that was fixed in the industrial production process. Urea ($CO(NH_2)_2$) is converted into ammonium, hydroxyl ion and bicarbonate in the presence of water and urease enzymes in the soil. The bicarbonate evolves into CO_2 and water. CO_2 emissions from urea application are calculated as follows:

$$PE_{urea,y} = M_{urea,y} \times EF_{CO2,urea} \times \frac{44}{12} \tag{4}$$

Where:

$PE_{urea,y}$	=	Project emissions from urea application at the plantation in year *y* (tCO_2/yr)
$M_{urea,y}$	=	Quantity of urea applied at the plantation in year y (tonnes urea / yr)
$EF_{CO2,urea}$	=	CO_2 emission factor for urea application (Default Value 0.2 tCO_2/turea)

Data and parameters not monitored

Parameter:	$\mathbf{EF_{CO2,urea}}$
Data unit:	t CO_2/t of urea
Description:	CO_2 emission factor for urea application
Source of data:	2006 IPCC Guidelines for National GHG Inventories, Vol. 5, Ch. 11, Page 11.32
Value to be applied:	0.2
Any comment:	

Data and parameters monitored

Data / Parameter:	$M_{urea,y}$
Data unit:	tonnes of urea per year
Description:	Quantity of urea applied at the plantation in year *y*
Source of data:	Records by project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts
Any comment:	

CO_2 emissions from application of limestone and dolomite

Adding carbonates to soils in the form of lime (e.g., calcic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) leads to CO_2 emissions as the limes dissolve and release bicarbonate, which evolves into CO_2 and water. The Tier 1 approach from the 2006 IPCC Guidelines for National GHG Inventories is used to estimate these emissions. CO_2 emissions from liming at the plantation are estimated as follows:

$$PE_{lime,y} = \left(M_{limestone,y} \times EF_{limestone} + M_{dolomite,y} \times EF_{dolomite}\right) \times \frac{44}{12} \quad \textbf{(5)}$$

Where:

$PE_{lime,y}$	=	Project emissions from application of limestone and dolomite at the plantation in year *y* (tCO_2/yr)
$M_{limestone,y}$	=	Quantity of calcic limestone ($CaCO_3$) applied at the plantation in year *y* ($tCaCO_3$**/yr)**
$M_{dolomite,y}$	=	Quantity of dolomite ($CaMg(CO_3)_2$) applied at the plantation in year *y* (t Ca Mg$(CO_3)_2$**/yr)**
$EF_{limestone}$	=	Carbon emission factor for calcic limestone ($CaCO_3$) application (Default Value 0.12 $tC/tCaCO_3$)
$EF_{dolomite}$	=	Carbon emission factor for dolomite ($CaMg(CO_3)_2$) application (Default Value 0.13 $tC/tCaMg(CO_3)_2$)

Data and parameters not monitored

Parameter:	$EF_{limestone}$
Data unit:	$tC/tCaCO_3$
Description:	Carbon emission factor for calcic limestone ($CaCO_3$) application
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 11 Section 11.3.1
Value to be applied:	0.12
Any comment:	

Parameter:	$EF_{dolomite}$
Data unit:	$tC/tCaMg(CO_3)_2$)
Description:	Carbon emission factor for dolomite ($CaMg(CO_3)_2$) application
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 11 Section 11.3.1
Value to be applied:	0.13
Any comment:	

Data and parameters monitored

Data / parameter:	$M_{Limestone,y}$
Data unit:	$tCaCO_3$**/year**
Description:	Quantity of calcic limestone ($CaCO_3$) applied at the plantation in year *y*
Source of data:	Records by project participants
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts
Any comment:	

Data / Parameter:	$M_{Dolomite,y}$
Data unit:	$tCaMg(CO_3)_2$**/year**
Description:	Quantity of dolomite ($CaMg(CO_3)_2$) applied at the plantation in year *y*
Source of data:	Records by project participants
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Cross-check records of applied quantities with purchase receipts
Any comment:	

Identification and stratification of the project area

Project participants should identify and transparently document the project area (i.e. the land area where biomass is cultivated under the CDM project activity) in the CDM-PDD, delineating the project area with GPS data.

