Draft baseline and monitoring methodology AM00XX

"Production of diesel using a mixed feedstock of gasoil and vegetable oil"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

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

- ACM0017 "Production of biodiesel for use as fuel";
- NM0312 "Production of diesel using a mixed feedstock of gasoil and vegetable oil at the inlet of Hydrotreatment Units" prepared by Alberto Pasqualini REFAP S.A.

This methodology also refers to the latest approved versions of the following tools:

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

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>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable".

Definitions

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

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

Dedicated plantations are plantations that are newly established as part of the project activity for the purpose of supplying oils seeds to project activity.

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".

Refinery is a plant which produces petrodiesel and/or renewable diesel from gasoil or vegetable oil.

Existing refinery is a refinery which started commercial operation at least three years prior to the start of the CDM project activity.

Gasoil is a mixture of middle distillates from various refinery streams for example: heavy and light atmospheric distillate and fluid catalytic cracking middle distillate (light cycle oil or coking gasoil) that constitute the feedstock for the hydrodesulphurization (HDS) unit.

Hydrodesulphurization process (HDS) is the process that consists of the addition of hydrogen to gasoil at high pressure and high temperature using a catalyst. This process, traditionally used in oil refineries for removal of sulphur, nitrogen, olefins and aromatic compounds from gasoil by means of several kinds of reactions, is also suitable for carrying out vegetable oil hydrogenation.

Petrodiesel is diesel produced only from petroleum sources, such as gasoil.

Petrodiesel HS is petrodiesel with high sulphur content.

Petrodiesel LS is petrodiesel with low sulphur content.

Petro/renewable diesel is the mixture of petrodiesel and renewable diesel and is produced through the hydrogenation of vegetable oil along with gasoil carried out in operating oil refineries, and with the same technical specification, according to national norms and regulations, to the diesel oil.

Renewable diesel is fuel produced through hydrogenation of vegetable oil.

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

Applicability

This methodology applies to project activities that produce petro/renewable diesel, by switching the feedstock from 100% gasoil to a mixture of gasoil and vegetable oil in an existing refinery.

The methodology is applicable under the following conditions:

Dedicated plantation:

(a) The vegetable oil is extracted from oil seeds that are produced in dedicated plantations which are established as a consequence of the project activity on clearly identified lands;

(b) The dedicated plantations are established:

  (i) On land which was, at the start of the project activity, 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 A/R CDM project activities;

(c) The plantations are not established on peatlands;

(d) 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;

(e) The land area of the dedicated plantations will be planted by direct planting and/or seeding;

(f) After harvest, regeneration will occur either by direct planting, seeding or natural sprouting;

Production of petro/renewable diesel:

(g) The project activity is carried out in a refinery that was producing only petrodiesel and no renewable diesel during the last three years prior to the start of the project activity. Under the project activity, the feedstock of the hydrodesulphurization process (HDS) unit is changed from 100 % gasoil to a mixture of gasoil and vegetable oil in the production of diesel. In case the project activity is introduced in new HDS unit, the project participants must have historical data of three years prior to the implementation of CDM project activity related to the petrodiesel produced by the refinery and the existing HDS unit;

(h) The energy consumption in the HDS unit under the project activity is lower or equal to the baseline scenario;

(i) Natural gas[1] is used as feedstock and fuel to produce hydrogen (H_2) in both the baseline scenario and under the project activity;

(j) Under the project activity, any combustible gases and off-gases formed during the hydrogenation of vegetable oil are flared and/or used in the refinery as fuel;

Consumption of petro/renewable diesel:

(k) The petro/renewable diesel is supplied to consumers within the host country who use the petro/renewable diesel for fuel combustion in existing stationary installations (e.g. diesel generators) and/or in vehicles;

(l) The consumer and the producer of the petro/renewable diesel are bound by a contract that allows the producer to monitor the consumption of petro/renewable diesel and that states that the consumer shall not claim CERs resulting from its consumption;

(m) No modifications in the consumer stationary installations or in the vehicles engines are necessary to consume/combust the petro/renewable diesel;

(n) In case of vehicles, the consumer (end-user) of the petro/renewable diesel is a captive fleet of vehicles;

(o) Only petro/renewable diesel consumed in excess of mandatory regulations is eligible for the purpose of the project activity.[2]

In addition, the applicability conditions included in the tools referred to above apply.

Finally, the methodology is only applicable if the most plausible baseline scenario, as identified per the section "Selection of the baseline scenario and demonstration of additionality" hereunder, is:

- For production of diesel (P): scenario P1;
- For Consumers (C): scenario C1; and
- For land used for plantations (L): scenario L1.

II. BASELINE METHODOLOGY PROCEDURE

Project boundary

The **spatial extent** of the project boundary encompasses:

- The HDS plant;
- The hydrogen production plant;

[1] The project participants can request for the revision of this methodology if they use different types of fuel in project scenario than baseline scenario and use other types of fuel than natural gas.

[2] 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.

- The vegetable oil production plant(s);
- Consumers (e.g. vehicles and existing stationary combustion installations where the petro/renewable diesel is consumed);
- The dedicated plantations;

If the land area of the dedicated plantations of the project activity 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.[3] Otherwise project emission sources related to the cultivation of the oil seeds shall be considered.

Simplified diagrams of the baseline scenario and project activity are presented in Figures 1 and 2.

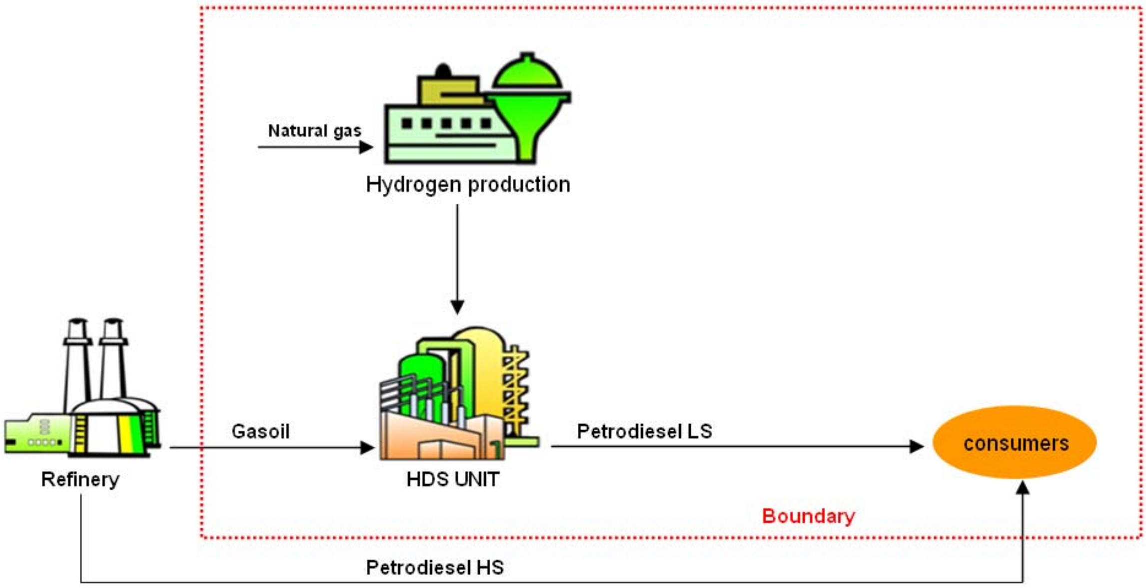


Figure 1: Baseline Scenario

[3] 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, a non-A/R project activity using biomass for energy need not account for emissions related to biomass production if it can demonstrate that the biomass used originates from a registered A/R project activity (i.e. through contractual agreement for procurement of biomass).

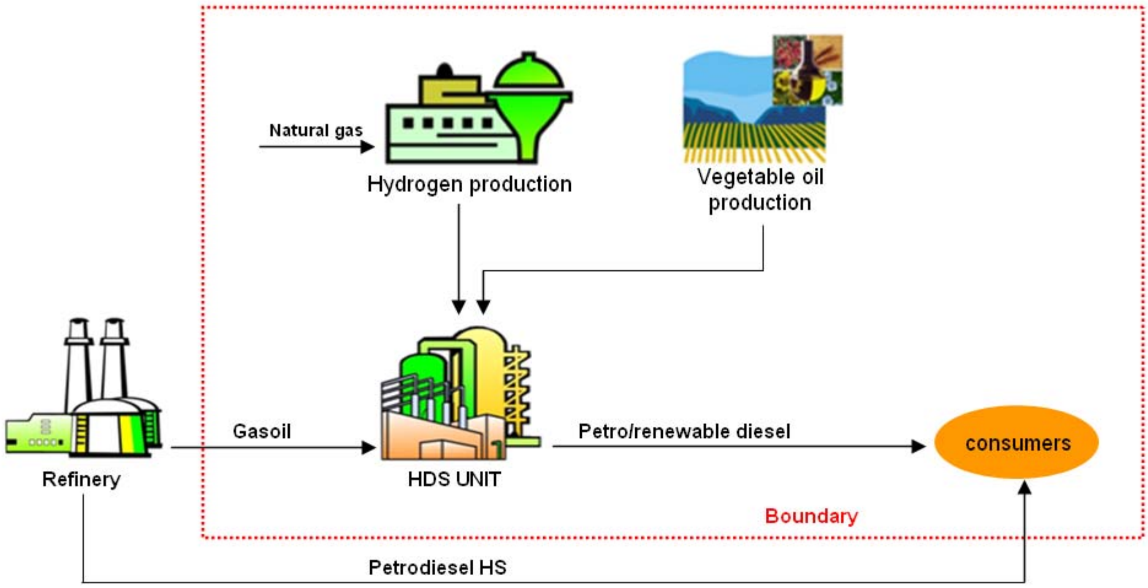


Figure 2: Project activity

The greenhouse gases included in or excluded from the project boundary are shown in **Table 1**.

