Draft revision to the approved baseline and monitoring methodology AM0057

"Avoided emissions from biomass wastes through use as feed stock in pulp and paper production or in bio-oil production"

I. SOURCE AND APPLICABILITY

Source

This methodology is based on the project activity "Avoided emissions from biomass wastes through use as feed stock in pulp and paper production, Kunak, Sabah", whose baseline and monitoring methodology and project design document were prepared by SV Carbon, Malaysia.

For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0220: "Avoided emissions from biomass wastes through use as feed stock in pulp and paper production" on http://cdm.unfccc.int/goto/MPappmeth

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

- "Tool for the demonstration and assessment of additionality";
- "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "Tool to calculate project emissions from electricity consumption";
- "Tool to determine project emissions from flaring gases containing methane".

Selected approach from paragraph 48 of the CDM modalities and procedures

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"

Definitions

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

Agricultural wastes include by-products and residues or waste streams from food production and processing, but excludes wastes from wood production and processing and municipal solid waste.

Pyrolysis is thermal decomposition occurring in the absence of oxygen.

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

Applicability

The methodology is applicable for project activities using agricultural wastes as feed stock for pulp and paper production or bio-oil production, where the end product is similar in characteristics and quality to existing high quality products in the market and does not require special use or disposal methods.

The following conditions apply to the methodology:

- The project activity is the construction of a new pulp and paper production facility or bio-oil production facility that uses agricultural wastes as feedstock;
- The waste should not be stored in conditions that would lead to anaerobic decomposition and, hence, generation of CH_4;
- The pulp and paper or bio-oil produced with the agricultural wastes is of similar characteristics and quality to existing high quality products in the market and does not require special use or disposal methods;
- During the production of pulp and paper, no significant additional process leading to emissions of greenhouse gas compared to the baseline scenario, except for electricity and fossil fuel consumption, is envisaged (an example of this can be the use of substance produced with highly GHG intensive activities). If this is the case, then the project participant must submit a request for deviation to include emissions from this source;
- Emission reductions are **only** claimed for avoidance of methane emissions when it can be demonstrated that the agricultural residues are left to decompose anaerobically;
- In the case of bio-oil, its production does not involve a process that leads to emissions of greenhouse gas except for those arising directly from pyrolysis, or associated with electricity or fossil fuel consumption;
- In case the biomass is combusted for the purpose of providing heat or electricity to the plant, the biomass fuel is derived from biomass residues, as specified in ACM0006;
- In the case of bio-oil, the pyrolysed residues (char) will be further combusted and the energy derived thereof used in the project activity. The residual waste from this process does not contain more than 1% residual carbon.

The on-site energy generation source supplying energy to the ~~pulp and paper~~ production plant can be a CDM project activity. To allow this option, only the amount of agricultural waste used as a feedstock in the project activity ~~pulp and paper production~~ shall be considered for the purpose of calculating baseline emissions. For this purpose, the amount of agricultural waste recovered and supplied to the production ~~pulp and paper~~ plant, but used for other purposes such as heat and power production also needs to be monitored.

II. BASELINE METHODOLOGY PROCEDURE

Project boundary

The spatial extent of the project boundary is the site of the project activity where the ~~pulp and paper~~ production plant is established. This includes the facilities for processing the agricultural waste ~~into pulp and paper~~, any on-site electricity generation and/or consumption, onsite fuel use, and the thermal energy generation.

The project boundary should include the transportation of the agricultural waste to the ~~pulp and paper~~ production plant in the case where transport distances have increased compared to the conventional handling of the waste.

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

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from decomposition of agricultural waste at the landfill site	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
Project Activity	Transportation of agricultural waste to the project site	CO_2	Yes	Main greenhouse gas emitted.
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small.
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small.
	Emissions from onsite use of fossil fuels	CO_2	Yes	CO_2 emissions from the on site use of fossil fuels can be significant.
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small.
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small.
	Emissions from onsite use of electricity	CO_2	Yes	CO_2 emissions from on site use of electricity can be significant.
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small.
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small.
	Emissions from the transport of ~~solid waste~~ waste produced in the plant from the manufacturing process to a disposal site	CO_2	Yes	Main greenhouse gas emitted.
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small.
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small.
	Emission of greenhouse gases in the off-gas from the pyrolysis process	CO_2	No	The CO_2 emitted is considered carbon neutral.
		CH_4	Yes	CH_4 may be emitted in the off-gas from the pyrolysis process.
		N_2O	Yes	N_2O may be emitted in the off-gas from the pyrolysis process.