Project participants should identify and describe in the CDM-PDD the key features of the project area, including, inter alia, the following elements:

- The applicable climate region according to the default IPCC classification, applying the guidance in Annex 3A.5 of Chapter 3, Volume 4, of the 2006 IPCC Guidelines;
- The relevant soil type according to World Reference Base for Soil Resources (WRB) or USDA soil classifications, following the decision trees in Annex 3A.5 of Chapter 3, Volume 4, of the 2006 IPCC Guidelines;
- ~~The land-use type during the last 10 years before implementation of the project activity, including any changes in the land-use during that period;~~

- ~~The land management practice(s) during the last 10 years before implementation of the project activity, including any changes in the management practice during that period;~~
- The vegetation type before the implementation of the project activity;
- Whether and how any land clearance is undertaken (e.g. harvesting, burning, etc);
- The land-use type (forest or cropland) under the project activity;
- The land management practices that are applied under the project activity.

If one or several of the above-mentioned features differ within the project area, project participants should stratify the land area in different strata *s* according to the features above. The land area of each stratum ($A_{PJ,s}$) should be clearly delineated in the CDM-PDD, using GPS data, and the features of each stratum should be transparently documented. Project participants may use geographical information systems (GIS) for that purpose.

CH_4 and N_2O emissions from the field burning of biomass

Biomass from the plantation may be burnt regularly during the crediting period (e.g. after harvest). In these cases, CH_4 and N_2O emissions should be calculated for each time that field burning is occurring, as follows:

$$PE_{FB,y} = \sum_{s_{FB}} A_{PJ,s_{FB}} \cdot M_{B,s_{FB}} \cdot C_{f,s_{FB}} \cdot \left(EF_{N2O,FB} \cdot GWP_{N2O} + EF_{CH4,FB} \cdot GWP_{CH4}\right) \quad \textbf{(6)}$$

Where:

$PE_{FB,y}$	=	Project emissions from field burning of biomass at the plantation site in year *y* (tCO_2e/yr)
$A_{PJ,s_{FB}}$	=	Size of the land area of stratum s_{FB} (ha)
$M_{B,s_{FB}}$	=	Average mass of biomass available for burning on stratum s_{FB} (t dry matter/ha)
$C_{f,s_{FB}}$	=	Combustion factor, accounting for the proportion of biomass that is actually burnt on stratum s_{FB} (dimensionless)
$EF_{N2O,FB}$	=	N_2O emission factor for field burning of biomass (tN_2O/tonne of dry matter). IPCC default values will be used, see guidance below
GWP_{N2O}	=	Global Warming Potential of nitrous oxide valid for the commitment period (tCO_2e/tN_2O)
$EF_{CH4,FB}$	=	CH_4 emission factor for field burning of biomass (tCH_4/tonne of dry matter). IPCC default values will be used, see guidance below
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
s_{FB}	=	Strata of the project area where biomass is burnt in year *y*[14]

[14] If biomass on a stratum is burnt two or more times in the year, emissions from this stratum should be accounted each time burning is occuring.

Data and parameters not monitored

Parameter:	$EF_{N2O,FB}$
Data unit:	tN_2O/t dry matter of biomass
Description:	N_2O emission factor for field burning of biomass
Source of data:	Select the most suitable value to the type of biomass from the 2006 IPCC Guidelines, Vol. 4, Ch. 2, Table 2.5
Value to be applied:	
Any comment:	

Parameter:	$EF_{CH4,FB}$
Data unit:	tCH_4/t dry matter of biomass
Description:	CH_4 emission factor for field burning of biomass
Source of data:	Select the most suitable value to the type of biomass from the 2006 IPCC Guidelines, Vol. 4, Ch. 2, Table 2.5
Value to be applied:	
Any comment:	

Data and parameters monitored

Data / Parameter:	$\mathbf{M_{B,s_{FB}}}$
Data unit:	ton dry matter per hectare
Description:	Average mass of biomass available for burning on stratum s_{FB} where s_{FB} are the strata of the project area where biomass is burnt in year y
Source of data:	Sample measurements by project participants
Measurement procedures (if any):	
Monitoring frequency:	Each time field burning takes place
QA/QC procedures:	
Any comment:	