Table 1: Emissions sources included in or excluded from the project boundary

Source		Gas	Included?	Justification / Explanation
Baseline	Consumption of petrodiesel	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project Activity	Production of excess hydrogen (H_2)	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Transportation of oil seeds and vegetable oil	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Energy consumption for production of vegetable oil	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Anaerobic treatment of wastewater from the production of vegetable oil	CO_2	No	Excluded for simplification
		CH_4	Yes	Main emission source
		N_2O	No	Excluded for simplification
	Cultivation of land to produce oil seeds in dedicated plantations	CO_2	Yes	Main emission source
		CH_4	Yes	Main emission source
		N_2O	Yes	Main emission source

Selection of the baseline scenario and demonstration of additionality

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

- Production of diesel (P);
- Consumers (C); and
- Land used for plantations (L).

For the **production of diesel (P)**, the baseline scenario should be determined as follows:

Step 1.1*: *Identify all realistic and credible alternatives for the production of diesel

Project participants should at least consider the following alternatives with respect to the production of diesel, *inter alia*:

P1: Production of diesel from 100% gasoil in the existing refinery and the existing HDS unit;

P2: Production of diesel from different mix of vegetable oil and gasoil than project activity;

P3: The proposed project activity not undertaken as a CDM project activity.

Step 1.2*: *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 1.3*: *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 **consumers (C)**, the baseline scenario should be determined as follows:

Step 2.1*: *Identify all realistic and credible alternatives for the fuel used by consumers.

Project participants should at least consider the following alternatives with respect to the consumers of petro/renewable diesel, *inter alia*:

C1: Consumption of petrodiesel;

C2: Consumption of petro/renewable diesel 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 petro/renewable diesel from the CDM project activity.

Step 2.2*: *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 2.3*: *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 2.4*: *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 **land use where the dedicated plantations are established (L)**, the baseline scenario should be determined as follows:

Step 3.1*: *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, *inter alia*:

L1: Continuation of current land use;

L2: Conversion to another plantation (annual or perennial);

L3: Conversion to oil plant plantations without CDM.

***Steps 3.2 – 3.4*:** Eliminate scenarios which are not in legal compliance or face prohibitive barriers or are not economically attractive, as described above in step 2.2. 2.3 and 2.4 for the consumers scenario.

The project participants should demonstrate that the most plausible scenario is the "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.

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".

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 petro/renewable diesel 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 petro/renewable diesel 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 petro/renewable diesel;

- If the A/R CDM project activity and the project activity covering the production, sale and consumption of petro/renewable diesel 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 petro/renewable diesel.

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 project activity, 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.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \tag{1}$$

Where:

ER_y	=	Emission reductions in year y (tCO_2)
BE_y	=	Baseline emissions in year y (tCO_2)
PE_y	=	Project emissions in year y (tCO_2)
LE_y	=	Leakage emissions in year y (tCO_2)

Baseline emissions

Baseline emissions include the emissions associated with the consumption of petrodiesel by the consumers which is displaced by the use of renewable diesel. The baseline emissions are calculated as follows:

$$BE_y = Q_{VO,y} \cdot R_{RD} \cdot d_{RD} \cdot NCV_{PD,y} \cdot EF_{CO_2,PD} \cdot 10^{-6} \tag{2}$$

Where:

BE_y	=	Baseline emissions in year y (tCO_2)
$Q_{VO,y}$	=	Amount of vegetable oil fed to HDS unit in year y (m^3)
R_{RD}	=	Ratio between the amount of renewable diesel produced per vegetable oil fed into the HDS unit (m^3 renewable diesel / m^3 vegetable oil) ()

d_{RD}	=	Density of renewable diesel (t/m³)
$NCV_{PD,y}$	=	Average net calorific value of petrodiesel in year *y* (MJ/tonne)
$EF_{CO2,PD}$	=	CO_2 emission factor of petrodiesel (tCO_2/TJ)

Project emissions

Project emissions include emissions from the following sources:

- Production of excess hydrogen (H_2) that is required in the project scenario to be used in the HDS unit in comparison to the baseline scenario;
- Transportation of oil seeds and vegetable oil;
- Energy consumption for the production of vegetable oil;
- Anaerobic treatment of wastewater from the production of vegetable oil;
- Cultivation of land to produce oil seeds in dedicated plantations (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 are calculated as follows:

$$PE_y = PE_{H_2,y} + PE_{TR,y} + PE_{VOP,y} + PE_{BC,y} \cdot AF_y \quad (3)$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2)
$PE_{H2,y}$	=	Project emissions due to the excess hydrogen production in year *y* (tCO_2)
$PE_{TR,y}$	=	Project emissions from the transportation of oil seeds and vegetable oil in year *y* (tCO_2)
$PE_{VOP,y}$	=	Project emissions due to the extraction of vegetable oil from the oil seeds in the vegetable oil production plant in year *y* (tCO_2)
$PE_{BC,y}$	=	Project emissions due to the cultivation of oil seeds in dedicated plantations in year *y* (tCO_2)
AF_y	=	Allocation factor for the oil seeds cultivation in year *y* (fraction)

Project emissions due to the excess hydrogen production

The project emission due to the excess hydrogen production shall include:

- The emissions due to the fossil fuel (in this case natural gas) combusted to produce excess hydrogen required to process vegetable oil in the HDS unit;
- The emissions due to the chemical reaction that forms the excess hydrogen required to process vegetable oil in the HDS unit.

The project emission due to the excess hydrogen production shall be calculated as follows:

$$PE_{H_2,y} = PE_{NG,H_2,y} + PE_{CO_2,H_2,y} \quad (4)$$

Where:

$PE_{H2,y}$	=	Project emissions due to the excess hydrogen production in year *y* (tCO_2)
$PE_{NG,H2,y}$	=	Project emissions due to natural gas combusted to produce excess hydrogen required to process vegetable oil in the HDS unit in year *y* (tCO_2)
$PE_{CO2,H2,y}$	=	Project emissions due to the chemical reaction that forms the excess hydrogen required to process vegetable oil in the HDS unit in year *y* (tCO_2)

Determination of $PE_{NG,H2,y}$

Project emissions due to natural gas combusted to produce excess hydrogen required to process vegetable oil in the HDS unit shall be calculated as follows:

$$PE_{NG,H_2,y} = VR_{H_2,Es,y} \cdot r_{E,H_2} \cdot EF_{CO_2,NG} \cdot 10^{-6} \quad \textbf{(5)}$$

Where:

$PE_{NG,H2,y}$	=	Project emissions due to natural gas combusted to produce H_2 required by the HDS unit during the year y (tCO_2)
$VR_{H2,Es,y}$	=	Volume of excess H_2 required in the HDS unit in year y (Nm^3 H_2)
$r_{E,H2}$	=	Rate of energy consumption for H_2 production (MJ/Nm^3 H_2)
$EF_{CO2,NG}$	=	CO_2 emission factor of natural gas consumed (tCO_2/TJ)

Determination of $VR_{H2,Es,y}$

$$VR_{H_2,Es,y} = VC_{H2,y} - \left(Q_{PRD,y} \cdot \frac{\sum_{x=1}^{3} VC_{H2,x}}{\sum_{x=1}^{3} Q_{PD,x}} \right) \quad \textbf{(6)}$$

Where:

$VR_{H2,Es,y}$	=	Volume of excess H_2 required in the HDS unit in year y (Nm^3 H_2)
$VC_{H2,y}$	=	Volume of H_2 consumed in the HDS unit in the year y (Nm^3 H_2)
$Q_{PRD,y}$	=	Total amount of petro/renewable diesel produced by the project activity in year y (m^3)
$VC_{H2,x}$	=	Volume of H_2 consumed in the HDS unit in year x (Nm^3 H_2)
$Q_{PD,x}$	=	Amount of petrodiesel produced in year x (m^3)
x	=	The most recent three years prior to the implementation of the project activity