Identification of the baseline scenario

Project proponents shall determine the most plausible baseline scenario through the application of the following steps:

Step 1. Identify all realistic and credible alternatives to the project activity

Project participants should use step 1 of the latest version of the "Tool for the demonstration and assessment of additionality", to identify all realistic and credible baseline alternatives. In doing so, relevant policies and regulations related to the management of agricultural waste should be taken into account. Such policies or regulations may include local regulation on open burning of the agricultural waste, incentives for use of the agricultural waste for energy production, etc. In addition, the assessment of alternative scenarios should take into account local economic and technological circumstances.

Realistic and credible alternatives should be developed separately regarding:

(1) How the agricultural waste would have been treated? and
(2) (i) What is the alternative feedstock for the paper production? or
(ii) What is the most likely alternative for the production of bio-oil?

For the baseline for the agricultural waste (1) at least the following alternatives should be analysed:

B1 Use of agricultural waste as material for paper or bio-oil production, not implemented as a CDM project.
B2 The agricultural waste is dumped or left to decay under mainly aerobic conditions, such as stockpiling.
B3 The agricultural waste is dumped or left to decay under clearly anaerobic conditions, such as landfilling.
B4 The agricultural waste is burnt in an uncontrolled manner without utilizing it for energy purposes.
B5 The agricultural waste is used for heat and/or electricity generation or as other source of energy in other projects.
B6 The agricultural waste is used for non-energy purposes, e.g. as mulching

For the production of paper, (2)(i) at least the following alternatives should be analysed:

P1 The project activity undertaken without CDM.
P2 Construction of a new pulp and paper plant and paper production using other locally available sources of cellulose.
P3 No installation of a new pulp and paper plant at the project site but paper production in other new and/or existing paper plants at other sites, using locally available cellulose typically used in the region.

For the bio-oil production baseline, (2)(ii), at least the following alternatives should be analysed:

O1 The project activity undertaken without CDM.

O2 Construction of a new bio-oil plant and the production of bio-oil using other locally available sources of biomass

O3 No installation of a new bio-oil plant at the project site, but bio-oil production in other new and/or existing bio-oil plants at other sites in the region or outside the region, using a locally available source of biomass typically used in the region.

Step 2. Eliminate alternatives that face prohibitive barriers or are economically not attractive

Project participants should use steps 2 of the latest version of the "Tool for the demonstration and assessment of additionality" to assess which of the above alternatives should be excluded from further consideration (e.g. alternatives facing prohibitive barriers or those clearly economically unattractive).

Step 3: Selection of baseline scenario

Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario. The least emission alternative will be identified for each component of the baseline scenario. In assessing these scenarios, any regulatory or contractual requirements should be taken into consideration.

The methodology is only applicable if:

- The most plausible baseline scenario for the agricultural waste is identified as the disposal of the waste in a landfill (Scenario B3); and
- In case of pulp and paper production, the most plausible baseline scenario for the production of paper is either P2 or P3;
- In case of bio-oil production, the most plausible baseline scenario for the production of bio-oil is either O2 or O3 .

If the identified scenario is B3, then either of the following needs to be demonstrated to ensure that the condition is expected to last during the crediting period:

- Establish that the identified landfill(s) can be expected to accommodate the agricultural waste to be used for the project activity for the duration of the crediting period; or
- Establish that it is common practice in the region to dispose of the agricultural waste in solid waste management site (landfill).

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"***.

The barriers may include the following:

- The use of agricultural waste may face technological barriers;
- The raw material is either not used or, in the case of paper and pulp, less than 10% of ~~the paper~~ production in the region is based on agricultural waste.

Baseline emissions

Baseline emissions include methane emissions from the agricultural wastes that would be dumped at the landfill as well as baseline emissions from production of paper or bio-oil in the absence of the project activity in either a new plant at the project site (P2 or O2) or in other (new) ~~paper~~ production facilities using locally available ~~cellulose~~ feedstock typically used in the region in the absence of the project activity (P3 or O3). As a conservative simplification, baseline emissions from production of paper are assumed to be zero.

Baseline emissions are calculated as follows:

$$BE_y = BE_{CH4,SWDS,y} \quad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2e/yr)
$BE_{CH4,SWDS,y}$	=	Methane emissions avoided during the year y, calculated according to the latest approved version of the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"

<u>Note</u>: For the purpose of this methodology, the value $W_{j,x}$ of the tool should correspond to the amount of agricultural waste used as feedstock for paper or bio-oil production, which as per the leakage section has been demonstrated is surplus and would have been disposed of in the landfill.