Data / Parameter:	$\mathbf{C_{f,s_{FB}}}$
Data unit:	-
Description:	Combustion factor, accounting for the proportion of biomass that is actually burnt on stratum s_{FB} where s_{FB} are the strata of the project area where biomass is burnt in year y
Source of data:	Sample measurements by project participants or assume a default value of 1
Measurement procedures (if any):	Measure the remaining biomass after field burning (if any)
Monitoring frequency:	Each time field burning takes place
QA/QC procedures:	
Any comment:	

Direct N_2O emissions from land management at the plantation ($PE_{N2O\text{-}N,dir,y}$)

N_2O emissions from land management at the plantation can occur from the following activities:

- N in crop residues (above-ground and below-ground);
- N mineralization associated with loss of soil organic matter resulting from change of land use or a change of management practices of mineral soils (applicable in case of mineral soils);
- Drainage/management of organic soils (applicable in case of organic soils).

Some emission sources may not be relevant for certain project types. Project participants should document and justify in the CDM-PDD which of these activities may occur in the context of the proposed project activity.

Direct soil N_2O emissions are calculated as follows:

$$PE_{N2O-N,dir,y} = \left\{ \begin{array}{l} \left(\sum_{s_{CR}} F_{CR,s_{CR},y} \right) \times EF_{N2O-N,dir} + \\ \sum_{s_{MS}} \left[F_{SOM,s_{MS},y} \times EF_{N2O-N,dir} \right] + \sum_{s_{OS}} \left[A_{PJ,s_{OS},y} \times EF_{N2O,N,OS} \right] \end{array} \right\} \times GWP_{N2O} \times \frac{44}{28}$$

(7)

Where:

$PE_{N2O\text{-}N,dir,y}$	=	Direct N_2O-N emissions from land management at the plantation in year *y* (tN_2O-N/yr)
$EF_{N2O\text{-}N,dir}$	=	Emission factor for direct nitrous oxide emissions from N inputs (Default Value 0.01 t N_2O-N/t N)
$F_{CR,s_{CR},y}$	=	Amount of N in crop residues (above ground and below ground), including N-fixing crops, returned to the soil on stratum s_{CR} in year *y* (t N/yr)
$F_{SOM,s_{MS},y}$	=	Amount of N in the mineral soil that is mineralized on stratum s_{MS} in year *y* in association with loss of soil carbon from soil organic matter as a result of a land use change or a change in the land management practice (t N/yr)
$A_{PJ,s_{OS},y}$	=	Size of the land area of stratum s_{OS} (ha)
$EF_{N2O,N,OS}$	=	Emission factor for direct nitrous oxide emissions from drained/managed organic soils (t N_2O-N per ha and year). Default values are provided below
s_{CR}	=	Strata of the project area where crops residues, including N-fixing crops, are returned to the soil
s_{MS}	=	Strata of the project area with mineral soils
s_{OS}	=	Strata of the project area with organic soils

The amount of N in crops residues returned to the soil ($F_{CR,s_{CR},y}$) is calculated for each stratum s_{CR} as follows:

$$F_{CR,s_{CR},y} = \sum_{c} M_{c,s_{CR},y} \times \left[R_{AG,c} \times w_{N,AG,c} \times \left(1 - Frac_{REMOVE,c,y}\right) \times \left(1 - f_{burnt,s_{CR},c,y} \times \left(1 - C_{f,c}\right)\right) + R_{BG,c} \times w_{N,BG,c}\right] \quad (8)$$

Where:

$F_{CR,s_{CR},y}$	=	Amount of N in crop residues (above ground and below ground), including N-fixing crops, returned to the soil on stratum s_{CR} in year *y* (t N/yr)
$M_{c,s_{CR},y}$	=	Quantity of crop type *c* that is harvested on stratum s_{CR} in year *y* (t dry matter)
$f_{burnt,s_{CR},c,y}$	=	Fraction of the area of stratum s_{CR}, cultivated with crop type *c*, that is burnt in year *y*
$C_{f,c}$	=	Combustion factor, accounting for the proportion of the crop residues from crop type *c* that are actually combusted when undertaking field burning
$R_{AG,c}$	=	Ratio of above-ground residue of crop type *c* to harvested yield for crop type *c*
$w_{N,AG,c}$	=	N content in the above-ground residues of crop type *c* (t N/t dry matter)
$Frac_{REMOVE,c,y}$	=	Fraction of above-ground biomass residues of crop type c that are removed from the plantation in year *y*
$R_{BG,c}$	=	Ratio of below-ground residue of crop type *c* to harvested yield for crop type *c*
$w_{N,BG,c}$	=	N content in the below-ground residues of crop type *c* (t N/t dry matter)
C	=	Crop types harvested on stratum s_{CR} in year *y*
s_{CR}	=	Strata of the project area where crops residues, including N-fixing crops, are returned to the soil

When soil C is lost through oxidation as a result of a land use change or a change in land management practices, this loss will be accompanied by a simultaneous mineralization of N. This N is regarded as an additional source of N available for conversion to N_2O. This quantity of N ($F_{SOM,sMS,y}$) is estimated for each stratum s_{MS} as follows:

$$F_{SOM,s_{MS},y} = \frac{SOC_{historic,s_{MS}} - SOC_{PJ,s_{MS}}}{T} \times \frac{1}{R} \times A_{PJ,s_{MS}} \quad (9)$$

Where:

$F_{SOM,s_{MS},y}$	=	Amount of N in the mineral soil that is mineralized on stratum s_{MS} in year *y* in association with loss of soil carbon from soil organic matter as a result of a land use change or a change in the land management practice (t N/yr)
$SOC_{historic,s_{MS}}$	=	Soil organic carbon stock with the land use and land management practices on stratum s_{MS} before the implementation of the project activity (tC/ha)
$SOC_{PJ,s_{MS}}$	=	Soil organic carbon stock with the land use and land management practices on stratum s_{MS} under the project activity (tC/ha)
T	=	Time dependence of the stock change factors (years)
R	=	C:N ratio of the soil organic matter
$A_{PJ,s_{MS}}$	=	Size of the land area of stratum s_{MS} (ha)

Data and parameters not monitored

Parameter:	$EF_{N2O,N,OS}$
Data unit:	t N_2O-N per ha and year
Description:	Emission factor for direct nitrous oxide emissions from drained/managed organic soils
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 11. Table 11.1, as provided below
Value to be applied:	(see table below)
Any comment:	

Applicable climate and soil type	**Emission factor (tN_2O-N/(ha year))**
Temperate organic crop and grassland soils	8
Tropical organic crop and grassland soil	16
Temperate and boreal organic nutrient rich forest soils	0.6
Temperate and boreal organic nutrient poor forest soils	0.1
Tropical organic forest soils	8

Data / parameter:	R
Data unit:	-
Description:	C:N ratio of the soil organic matter
Source of data:	If reliable and well documented country-specific or regional data are available, such data should be used. If such data is not available, project participants should assume, consistent with the 2006 IPCC Guidelines, a default value of 15 for situations involving land-use change from forest land or grassland to cropland and a default value of 10 for situations involving management changes on cropland
Measurement procedures (if any):	-
Any comment:	

Data and parameters monitored

Data / parameter:	$M_{c,s_{CR},y}$
Data unit:	t dry matter
Description:	Quantity of crop type *c* that is harvested on stratum s_{CR} in year *y* where • *c* are the crop types harvested on stratum s_{CR} in year *y*, and • s_{CR} are the strata of the project area where crops residues, including N-fixing crops, are returned to the soil where *c* are the crop types harvested on stratum s_{CR} in year *y*
Source of data:	Records by project proponents
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Data / parameter:	$f_{burnt,s_{CR},c,y}$
Data unit:	-
Description:	Fraction of the area of stratum s_{CR}, cultivated with crop type *c*, that is burnt in year *y* where: • *c* are the crop types harvested on stratum s_{CR} in year *y*; and • s_{CR} are the strata of the project area where crops residues, including N-fixing crops, are returned to the soil
Source of data:	Records by project proponents
Measurement procedures (if any):	
Monitoring frequency:	Each time field burning is taking place
QA/QC procedures:	
Any comment:	