Determination of $r_{E,H2}$

$$r_{E,H_2} = \frac{\sum_{x=1}^{3} FC_{NG,H2,x} \cdot NCV_{NG,x}}{\sum_{x=1}^{3} VP_{H2,x}} \quad \textbf{(7)}$$

Where:

$r_{E,H2}$	=	Rate of energy consumption for H_2 production (MJ/Nm^3 H_2)
$FC_{NG,H2,x}$	=	Amount of natural gas consumed as fuel for H_2 production in year x (Nm^3)
$NCV_{NG,x}$	=	Net calorific value of natural gas combusted in year x (MJ/Nm^3)
$VP_{H2,x}$	=	Volume of H_2 produced in the H_2 production facility in year x (Nm^3 H_2)
x	=	The most recent three years prior to the implementation of the project activity

Determination of $PE_{CO2,H2,y}$

Project emissions due to the chemical reaction that forms the excess hydrogen required to process vegetable oil in the HDS unit shall be determined as follows:

$$PE_{CO_2,H_2,y} = F \cdot VR_{H_2,Es,y} \cdot 10^{-6} \quad \textbf{(8)}$$

With,

$$F = 490.6 \cdot \eta_{H2,react,y} \quad \textbf{(9)}$$

Where:

$PE_{CO2,\ H2,\ y}$	=	Project emissions due to the chemical reaction that forms the excess hydrogen required to process vegetable oil in the HDS unit in year *y* (tCO_2)
F	=	Factor used to relate the volume of H_2 produced to the mass of CO_2 emitted in the reaction ($gCO_2/Nm^3\ H_2$), refer to Annex 2
$VR_{H2,Es,y}$	=	Volume of excess H_2 required in the HDS unit in year *y* ($Nm^3\ H_2$)
$\eta_{H2,react,y}$	=	Reaction efficiency of H_2 formation in year *y*

Project emissions from the transportation of oil seeds and vegetable oil

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

Project emissions from transportation oil seeds and vegetable oil include the following sources, where applicable:

- Any transportation of oil seeds to the vegetable oil production plant(s);
- Any transportation of vegetable oil to the HDS unit.

Option 1:

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

$$PE_{TR,y} = \sum_{m} \left(\frac{MT_{m,y}}{TL_m} \times AVD_m \times EF_{km} \right) \quad \textbf{(10)}$$

Where:

$PE_{TR,y}$	=	Project emissions from the transportation of oil seeds and vegetable oil in year *y* (tCO_2)
$MT_{m,y}$	=	Amount of material *m* transported in year *y* (t)
TL_m	=	Average truck load for vehicles transporting material *m* (t)
AVD_m	=	Average distance travelled by vehicles transporting material *m* (km), including the return trip(s)
EF_{km}	=	CO_2 emission factor for vehicles transporting material (tCO_2/km)
m	=	Type of material transported (e.g. oil seeds, vegetable oil)

Option 2:

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

$$PE_{TR,y} = \sum_{m}\sum_{i}\left(FC_{m,i,y} \times NCV_{i,y} \times EF_{CO2,i} \cdot 10^{-6}\right) \quad \textbf{(11)}$$

Where:

$PE_{TR,y}$	=	Project emissions from the transportation of oil seeds and vegetable oil in year *y* (tCO_2)
$FC_{m,i,y}$	=	Fuel consumption of fossil fuel type *i* for transporting material *m* in year *y* (tonne)
$NCV_{i,y}$	=	Net calorific value of fossil fuel type *i* in year *y* (MJ/tonne)
$EF_{CO2,i}$	=	CO_2 emissions factor for fossil fuel type *i* (tCO_2/TJ)
i	=	Fossil fuel types used for transporting material *m* in year *y*
m	=	Type of material transported (e.g. oil seeds, vegetable oil)

<u>Project emissions due to the extraction of vegetable oil from the oil seeds in the vegetable oil production plant</u>

The project emission due to the extraction of vegetable oil from the oil seeds in the vegetable oil production plant shall include:

- The emissions due to the energy consumption (fossil fuel and/or electricity) for the production of vegetable oil; and
- The emissions due to the anaerobic treatment of wastewater from the production of vegetable oil.

$$PE_{VOP,y} = PE_{FC,y} + PE_{EC,y} + PE_{WW,y} \quad \textbf{(12)}$$

Where:

$PE_{VOP,y}$	=	Project emissions due to the extraction of vegetable oil from the oil seeds in the vegetable oil production plant, including transportation in year *y* (tCO_2)
$PE_{FC,y}$	=	Project emissions from fossil fuel combustion by the project activity in year *y* (tCO_2)
$PE_{EC,y}$	=	Project emissions from electricity consumption by the project activity in year *y* (tCO_2)
$PE_{WW,y}$	=	Project emissions from anaerobic treatment of wastewater from the vegetable oil production plant in year *y* (tCO_2)

<u>Determination of $PE_{FC,y}$</u>

Project emissions from fossil fuel combustion by the project activity in year *y* ($PE_{FC,y}$) are calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", where the sources *j* in the tool correspond to all sources of fossil fuel consumption by the project activity, including vegetable oil production plant(s). Fossil fuel consumption, if any, for electricity generation should not be included. All emission sources should be documented transparently in the CDM-PDD.

<u>Determination of $PE_{EC,y}$</u>

Project emissions from electricity consumption by the project activity in year *y* ($PE_{EC,y}$) are calculated using the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" where the electricity consumption sources *j* in the tool corresponds to all electricity consumption sources under the project activity, including the vegetable oil production plant. All emission sources should be documented transparently in the CDM-PDD.

Determination of $PE_{WW,y}$

In case that the methane from the anaerobic treatment of wastewater is vented to the atmosphere:

If the methane from anaerobic treatment of wastewater is vented to the atmosphere, the project emissions from anaerobic treatment of wastewater from the vegetable oil production plant ($PE_{WW,y}$) are calculated as follows:

$$PE_{WW,y} = \sum_{d=1}^{365} Q_{WW,d,y} \times COD_{WW,d,y} \times B_0 \times MCF_P \times GWP_{CH4} \quad \textbf{(13)}$$

Where:

$PE_{WW,y}$	=	Project emissions from anaerobic treatment of wastewater from the vegetable oil production plant in year *y* (tCO_2)
$Q_{WW,d,y}$	=	Amount of wastewater treated anaerobically or released untreated from the vegetable oil production plant on day *d* in year *y* (m^3)
$COD_{WW,d,y}$	=	Chemical Oxygen Demand (COD) of wastewater on day *d* in year *y* ($tCOD/m^3$)
B_0	=	Maximum methane producing capacity ($tCH_4/tCOD$)
MCF_p	=	Methane conversion factor (fraction)
GWP_{CH4}	=	Global warming potential of methane (tCO_2/tCH_4)

In case that the methane from the anaerobic treatment of wastewater is flared:

If the methane from anaerobic treatment of wastewater is flared, then the "Tool to determine project emissions from flaring gases containing methane" should be used to estimate project emissions from anaerobic treatment of wastewater from the vegetable oil production plant ($PE_{WW,y}$).

Project emissions from the cultivation of oil seeds 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 shall not be accounted as project emissions under this methodology.

Project emissions from the cultivation of oil seeds in dedicated plantations are calculated using one of the following two options:

- Option 1: This option calculates the emissions based on actual data from the cultivation process, hence, it requires the collection of more data by the project participants and may be used for other oil seeds that cannot apply the Option 2 below;

- Option 2: This option can only be used for oil seeds from **palm** or **jatropha**. In this option a simple approach is apply, using conservative default values for the emissions associated with the cultivation of lands, taking into account different geographical regions.

Option 1: Use of project specific data

Project emissions associated with the cultivation of land vary between different project types. Table 2 describes how different emission sources should be estimated. Project proponents should estimate the emissions using approved tools or Annex 1 "Project emissions associated with the cultivation of lands to produce oil seeds".

Project participants should clearly document and justify which emission sources are applicable to the project activity. An spreadsheet that can be used to calculate the emission factors for the GHG emissions associated with the cultivation of land to produce oil seeds for different type of crops under different climatic conditions is provided at the following web link at UNFCCC CDM website <http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>.

Table 2: Cases for which relevant emission sources from the cultivation of oil seed 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	21, 22, 23	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	24	Should be estimated if **urea** is applied as a nitrogen source at the plantation
CO_2 emissions from application of limestone and dolomite	25	Should be estimated if **limestone or dolomite** is applied to the plantation to reduce soil acidity and improve plant growth
CH_4 and N_2O emissions from the field burning of biomass	26	Should be estimated if biomass from the plantation is to be burnt regularly during the crediting period (e.g. after harvest)
N_2O emissions from land management at the plantation	27, 28, 29, 30, 31, 32	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	33	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	34, 35, 36, 37, 38	Should be estimated if land use change or change in land management practices is introduced with the cultivation of biomass under the project activity. For perennial plants only, 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 these emissions are expected to be negligible and they are accounted for as zero. 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

Option 2: Use of a default emission factor

$$PE_{BC,y} = \sum_{s} A_{s,y} \cdot EF_{s,y} \tag{14}$$

Where:

$PE_{BC,y}$	=	Project emissions from the cultivation of oil seeds in dedicated plantations in year y (tCO_2)
$A_{s,y}$	=	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_2/ha). See Table 3 below for available values

Table 3: Conservative default emission factors for the GHG emissions associated with the cultivation of land to produce oil seeds during one year

Crop	Climate Zone[4]	$EF_{s,y}$ (tCO_2e/ha)
Palm	Tropical Moist	1.87
Palm	Tropical Wet	1.87
Jatropha	Tropical Moist	1.76
Jatropha	Tropical Dry	2.52

Leakage

Leakage emissions includes:

- The upstream emissions of excess natural gas required for the production of hydrogen; and
- Positive leakage associated with the avoided production of petrodiesel.

The leakage emissions are calculated as follows:

$$LE_y = LE_{NG,y} - LE_{PD,y} \tag{15}$$

Where:

LE_y	=	Leakage emissions in year y (tCO_2)
$LE_{NG,y}$	=	Leakage emissions related to the upstream emissions of excess natural gas required in year y (tCO_2)
$LE_{PD,y}$	=	Leakage emissions related to the avoided production of petrodiesel in year y (tCO_2)

Leakage emissions related to the upstream emissions of excess natural gas required

Leakage emissions related to the upstream emissions of excess natural gas required in the project activity includes: (i) fugitive CH_4 emissions related to natural gas extraction, processing and transportation to the refinery, and (ii) emissions related to the removal of CO_2 from the raw natural gas stream.

[4] See Annex 3.

$$LE_{NG,y} = LE_{CH4,y} + LE_{CO2,y} \quad \textbf{(16)}$$

Where:

$LE_{NG,y}$	=	Leakage emissions related to the upstream emissions of excess natural gas required in year y (tCO_2)
$LE_{CH4,y}$	=	Leakage emissions due to fugitive upstream CH_4 emissions in year y (tCO_2)
$LE_{CO2,y}$	=	Leakage emissions due to the removal of CO_2 from the raw natural gas stream in year y (tCO_2)

Determination of fugitive upstream methane emissions ($LE_{CH4,y}$)

Leakage emissions due to fugitive upstream CH_4 emissions shall be determined by multiplying the amount of excess of natural gas used as feedstock and fuel for H_2 production in the project activity compared to baseline scenario, with an emission factor for fugitive CH_4 emissions ($EF_{NG,upstream,CH4}$) from natural gas consumption, and the net calorific value of natural gas, as follows:

$$LE_{CH4,y} = Q_{NG,Es,y} \cdot NCV_{NG,y} \cdot EF_{NG,upstream,CH4} \cdot GWP_{CH4} \cdot 10^{-3} \quad \textbf{(17)}$$

Where:

$LE_{CH4,y}$	=	Leakage emissions due to fugitive upstream CH_4 emissions in year y (tCO_2)
$Q_{NG,Es,y}$	=	Amount of excess of natural gas used as feedstock and fuel for H_2 production in the project activity compared to baseline scenario in year y (Nm^3)
$NCV_{NG,y}$	=	Average net calorific value of the natural gas combusted in year y (MJ/Nm^3)
$EF_{NG,upstream,CH4}$	=	Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution (tCH_4/GJ)
GWP_{CH4}	=	Global warming potential of Methane (tCO_2/tCH_4)

Note that the emission factor for fugitive upstream emissions for natural gas ($EF_{NG,upstream,CH4}$) should include fugitive emissions from production, processing, transport and distribution of natural gas, as indicated in the table below. Where default values from this table are used, the natural gas emission factors for the location of the project activity should be used. The US/Canada values may be used in cases where it can be shown that the relevant system element (gas production and/or processing/transmission/ distribution) is predominantly of recent vintage and built and operated to international standards.

Since the fugitive upstream emissions for coal depends on the source (underground or surface mines), project participants should use the emission factor that corresponds to the predominant source (underground or surface) currently used by coal-based power plants in the region.

Note further that in case of coal the emission factor is provided based on a mass unit and needs to be converted in an energy unit, taking into account the net calorific value of the coal. Moreover, all values used from Table 4 are to be converted to the appropriate units in order to be correctly used in the equations provided in this methodology.

Table 4 Default emission factors for fugitive CH_4 upstream emissions

Activity	Unit	Default emission factor	Reference for the underlying emission factor range in Volume 3 of the *1996 Revised IPCC Guidelines*
Coal			
Underground mining	t CH4 / kt coal	13.4	Equations 1 and 4, p. 1.105 and 1.110
Surface mining	t CH4 / kt coal	0.8	Equations 2 and 4, p.1.108 and 1.110
Oil			
Production	t CH4 / PJ	2.5	Tables 1-60 to 1-64, p. 1.129 - 1.131
Transport, refining and storage	t CH4 / PJ	1.6	Tables 1-60 to 1-64, p. 1.129 - 1.131
Total	t CH4 / PJ	4.1	
Natural gas			
USA and Canada			
Production	t CH4 / PJ	72	Table 1-60, p. 1.129
Processing, transport and distribution	t CH4 / PJ	88	Table 1-60, p. 1.129
Total	t CH4 / PJ	160	
Eastern Europe and former USSR			
Production	t CH4 / PJ	393	Table 1-61, p. 1.129
Processing, transport and distribution	t CH4 / PJ	528	Table 1-61, p. 1.129
Total	t CH4 / PJ	921	
Western Europe			
Production	t CH4 / PJ	21	Table 1-62, p. 1.130
Processing, transport and distribution	t CH4 / PJ	85	Table 1-62, p. 1.130
Total	t CH4 / PJ	105	
Other oil exporting countries / Rest of world			
Production	t CH4 / PJ	68	Table 1-63 and 1-64, p. 1.130 and 1.131
Processing, transport and distribution	t CH4 / PJ	228	Table 1-63 and 1-64, p. 1.130 and 1.131
Total	t CH4 / PJ	296	

Note: The emission factors in this table have been derived from IPCC default Tier 1 emission factors provided in Volume 3 of the 1996 Revised IPCC Guidelines, by calculating the average of the provided default emission factor range.

Determination of upstream emissions due to CO_2 removal from raw natural gas stream ($LE_{CO2,y}$)

In processing natural gas, CO_2 contained in the raw gas is removed and usually vented to the atmosphere. The CO_2 is removed to upgrade the gas to specifications required for commercial application. Emissions from venting of the CO_2 only need to be estimated if the average CO_2 content of the raw gas, which is processed in the gas processing plants supplying the applicable gas transmission and distribution system, is higher than 5% on a volume basis. In this case, the leakage emissions $LE_{CO2,y}$ are to be estimated as follows:

$$LE_{CO2,y} = Q_{NG,Es,y} \cdot \frac{r_{CO2}}{1 - r_{CO2}} \cdot \rho_{CO2} \qquad \textbf{(18)}$$

Where:

$LE_{CO2,y}$	=	Leakage emissions due to the removal of CO_2 from the raw natural gas stream in year y (tCO_2)
$Q_{NG,Es,y}$	=	Amount of excess of natural gas used as feedstock and fuel for H_2 production in the project activity compared to baseline scenario in year y (Nm^3)
r_{CO2}	=	Average CO_2 content in the raw natural gas stream on volume basis (fraction)
ρ_{CO2}	=	Density of CO_2 under standard conditions (tCO_2/Nm^3)

Determination of $Q_{NG,Es,y}$

$$Q_{NG,Es,y} = VR_{H_2,Es,y} \cdot \frac{\sum_{x=1}^{3}\left(Q_{NG,FS,x} + FC_{NG,H2,x}\right)}{\sum_{x=1}^{3} VP_{H2,x}} \qquad \textbf{(19)}$$

Where:

$Q_{NG,Es,y}$	=	Amount of excess of natural gas used as feedstock and fuel for H_2 production between baseline scenario and project activity in year *y* (Nm^3)
$VR_{H2,Es,y}$	=	Volume of excess H_2 required in the HDS unit in year *y* (Nm^3 H_2) (Calculated following the equation 6 above.)
$Q_{NG,FS,x}$	=	Amount of natural gas used as feedstock for H_2 production in year *x* (Nm^3)
$FC_{NG,H2,x}$	=	Amount of natural gas consumed as fuel for H_2 production in year *x* (Nm^3)
$VP_{H2,x}$	=	Volume of H_2 produced in the H_2 production facility in year *x* (Nm^3 H_2)
x	=	The most recent years prior to the implementation of the project activity

Leakage emissions related to the avoided production of petrodiesel

The production of renewable diesel reduces indirect ("upstream") emissions associated with the production of petrodiesel which is displaced by the renewable diesel. 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 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. EB 25 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."