Data / parameter:	$R_{AG,c}$
Data unit:	-
Description:	Ratio of above-ground residue of crop type *c* to harvested yield for crop type *c*
Source of data:	Records by project proponents
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

Data / parameter:	$Frac_{REMOVE,c,y}$
Data unit:	-
Description:	Fraction of above-ground biomass residues of crop type c that are removed from the plantation in year *y* where: • *c* are the crop types harvested on stratum s_{CR} in year *y*, and • s_{CR} are the strata of the project area where crops residues, including N-fixing crops, are returned to the soil where *c* are the crop types harvested on stratum s_{CR} in year *y*
Source of data:	Records by project proponents
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	
Any comment:	

Emissions from the production of synthetic fertilizer that is used at the plantations ($PE_{FP,y}$)

The GHG emissions from the production of synthetic fertilizer are estimated for each synthetic fertilizer type *f* by multiplying an emission factor with the monitored quantity of fertilizer applied at the plantations during year *y*, as follows:

$$PE_{FP,y} = \sum_{f} \left(EF_{CO2e,FP,f} \cdot M_{SF,q,y} \right) \quad (10)$$

Where:

$PE_{FP,y}$	=	Project emissions related to the production of synthetic fertilizer that is used at the dedicated plantations in year *y* (tCO_2e/yr)
$EF_{CO2e,FP,f}$	=	Emission factor for GHG emissions associated with the production of fertilizer type *f* (tCO_2e/kg fertilizer). Default value is provided below
$M_{SF,q,y}$	=	Amount of synthetic fertilizer *q* applied at the plantation in year *y* where *q* are the synthetic fertilizer types applied at the plantation in year *y*(tn fertilizer/yr)

Data and parameters not monitored

Data / Parameter:	$EF_{CO2e,FP,f}$
Data unit:	tCO_2e/tfertilizer
Description:	Emissions factor for GHG emissions associated with the production of fertilizer type *f*
Source of data:	Use default values as provided in the Tables below.
Value to be applied:	see tables below
Any comment:	Source: Calculated based on Wood and Cowie (2004) and Swaminathan (2004)

N Fertilizer Type	**Emission factor (tCO_2/tN)**
Urea	1.7
Ammonium nitrate	7.1
Ammonium sulfate	2.0
Calcium nitrate	11.7
Ammonium Phosphate	2.7
Liquid urea/ammonium nitrate	4.9

P Fertilizer Type	**Emission factor ($tCO2/tP_2O_5$)**
Phosphate rock	2.0
Ammonium phosphate	0.3
Tripple super phosphate	0.5
Single super phosphate	0.2

K Fertilizer Type	**Emission factor (tCO_2/tK_2O)**
Potassium chloride	0.4
Potassium sulphate	0.3

CO_2 emissions resulting from changes in soil carbon stocks following land use changes or changes in the land management practices ($PE_{CO2,soil,y}$)

CO_2 emissions from decreases of carbon stocks in soil carbon pools as a result of land use changes or changes in management practices should be estimated, using the IPCC Tier 1/2 approaches in the 2006 Guidelines for National GHG Inventories. In cases where carbon stocks in soil carbon pools increase as a result of the project activity, these increases should not be accounted as emission reductions and $PE_{CO2,soil,y}$ should be assumed as zero.

The approach to estimate carbon stock changes in soil organic carbon pools is different for organic and mineral soils. Changes in inorganic soil carbon are neglected. Project emissions may include emissions from mineral and organic soils within the project area:

$$PE_{CO2,soil,y} = PE_{CO2,MS,y} + PE_{CO2,OS,y} \qquad \textbf{(11)}$$

Where:

$PE_{CO2,soil,y}$	=	Project emissions of CO_2 in year *y* resulting from changes in soil carbon stocks following a land use change or a change in the land management practices (tCO_2/yr)
$PE_{CO2,MS,y}$	=	Project emissions of CO_2 in year *y* resulting from changes in soil carbon stocks of mineral soils following a land use change or a change in the land management practices (tCO_2/yr)
$PE_{CO2,OS,y}$	=	Project emissions of CO_2 in year *y* resulting from changes in soil carbon stocks of organic soils following a land use change or a change in the land management practices (tCO_2/yr)