$$LE_{PD,y} = Q_{VO,y} \cdot R_{RD} \cdot d_{RD} \cdot \left(EF_{PROD} + EF_{REF} + EF_{LDT}\right) \qquad \textbf{(20)}$$

Where:

$LE_{PD,y}$	=	Leakage emissions related to the avoided production of petrodiesel (tCO_2)
$Q_{VO,y}$	=	Amount of vegetable oil fed to HDS unit in year *y* (m^3)
R_{RD}	=	Ratio on volume basis of renewable diesel produced to vegetable oil fed to in the HDS unit (determined by carrying out a mass balance around the HDS unit or a laboratory test using relevant national or international standards)
d_{RD}	=	Density of renewable diesel (tonne/Nm^3)
EF_{PROD}	=	Emission factor for production of crude oil (tCO_2/tonne of petrodiesel)
EF_{REF}	=	Emission factor related to oil refining (tCO_2/tonne of petrodiesel)
EF_{LDT}	=	Emission factor related to long distance transportation (tCO_2/tonne of petrodiesel)

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

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").[5]

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter:	R_{RD}
Data unit:	m^3 renewable diesel / m^3 vegetable oil
Description:	Ratio between the amount of renewable diesel produced per vegetable oil fed into the HDS unit
Source of data:	Onsite measurements and calculations by the project participants
Measurement procedures (if any):	This parameter is to be determined by carrying out a mass balance around the HDS unit or a laboratory test using relevant national or international standards
Any comment:	This parameter is determined once and fixed through out the crediting period

Data / Parameter:	d_{RD}
Data unit:	$tonne/Nm^3$
Description:	Density of renewable diesel
Source of data:	Onsite measurements and calculations by the project participants
Measurement procedures (if any):	This parameter is to be estimated from (i) the density of the petrodiesel, (ii) the density of the petro/renewable diesel, and (iii) the volume fraction of renewable diesel (obtained by multiplying $Q_{VO,y}$ and R_{RD}) against petrodiesel (obtained by running the HDS unit only with gasoil)
Any comment:	This parameter is determined once and fixed through out the crediting period

Data / Parameter:	$EF_{CO2,PD}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of petrodiesel
Source of data:	IPCC default value at the lower limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement procedures (if any):	-
Any comment:	-

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

Data / Parameter:	$EF_{CO2,i}$
Data unit:	tCO_2/TJ
Description:	CO_2 emissions factor for fossil fuel type *i*
Source of data:	The following data sources may be used if the relevant conditions apply: **Data source** — **Conditions for using the data source** a) Values provided by the fuel supplier in invoices — This is the preferred source b) Measurements by the project participants — If a) is not available c) Regional or national default values — If a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances) d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories — If a) is not available
Measurement procedures (if any):	For a) and b): Measurements should be undertaken in line with national or international fuel standards
Any comment:	-

Data source	**Conditions for using the data source**
a) Values provided by the fuel supplier in invoices	This is the preferred source
b) Measurements by the project participants	If a) is not available
c) Regional or national default values	If a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)
d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If a) is not available

Data / Parameter:	$VC_{H2,x}$
Data unit:	Nm^3
Description:	Volume of H_2 consumed in the HDS unit in year *x*
Source of data:	Plant historical data
Measurement procedures (if any):	Flow meter at the inlet of the unit
Any comment:	-

Data / Parameter:	$Q_{PD,x}$
Data unit:	m^3
Description:	Amount of petrodiesel produced in year *x*
Source of data:	Plant historical data
Measurement procedures (if any):	Flow meter at the outlet of the unit.
Any comment:	-

Data / Parameter:	$FC_{NG,H2,x}$
Data unit:	Nm^3
Description:	Amount of natural gas consumed as fuel for H_2 production in year *x*
Source of data:	Plant historical data
Measurement procedures (if any):	-
Any comment:	-

<table>
<tr><th>Data / Parameter:</th><th colspan="2">$NCV_{NG,x}$</th></tr>
<tr><td>Data unit:</td><td colspan="2">MJ/Nm^3</td></tr>
<tr><td>Description:</td><td colspan="2">Net calorific value of natural gas combusted in year x</td></tr>
<tr><td rowspan="6">Source of data:</td><td colspan="2">The following data sources may be used if the relevant conditions apply:</td></tr>
<tr><td>Data source</td><td>Conditions for using the data source</td></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available.
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the upper limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
<tr><td>Measurement procedures (if any):</td><td colspan="2">For a) and b): Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Any comment:</td><td colspan="2">-</td></tr>
</table>

Data / Parameter:	$VP_{H2,x}$
Data unit:	Nm^3
Description:	Volume of H_2 produced in the H_2 production facility in year *x*
Source of data:	Plant historical data
Measurement procedures (if any):	Flow meter at the outlet of the facility.
Any comment:	-

Data / Parameter:	B_0
Data unit:	$tCH_4/tCOD$
Description:	Maximum methane producing capacity
Source of data:	2006 IPCC Guidelines for National GHG Inventories
Measurement procedures (if any):	The default IPCC value for B_0 is 0.25 $kgCH_4/kgCOD$. Taking into account the uncertainty of this estimate, project participants should use a value of 0.265 $kgCH_4/kgCOD$ as a conservative assumption for B_0.
Any comment:	-

Data / Parameter:	MCF_p
Data unit:	fraction
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 are difficult to obtain
Measurement procedures (if any):	-
Any comment:	Preferably local specific value should be used. In absence of local values, MCFp default values can be obtained from table 6.3, chapter 6, volume 4 from 2006 IPCC Guidelines for National GHG Inventories

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2/tCH_4
Description:	Global warming potential of methane
Source of data:	IPCC
Measurement procedures (if any):	Default to be applied: 21 for the first commitment period.
Any comment:	This parameter shall be updated according to any future COP/MOP decisions

Data / Parameter:	$EF_{NG,upstream,CH4}$
Data unit:	tCH_4/GJ
Description:	Emission factor for upstream fugitive methane emissions of natural gas from production, transportation and distribution
Source of data:	Where reliable and accurate national data on fugitive CH_4 emissions associated with the production, and in case of natural gas, the transportation and distribution of the fuels is available, project participants should use this data to determine average emission factors by dividing the total quantity of CH_4 emissions by the quantity of fuel produced or supplied respectively. Where such data is not available, project participants should use the default values provided in the Table 4 in the baseline methodology
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	r_{CO2}
Data unit:	fraction
Description:	Average CO_2 content in the raw natural gas stream on volume basis
Source of data:	Official, governmental or public studies; public databases; or written statements from the applicable natural gas processing facility(ies), including the average chemical composition of the raw gas in the reservoirs where the project activity natural gas is extracted from
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	ρ_{CO2}
Data unit:	tCO_2/Nm^3
Description:	Density of the CO_2 under standard conditions
Source of data:	A default value of 0.001978 t CO_2 / Nm^3 CO_2 under standard conditions
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$EF_{CO2,NG}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor of natural gas consumed
Source of data:	The following data sources may be used if the relevant conditions apply:
Measurement procedures (if any):	For a) and b): Measurements should be undertaken in line with national or international fuel standards
Any comment:	-

Data source	**Conditions for using the data source**
a) Values provided by the fuel supplier in invoices	This is the preferred source
b) Measurements by the project participants	If a) is not available
c) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If a) is not available

Data / Parameter:	$Q_{NG,FS,x}$
Data unit:	Nm^3
Description:	Amount of natural gas used as feedstock for H_2 production in year *x*
Source of data:	Plant historical data
Measurement procedures (if any):	Flow meter at the inlet of the facility for feedstock
Any comment:	-

Data / Parameter:	EF_{PROD}
Data unit:	tCO_2/tonne of petrodiesel
Description:	Emission factor for production of crude oil
Source of data:	-
Value to be applied:	**0.073 tCO_2/tonne of petrodiesel.**[6] 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:	-

Data / Parameter:	EF_{REF}
Data unit:	tCO_2/tonne of 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 **0.233 tCO_2**/tonne of petrodiesel can be used.[7] (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:	-

Data / Parameter:	EF_{LDT}
Data unit:	tCO_2/tonne of 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

Describe and specify in the CDM-PDD all monitoring procedures, including the type of measurement instrumentation used and 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. Meters should be installed, maintained and calibrated according to equipment manufacturer instructions and be in line with relevant standards. If such standards are not available, use national standards. If a national standard is not available, then use international standards.

All monitoring should be attended to by appropriate and adequate personnel, as assessed by the project developer. All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.
In addition, the monitoring provisions in the tools referred to in this methodology apply.

[6] 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.