CO_2 emissions from mineral soils

For mineral soils, the IPCC Tier 1 method is used to estimate soil carbon emissions. Consistent with the IPCC Tier 1 approach, it is assumed that soil carbon stocks were in an equilibrium before the implementation of the project activity (or would have reached an equilibrium in the absence of the project activity) and change in a linear fashion during a transition period to a new equilibrium as result of the change in the land use or land management practice.

Annual CO_2 emissions from soil carbon stock changes are calculated based on the difference between the soil organic carbon stock before and after implementation of the project activity and the duration of the transition period (i.e. the time dependence of the stock change factors *T*), as follows:

$$PE_{CO2,MS,y} = \sum_{s_{MS}} \frac{SOC_{historic,s_{MS}} - SOC_{PJ,s_{MS}}}{T} \times A_{PJ,s_{MS}} \times \frac{44}{12} \qquad \textbf{(12)}$$

Where:

$PE_{CO2,MS,y}$	=	Project emissions of CO_2 in year *y* resulting from changes in soil carbon stocks of mineral soils following a land use change or a change in the land management practices (tCO_2/yr)
$SOC_{historic,s_{MS}}$	=	Soil organic carbon stock with the land use and land management practices on stratum s_{MS} before the implementation of the project activity (tC/ha)
$SOC_{PJ,s_{MS}}$	=	Soil organic carbon stock with the land use and land management practices on stratum s_{MS} under the project activity (tC/ha)

$A_{PJ,s_{MS}}$	=	Size of the land area of stratum s_{MS} (ha)
T	=	Time dependence of the stock change factors (years). In case of a renewable crediting period: 20 years. In case of a single crediting period: 10 years.
s_{MS}	=	Strata of the project area with mineral soils

The soil organic carbon stock is calculated based on reference soil organic carbon stock value of stratum s_{MS} ($SOC_{REF,s_{MS}}$) for the relevant soil type and climate region and stock change factors (F_{LU}, F_{MG} and F_I) that reflect that land-use type, the land management practices and any carbon input in the soil, as follows:

$$SOC_{historic,s_{MS}} = SOC_{REF,s_{MS}} \times F_{LU,historic,s_{MS}} \times F_{MG,historic,s_{MS}} \times F_{I,historic,s_{MS}} \quad (13)$$

and

$$SOC_{PJ,s_{MS}} = SOC_{REF,s_{MS}} \times F_{LU,PJ,s_{MS}} \times F_{MG,PJ,s_{MS}} \times F_{I,PJ,s_{MS}} \quad (14)$$

Where:

$SOC_{historic,s_{MS}}$	=	Soil organic carbon stock with the land use and land management practices on stratum s_{MS} before the implementation of the project activity (tC/ha)
$SOC_{PJ,s_{MS}}$	=	Soil organic carbon stock with the land use and land management practices on stratum s_{MS} under the project activity (tC/ha)
$SOC_{REF,s_{MS}}$	=	Reference soil organic carbon stock value for stratum s_{MS} (tC/ha). IPCC default values will be used, see guidance below
$F_{LU,historic,s_{MS}}$	=	Stock change factor for the historic land-use system on stratum s_{MS}
$F_{LU,PJ,s_{MS}}$	=	Stock change factor for the land-use system on stratum s_{MS} under the project activity
$F_{MG,historic,s_{MS}}$	=	Stock change factor for the historic land management regime on stratum s_{MS}
$F_{MG,PJ,s_{MS}}$	=	Stock change factor for the land management regime on stratum s_{MS} under the project activity
$F_{I,historic,s_{MS}}$	=	Stock change factor for input of organic matter on stratum s_{MS} for the historical situation
$F_{I,PJ,s_{MS}}$	=	Stock change factor for input of organic matter on stratum s_{MS} under the project activity
s_{MS}	=	Strata of the project activity with mineral soils

CO_2 emissions from organic soils

For organic soils, the land area is multiplied with an annual emission factor that estimates the losses of carbon following drainage. Annual project emissions are calculated as follows:

$$PE_{CO2,OS,y} = \sum_{s_{OS}} A_{PJ,s_{OS}} \times EF_{organic,s_{OS}} \times \frac{44}{12} \quad (15)$$

Where:

$PE_{CO2,OS,y}$	=	Project emissions of CO_2 in year *y* resulting from changes in soil carbon stocks of organic soils following a land use change or a change in the land management practices (tCO_2/yr)
$A_{PJ,s_{OS}}$	=	Size of the land area of stratum s_{OS} (ha)
$EF_{organic,s_{OS}}$	=	Emission factor for carbon soil losses for organic soils on stratum s_{OS} (tonnes C per ha and year). IPCC default values will be used, see guidance below.
s_{OS}	=	Strata of the project area with organic soils

Data and parameters not monitored

Parameter:	**T**
Data unit:	years
Description:	Time dependence of the stock change factors
Source of data:	-
Value to be applied:	In case of a renewable crediting period: 20 years (commonly used value) In case of a single crediting period: 10 years
Any comment:	

Parameter:	$SOC_{REF,s_{MS}}$
Data unit:	tC/ha
Description:	Reference soil organic carbon stock value for stratum s_{MS} where s_{MS} are the strata of the project area with mineral soils
Source of data:	Select the applicable value for the soil type identified from the 2006 IPCC Guidelines, Vol. 4, Ch. 2, Table 2.3
Value to be applied:	
Any comment:	

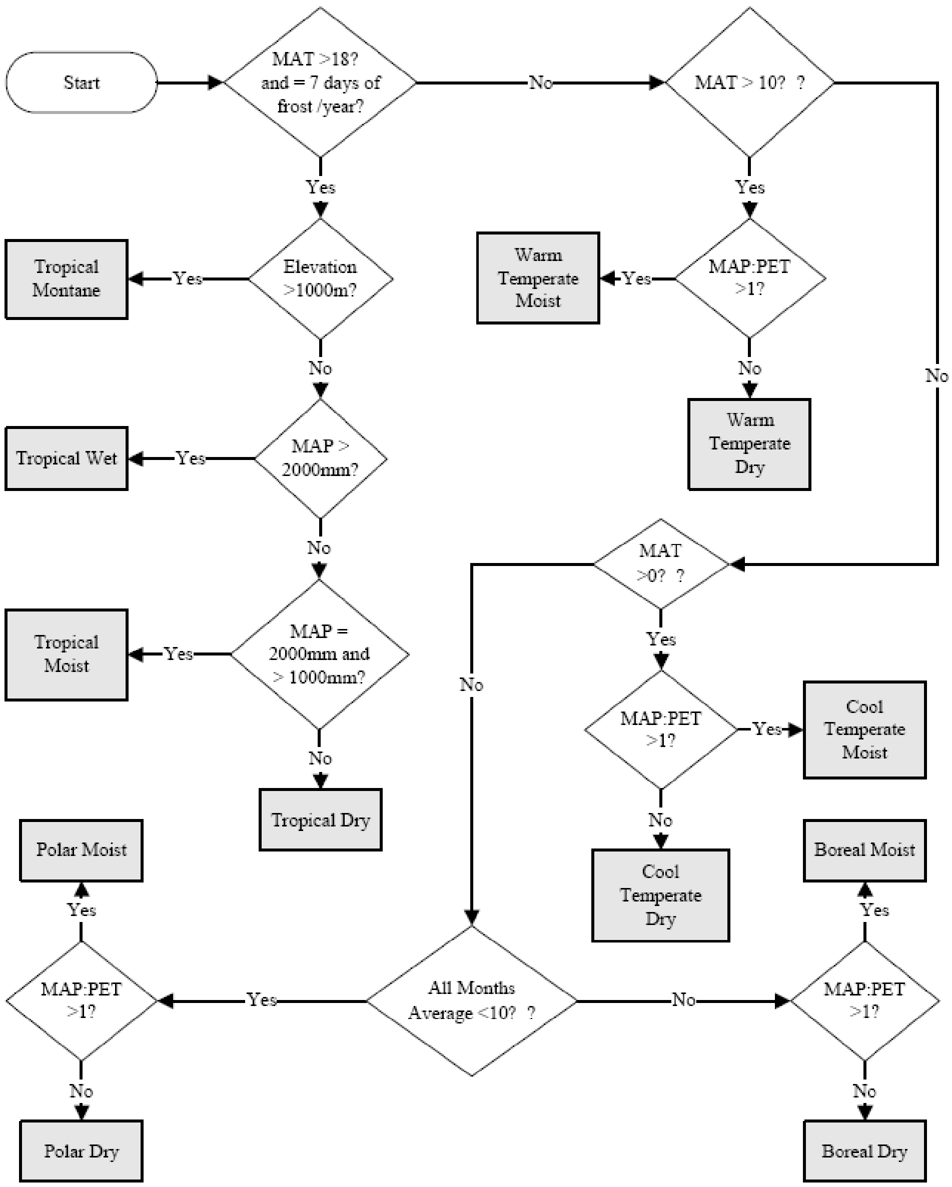
Parameter:	$\mathbf{F_{LU,historic,sMS}}$, $\mathbf{F_{MG,historic,sMS}}$, $\mathbf{F_{I,historic,sMS}}$
Data unit:	dimensionless
Description:	Stock change factor on stratum s_{MS} for the historic land-use system ($\mathbf{F_{LU,historic,sMS}}$), for the historic management regime ($\mathbf{F_{MG,historic,sMS}}$) and for input of organic matter for the historical situation ($\mathbf{F_{I,historic,sMS}}$)
Source of data:	If available, reliable, well documented and reasonably representative for the project area, regional or national stock change factors should be used. If such data is not available, the following default values from the 2006 IPCC Guidelines should be used: Forest land: Use 1.0 for all factors Cropland: Vol. 4, Ch. 5, Table 5.5 Grassland: Vol.4, Ch. 6, Table 6.2
Value to be applied:	
Any comment:	