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

Data and parameters monitored

Data / Parameter:	$NCV_{PD,y}$
Data unit:	MJ/tonne
Description:	Average net calorific value of petrodiesel in year *y*
Source of data:	The following data sources may be used if the relevant conditions apply: **Data source** / **Conditions for using the data source** a) Measurements by the project participants — This is the preferred source b) Regional or national default values — If a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances) c) IPCC default values at the upper limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories — If a) is not available
Measurement procedures (if any):	For a): Measurements should be undertaken in line with national or international fuel standards
Monitoring frequency:	For a): Monthly, averaged for the year For b) and c): Annually
QA/QC procedures:	Verify that the values under a) and b) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a) or b) should have ISO17025 accreditation or justify that they can comply with similar quality standards
Any comment:	-

Data / Parameter:	$Q_{VO,y}$
Data unit:	m^3
Description:	Amount of vegetable oil fed to HDS unit in year *y* (m^3 VO)
Source of data:	Onsite measurements by the project participants
Measurement procedures (if any):	The volume of vegetable oil fed into HDS unit shall be monitored by the flow meter at the inlet of the unit
Monitoring frequency:	Continuously, data is presented as hourly average
QA/QC procedures:	The flow meter will be calibrated according to the suppliers' specifications and following the refinery QA/QC procedures.
Any comment:	In case the production of renewable/petrodiesel is seasonal, such parameter will be monitored continuously only when vegetable oil is introduced in the HDS unit

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{NG,y}$</td></tr>
<tr><td>Data unit:</td><td>MJ/Nm^3</td></tr>
<tr><td>Description:</td><td>Average net calorific value of the natural gas combusted in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available.
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the upper limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency:</td><td>For a): Each batch of fuel supplied, averaged for the year
For b): Monthly, averaged for the year
For c) and d): Annually</td></tr>
<tr><td>QA/QC procedures:</td><td>Verify that the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

Data / Parameter:	$VC_{H2,y}$
Data unit:	Nm^3
Description:	Volume of H_2 consumed in the HDS unit in the year *y*
Source of data:	Onsite measurements by the project participants
Measurement procedures (if any):	The volume of H_2 consumed in the HDS unit shall be monitored by the flow meter at the inlet of the unit
Monitoring frequency:	Continuously, data is presented as hourly average
QA/QC procedures:	The flow meter will be calibrated according to the suppliers' specifications and following the refinery QA/QC procedures
Any comment:	In case the production of petro/renewable diesel is seasonal, such parameter will be monitored continuously only when vegetable oil is introduced in the HDS unit

Data / Parameter:	$Q_{PRD,y}$
Data unit:	m^3
Description:	Total amount of petro/renewable diesel produced by the project activity in year *y* (m^3)
Source of data:	Onsite measurements by the project participants
Measurement procedures (if any):	Total amount of petro/renewable diesel produced shall be monitored by the flow meter at the outlet of the HDS unit
Monitoring frequency:	Continuously, data is presented as hourly average
QA/QC procedures:	The flow meter will be calibrated according to the suppliers' specifications and following the refinery QA/QC procedures
Any comment:	In case the production of petro/renewable is seasonal, such parameter will be monitored continuously only when vegetable oil is introduced in the HDS unit

Data / Parameter:	$\eta_{H2,react,y}$
Data unit:	Fraction
Description:	Reaction efficiency of H_2 formation in year *y*
Source of data:	Default factor or onsite measurements by the project participants
Measurement procedures (if any):	The project participants can use a conservative default value of 1 or can calculate it considering the stoichiometry of the reaction to produce H_2 and the actual amount of end products obtained and document transparently in the CDM-PDD. Measurements should be undertaken in line with national or international standards
Monitoring frequency:	Monthly
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$MT_{m,y}$
Data unit:	Tonne
Description:	Amount of 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 type of material transported (e.g. oil seeds, vegetable oil) 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*
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 plant

Data / Parameter:	TL_m
Data unit:	Tonne
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*
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:	Tonne
Description:	Fuel consumption of fossil fuel 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

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{i,y}$</td></tr>
<tr><td>Data unit:</td><td>MJ/tonne</td></tr>
<tr><td>Description:</td><td>Net calorific value of fossil fuel type i in year y</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available.
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the upper limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency:</td><td>For a): Each batch of fuel supplied, averaged for the year
For b): Monthly, averaged for the year
For c) and d): Annually</td></tr>
<tr><td>QA/QC procedures:</td><td>Verify that the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

Data / Parameter:	$Q_{WW,d,y}$
Data unit:	m^3
Description:	Amount of wastewater treated anaerobically or released untreated from the vegetable oil production plant on day *d* in year *y*
Source of data:	Onsite measurements by the project participants
Measurement procedures (if any):	Amount of wastewater treated anaerobically or released untreated from the vegetable oil production plant shall be monitored by the flow meter at the outlet of vegetable oil production facility wastewater stream
Monitoring frequency:	Continuously, data is presented as daily average
QA/QC procedures:	The flow meter will be calibrated according to the suppliers' specifications and following the refinery QA/QC procedures
Any comment:	If the wastewater is treated aerobically, emissions are assumed to be zero, and hence this parameter does not need to be monitored. For the days when the vegetable oil production plant is not operational, the value is zero for this parameter for that particular day

Data / Parameter:	$COD_{WW,d,y}$
Data unit:	$tCOD/m^3$
Description:	Chemical Oxygen Demand (COD) of wastewater on day *d* in year *y*
Source of data:	Onsite measurements by the project participants
Measurement procedures (if any):	COD of wastewater shall be monitored at the outlet of vegetable oil production plant wastewater stream following national or international standards
Monitoring frequency:	Daily
QA/QC procedures:	-
Any comment:	If the wastewater is treated aerobically, emissions are assumed to be zero, and hence this parameter does not need to be monitored. For the days when the vegetable oil production plant is not operational, the value is zero for this parameter for that particular day

Data / Parameter:	$A_{s,y}$
Data unit:	ha
Description:	Area in which oil seed type *s* is cultivated for use in the project plant in year *y*
Source of data:	Onsite measurements by the project participants
Measurement procedures (if any):	Measure the area in which oil seed type *s* is cultivated for each plantations and use the largest area among all the plantations in year *y* for this parameter
Monitoring frequency:	Each plantation
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	AF_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:	-

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

$$\mathrm{PE}_{\mathrm{N2O-N,Fer,y}} = F_{N,y} \times EF_{N2O-N,dir} \times GWP_{N2O} \times \frac{44}{28} \quad \textbf{(21)}$$

Where:

$PE_{N2O\text{-}N,Fer,y}$	=	Direct N_2O-N emissions from land management at the plantation in year *y* (tCO_2e)
$F_{N,y}$	=	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). Where $F_{N,y} = F_{ON,y} + F_{SN,y}$
$EF_{N2O\text{-}N,dir}$	=	Emission factor for direct nitrous oxide emissions from Nitrogen 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:

$$\mathrm{F}_{\mathrm{ON,y}} = \sum_{\mathrm{p}} \mathrm{M}_{\mathrm{OF,p,y}} \times \mathrm{w}_{\mathrm{N,p,y}} \quad \textbf{(22)}$$

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)
$M_{OF,p,y}$	=	Amount of organic fertilizer *p* applied at the plantation in year *y* (t organic fertilizer)
$w_{N,p,y}$	=	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:

$$\mathrm{F}_{\mathrm{SN,y}} = \sum_{\mathrm{q}} \mathrm{M}_{\mathrm{SF,q,y}} \times \mathrm{w}_{\mathrm{N,q,y}} \quad \textbf{(23)}$$

Where:

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

Data / parameter:	$EF_{N2O\text{-}N,dir}$
Data unit:	tN_2O-N/tN 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:	-

Data / 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
Value to be applied:	310 for the first commitment period
Any comment:	-

Data and parameters monitored

Data / Parameter:	$M_{OF,p,y}$
Data unit:	t organic fertilizer
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:	t synthetic fertilizer
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:

$$PE_{urea,y} = M_{urea,y} \times EF_{CO2,urea} \times \frac{44}{12} \quad \textbf{(24)}$$

Where:

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

Data and parameters not monitored

Data / parameter:	$EF_{CO2,urea}$
Data unit:	t CO_2/t 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:	t urea
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:

$$PE_{lime,y} = \left(M_{limestone,y} \times EF_{limestone} + M_{dolomite,y} \times EF_{dolomite}\right) \times \frac{44}{12} \quad \textbf{(25)}$$

Where:

$PE_{lime,y}$	=	Project emissions from application of limestone and dolomite at the plantation in year *y* (tCO_2)
$M_{limestone,y}$	=	Quantity of calcic limestone ($CaCO_3$) applied at the plantation in year *y* ($tCaCO_3$)
$M_{dolomite,y}$	=	Quantity of dolomite ($CaMg(CO_3)_2$) applied at the plantation in year *y* ($t\ Ca\ Mg(CO_3)_2$)
$EF_{limestone}$	=	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

Data / 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:	-

Data / 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:	$tCaCO_3$
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:	$tCaMg(CO_3)_2$
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 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:

$$PE_{FB,y} = \sum_{s_{FB}} A_{PJ,s_{FB}} \cdot M_{B,s_{FB}} \cdot C_{f,s_{FB}} \cdot \left(EF_{N2O,FB} \cdot GWP_{N2O} + EF_{CH4,FB} \cdot GWP_{CH4} \right) \tag{26}$$

Where:

$PE_{FB,y}$	=	Project emissions from field burning of biomass at the plantation site in year *y* (tCO_2)
$A_{PJ,s_{FB}}$	=	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/t 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/t 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*[8]

Data and parameters not monitored

Data / Parameter:	$EF_{N2O,FB}$
Data unit:	tN_2O/t dry matter
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:	-

Data / Parameter:	$EF_{CH4,FB}$
Data unit:	tCH_4/t dry matter
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:	-

8 If biomass on a stratum is burnt two or more times in the year, emissions from this stratum should be accounted for each time burning occurs.