Parameter:	$\mathbf{F_{LU,PJ,sMS}}$, $\mathbf{F_{MG,PJ,sMS}}$, $\mathbf{F_{I,PJ,sMS}}$
Data unit:	dimensionless
Description:	Stock change factor for the land-use system on stratum s_{MS} under the project activity, Stock change factor for the historic land management regime on stratum s_{MS} and Stock change factor for input of organic matter on stratum s_{MS} for the historical situation.
Source of data:	If available, reliable, well documented and reasonably representative for the project area, regional or national stock change factors should be used. If such data is not available, the following default values from the 2006 IPCC Guidelines should be used: Forest land: Use 1.0 for all factors Cropland: Vol. 4, Ch. 5, Table 5.5 Grassland: Vol.4, Ch. 6, Table 6.2
Value to be applied:	
Any comment:	

Parameter:	$EF_{organic,sOS}$
Data unit:	tonnes C per hectare and year
Description:	Emission factor for carbon soil losses for organic soils on stratum s_{OS}
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 5, Table 5.6
Value to be applied:	Select the suitable default value as follows: The plantation is cropland: Vol. 4, Ch. 5, Table 5.6 The plantation is forest land: Vol. 4, Ch. 4, Table 4.6
Any comment:	

Annex 2: Climate Zone

Figure 3A.5.2 **Classification scheme for default climate regions. The classification is based on elevation, mean annual temperature (MAT), mean annual precipitation (MAP), mean annual precipitation to potential evapotransporation ratio (MAP:PET), and frost occurrence.**



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History of the document

Version	Date	Nature of revision(s)
03	EB 50, Annex # 16 October 2009	To expand the applicability to the production of biodiesel from oil that is produced with oil seeds from plants cultivated in dedicated plantations on degraded or degrading lands. The methodology allows for cases where dedicated plantations are in a land area included in the project boundary of one or several registered CDM A/R project activities.
02	EB 33, Annex 4 27 July 2007	To expand the applicability to project activities that use surplus fats from biogenic origin, such as animal fat residues, to produce biofuels.
01	EB 29, Annex 3 16 February 2007	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		