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential of methane valid for the commitment period
Source of data:	IPCC
Value to be applied:	21 for the first commitment period
Any comment:	-

Data and parameters monitored

Data / Parameter:	$\mathbf{M_{B,s_{FB}}}$
Data unit:	t dry matter /ha
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 ($PE_{N2O-N,dir,y}$)

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

- Nitrogen in crop residues (above-ground and below-ground);
- Nitrogen 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:

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

(27)

Where:

$PE_{N2O\text{-}N,dir,y}$	=	Direct N_2O-N emissions from land management at the plantation in year *y* (tCO_2)
$EF_{N2O\text{-}N,dir}$	=	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 Nitrogen 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)
$F_{SOM,s_{MS},y}$	=	Amount of Nitrogen 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)
$A_{PJ,s_{OS},y}$	=	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 /ha). 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 Nitrogen in crops residues returned to the soil ($F_{CR,s_{CR},y}$) is calculated for each stratum s_{CR} as follows:

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

(28)

Where:

$F_{CR,s_{CR},y}$	=	Amount of Nitrogen 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)
$M_{c,s_{CR},y}$	=	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 Carbon 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 Nitrogen. This Nitrogen is regarded as an additional source of Nitrogen available for conversion to N_2O. This quantity of N ($F_{SOM,sMS,y}$) is estimated for each stratum s_{MS} as follows:

$$F_{SOM,s_{MS},y} = \frac{SOC_{historic,s_{MS}} - SOC_{PJ,s_{MS}}}{T} \times \frac{1}{R} \times A_{PJ,s_{MS}} \quad \textbf{(29)}$$

Where:

$F_{SOM,s_{MS},y}$	=	Amount of Nitrogen 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)
$SOC_{historic,s_{MS}}$	=	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	=	Carbon: Nitrogen ratio of the soil organic matter
$A_{PJ,s_{MS}}$	=	Size of the land area of stratum s_{MS} (ha)

Indirect N_2O emissions

Indirect N_2O emissions comprise N_2O emissions due to atmospheric decomposition of Nitrogen volatilized from the plantation and N_2O emissions from leaching/run-off:

$$PE_{N2O-N,ind,y} = (PE_{N2O-N,ind,ATD,y} + PE_{N2O-N,ind,L,y}) \times \frac{44}{28} \times GWP_{N20} \quad \textbf{(30)}$$

Where:

$PE_{N2O-N,ind,y}$	=	Indirect N_2O-N emissions from land management at the plantation in year y (tCO_2)
$PE_{N2O-N,ind,ATD,y}$	=	Indirect N_2O-N emissions due to atmospheric deposition of nitrogen volatilized from the soil of the plantation in year y (tN_2O-N)
$PE_{N2O-N,ind,L,y}$	=	Indirect N_2O-N emissions due to leaching/run-off as a result of nitrogen application at the plantation in year y (tN_2O-N)

Indirect N_2O emissions due to atmospheric deposition of nitrogen volatilized from the soil of the plantation are calculated as follows:

$$PE_{N2O-N,ind,ATD,y} = \left(F_{SN,y} \cdot Frac_{GASF} + F_{ON,y} \cdot Frac_{GASM}\right) \cdot EF_{N2O-N,ATD} \quad \textbf{(31)}$$

Where:

$PE_{N2O-N,ind,ATD,y}$	=	Indirect N_2O-N emissions due to atmospheric deposition of nitrogen volatilized from the soil of the plantation in year y (tN_2O-N)
$F_{SN,y}$	=	Amount of synthetic fertilizer nitrogen applied at the plantation in year y (t N)
$Frac_{GASF}$	=	Fraction of synthetic fertilizer N that volatilizes as NH_3 and NO_X (t N volatilized / t N applied)
$F_{ON,y}$	=	Amount of organic fertilizer nitrogen from animal manure, sewage, compost or other organic amendments applied at the plantation in year y (t N)

$Frac_{GASM}$	=	Fraction of organic N fertilizer that volatilizes as NH_3 and NO_X (t N volatilized / t N applied)
$EF_{N2O-N,ATD}$	=	Emission factor for atmospheric deposition of N on soils and water surfaces (t N_2O-N / t N volatilized)

Indirect N_2O emissions due to leaching and runoff only need to be estimated if leaching and runoff occurs. They are calculated as follows:

$$PE_{N2O-N,ind,L,y} = \left(F_{SN,y} + F_{ON,y} + \sum_{s_{CR}} F_{CR,s_{CR},y} + \sum_{s_{MS}} F_{SOM,s_{MS},y} \right) \cdot Frac_{LEACH} \cdot EF_{N2O-N,L} \quad \textbf{(32)}$$

Where:

$PE_{N2O-N,ind,L,y}$	=	Indirect N_2O-N emissions due to leaching/run-off as a result of nitrogen application at the plantation in year *y* (tN_2O-N)
$F_{SN,y}$	=	Amount of synthetic fertilizer nitrogen applied at the plantation in year *y* (t N)
$F_{ON,y}$	=	Amount of organic fertilizer nitrogen from animal manure, sewage, compost or other organic amendments applied at the plantation in year *y* (t N)
$F_{CR,s_{CR},y}$	=	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)
$F_{SOM,s_{MS},y}$	=	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)
$Frac_{LEACH}$	=	Fraction of all N added to/mineralized in the soil of the plantation that is lost through leaching and runoff (t N leached and runoff / t N applied)
$EF_{N2O-N,L}$	=	Emission factor for N_2O emissions from N leaching and runoff (t N_2O-N / t N leached and runoff)
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

Data and parameters not monitored

Data / Parameter:	$EF_{N2O,N,OS}$
Data unit:	t N_2O-N/-ha
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 / Parameter:	$Frac_{GASM}$
Data unit:	t N volatilized / t N applied
Description:	Fraction of organic N fertilizer that volatilizes as NH_3 and NO_X
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 11. Table 11.3
Value to be applied:	0.2
Any comment:	-

Data / Parameter:	$Frac_{GASF}$
Data unit:	t N volatilized / t N applied
Description:	Fraction of synthetic fertilizer N that volatilizes as NH_3 and NO_X
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 11. Table 11.3
Value to be applied:	0.1
Any comment:	-

Data / Parameter:	$Frac_{LEACH}$
Data unit:	t N leached and runoff / t N applied
Description:	Fraction of all N added to/mineralized in the soil of the plantation that is lost through leaching and runoff
Source of data:	2006 IPCC Guidelines, Vol. 4, Ch. 11. Table 11.3
Value to be applied:	0.3
Any comment:	-

Data and parameters monitored

Data / Parameter:	$\mathbf{M_{c,s_{CR},y}}$
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:	$\mathbf{f_{burnt,s_{CR},c,y}}$
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:

$$PE_{FP,y} = \sum_{f} \left(EF_{CO2e,FP,f} \cdot M_{SF,q,y} \right) \quad \textbf{(33)}$$

Where:

$PE_{FP,y}$	=	Project emissions related to the production of synthetic fertilizer that is used at the dedicated plantations in year *y* (tCO_2)
$EF_{CO2e,FP,f}$	=	Emission factor for GHG emissions associated with the production of fertilizer type *f* (tCO_2e/ t 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*(t fertilizer/yr)

Data and parameters not monitored

Data / Parameter:	$EF_{CO2e,FP,f}$
Data unit:	tCO_2e/t fertilizer
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:

$$PE_{CO2,soil,y} = PE_{CO2,MS,y} + PE_{CO2,OS,y} \quad \textbf{(34)}$$

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)
$PE_{CO2,MS,y}$	=	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)
$PE_{CO2,OS,y}$	=	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)

<u>*CO_2 emissions from mineral soils*</u>

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:

$$PE_{CO2,MS,y} = \sum_{s_{MS}} \frac{SOC_{historic,s_{MS}} - SOC_{PJ,s_{MS}}}{T} \times A_{PJ,s_{MS}} \times \frac{44}{12} \quad \textbf{(35)}$$

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)
$SOC_{historic,s_{MS}}$	=	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:

$$SOC_{historic,s_{MS}} = SOC_{REF,s_{MS}} \times F_{LU,historic,s_{MS}} \times F_{MG,historic,s_{MS}} \times F_{I,historic,s_{MS}} \quad \textbf{(36)}$$

and

$$SOC_{PJ,s_{MS}} = SOC_{REF,s_{MS}} \times F_{LU,PJ,s_{MS}} \times F_{MG,PJ,s_{MS}} \times F_{I,PJ,s_{MS}} \qquad \textbf{(37)}$$

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

<u>CO_2 emissions from organic soils</u>

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:

$$PE_{CO2,OS,y} = \sum_{s_{OS}} A_{PJ,s_{OS}} \times EF_{organic,s_{OS}} \times \frac{44}{12} \qquad \textbf{(38)}$$

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)
$A_{PJ,s_{OS}}$	=	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} (t C/ha). IPCC default values will be used, see guidance below.
s_{OS}	=	Strata of the project area with organic soils

Data and parameters not monitored

Data / 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:	-

Data / 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:	-

Data / Parameter:	$F_{LU,historic,sMS}$, $F_{MG,historic,sMS}$, $F_{I,historic,sMS}$
Data unit:	dimensionless
Description:	Stock change factor on stratum s_{MS} for the historic land-use system ($F_{LU,historic,sMS}$), for the historic management regime ($F_{MG,historic,sMS}$) and for input of organic matter for the historical situation ($F_{I,historic,sMS}$)
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:	-

Data / Parameter:	$F_{LU,PJ,sMS}$, $F_{MG,PJ,sMS}$, $F_{I,PJ,sMS}$
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:	-

Data / Parameter:	$EF_{organic,sOS}$
Data unit:	t C /hectare
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: Determination of factor F in the production of Hydrogen

Fuel is combusted to supply energy to the reactor where H_2 is generated by reforming natural gas with steam. The other emission source related to H_2 production is represented by the chemical reaction that occurs when H_2 is generated.

The reforming of natural gas with steam is the process used to generate H_2. The chemical reactions are:

$$CH_4 + H_2O \rightarrow CO + 3H_2 \quad \textbf{(39)}$$

$$CO + H_2O \rightarrow CO_2 + H_2 \quad \textbf{(40)}$$

The *F* factor used in Equation (9) is obtained as follows:

As the volume of H_2 required by the HDS unit to process a certain amount of vegetable oil is known in the refinery activity, the proposed methodology uses this value to obtain the mass of CO_2 produced in the chemical reaction that forms H_2.

To obtain the mass of CO_2 generated in the chemical reaction using the volume of H_2 required by the hydrogenation process, the *"ideal gas equation"* is applied as follows:

$$n_{H_2} = \frac{P_{H_2} \cdot V_{H_2}}{R \cdot T_{H_2}} \quad \textbf{(41)}$$

Where:

n_{H2}	=	Number of moles of H_2 produced in the reaction (mol)
R	=	8.314 (m^3 Pa/K mol)
V_{H2}	=	Volume of H_2 produced in the reaction (Nm^3)
T	=	273 (K), temperature of gases in normal conditions
P_{H2}	=	101,325 (Pa), pressure of gases in normal conditions

Naming *"a"* the constant that multiplies the volume of H_2, the abovementioned *"ideal gas equation"* yields:

$$n_{H_2} = a \cdot V_{H_2} \quad \textbf{(42)}$$

Where:

a	=	44.6 (mol/Nm^3)

Basing on the stoichiometry of the reaction of H_2

$$CH_4 + 2H_2O = CO_2 + 4H_2 \quad \textbf{(43)}$$

The number of moles of CO_2 emitted per mole of H_2 produced is:

$$n_{CO_2} = \frac{1}{4} \cdot n_{H_2} \quad \textbf{(44)}$$

Substituting Equation (42) in Equation (44):

$$n_{CO_2} = \frac{a}{4} \cdot V_{H_2} \quad \textbf{(45)}$$

To obtain the mass of CO_2 produced in the reaction, it is necessary to multiply Equation (45) by the molar mass of carbon dioxide, as follows:

$$m_{CO_2} = M_{CO_2} \cdot \frac{a}{4} \cdot V_{H_2} \quad \textbf{(46)}$$

Where:

M_{CO2} = Molar mass of CO_2, equal to 44 g/mol

Thus, the F factor becomes:

$$F = \frac{44.6 \cdot 44}{4} = 490.6$$

As the H_2 chemical formation reaction is not 100 percent efficient the factor F must be multiplied by $\eta_{reaction}$, which is the efficiency of the H_2 formation reaction.

Thus, the *F* factor used in Equation (9) is:

$$F = 490.6 \cdot \eta_{reaction} \quad \textbf{(47)}$$

And, the mass of CO_2 produced in the chemical formation reaction of H_2 is

$$m_{CO_2} = 490.6 \cdot \eta_{reaction} \cdot V_{H_2} \quad \textbf{(48)}$$

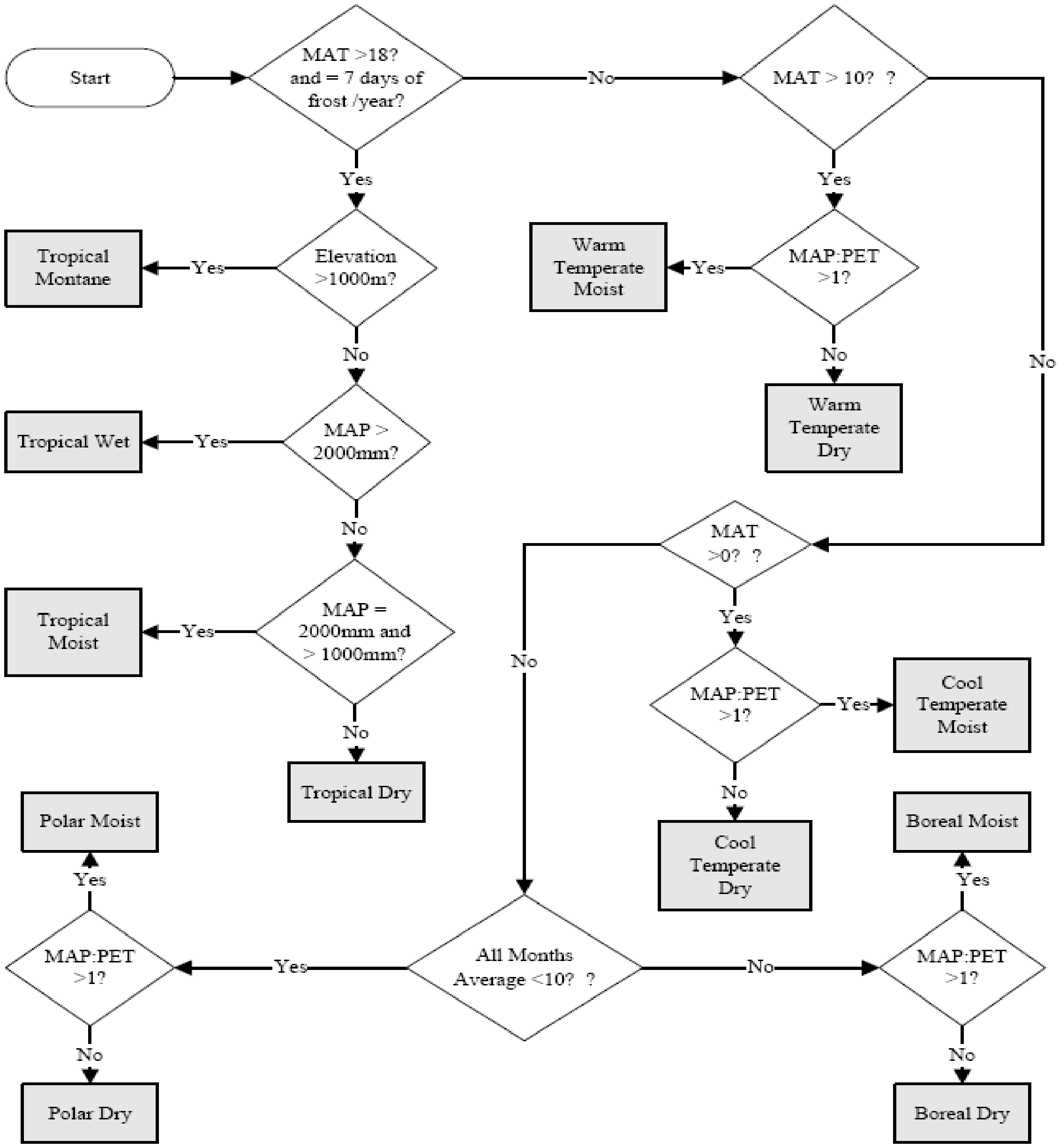
Where:

m_{CO2} = Mass of CO_2 (g)

V_{H2} = Volume of H_2 produced in the reaction (Nm^3)

Annex 3: 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

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