Project emissions

Project emissions are calculated as follows:

$$PE_y = PE_{FC,j,y} + PE_{EC,y} + PE_{CO2,TR,y} + PE_{CO2,SWTR,y} + \sout{PE_{Pi}}PE_{Py,,y} \quad \textbf{(2)}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e/yr)
$PE_{FC,j,y}$	=	Project emissions from fossil fuel combustion in process *j* during the year *y* (tCO2 / yr)
$PE_{EC,y}$	=	Project emissions from electricity consumption by the project activity during the year y (tCO_2e/yr)
$PE_{CO2,TR,y}$	=	Project emissions from increased transport of agricultural waste to the plant in year y (tCO_2e/yr)
$PE_{CO2,SWTR,y}$	=	Project emissions from the transport of solid waste from the manufacturing process to a disposal site (tCO_2e/yr)
$PE_{Py,y}$	=	Project emissions in the off-gas from the pyrolysis process in year y (tCO2e)

Project emissions from fossil fuel combustion ($PE_{FC,j,y}$)

The project emissions from fossil fuel combustion ($PE_{FC,j,y}$) will be calculated following the latest version of "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". For this purpose, the processes *j* in the tool corresponds to all fossil fuel combustion in the ~~paper~~ production plant established as part of the project activity, as well as any other on-site fuel combustion for the purposes of the project activity.

Project emissions from electricity consumption by the project activity ($PE_{EC,y}$)

The project emissions from electricity consumption ($PE_{EC,y}$) will be calculated following the latest version of "Tool to calculate project emissions from electricity consumption". Electricity consumption by the project activity may include, inter alia, electricity consumption by the production ~~paper~~ plant or any electricity requirements for the treatment of the biomass. While it is stated in the tool that it is not applicable to cases where captive renewable power generation technologies installed at the project site supply the electricity consumed by the project activity, it is applicable for the purpose of this methodology on the condition that the biomass used for power and heat provision (if any) are from biomass residues.

Project emissions from transport of agricultural waste to the plant ($PE_{CO2,TR,y}$)

In cases where the agricultural waste is not generated directly at the project site, project participants shall determine CO_2 emissions resulting from transportation of the agricultural waste to the project plant.

Project participants may choose between two different approaches to determine emissions: an approach based on distance and vehicle type (option 1) or on fuel consumption (option 2).

<u>*Option 1:*</u>

Emissions are calculated on the basis of distance and the number of trips (or the average truck load):

$$PE_{CO2,TR,y} = N_{AW,y} \cdot AVD_{AW,y} \cdot EF_{km,CO2,y} \qquad \textbf{(3)}$$

or

$$PE_{CO2,TR,y} = \frac{\sum_k BF_{PJ,k,y}}{TL_{AW,y}} \cdot AVD_{AW,y} \cdot EF_{km,CO2,y} \qquad \textbf{(4)}$$

Where:

$PE_{CO2,TR,y}$	=	Project emissions from transport of agricultural waste to the plant in year y (tCO_2e/yr)
$N_{AW,y}$	=	Number of round trips (from and to) truck(s) made for the delivery of agricultural waste during the year *y*
$AVD_{AW,y}$	=	Average round trip distance (from and to) between the agricultural waste supply sites and the site of the project activity during the year *y* (km)
$EF_{km,CO2,y}$	=	Average CO_2 emission factor for the trucks measured during the year y (tCO_2/km)
$BF_{PJ,k,y}$	=	Quantity of agricultural waste type *k* used for paper or bio-oil production as a result of the project activity during the year *y* (tons) For the purpose of determining $PE_{CO2,TR,y}$ this should include all agricultural waste (including those for the purpose of energy production).
$TL_{AW,y}$	=	Average truck load of the trucks used (tons)

Option 2:

Emissions are calculated based on the actual quantity of fossil fuels consumed for transportation of agricultural waste (including agricultural waste used for the purpose of energy production).

$$PE_{CO2,TR,y} = \sum_{i} FC_{TR,i,y} \cdot NCV_{i} \cdot EF_{CO2,FF,i} \qquad \textbf{(5)}$$

Where:

$PE_{CO2,TR,y}$	=	Project emissions from transport of agricultural waste to the plant in year y (tCO_2e/yr)
$FC_{TR,i,y}$	=	Fuel consumption of fuel type *i* in trucks for transportation of agricultural waste during the year *y* (mass or volume unit)
$EF_{CO2,FF,i}$	=	CO_2 emission factor for fossil fuel type *i* (tCO_2/MJ)
NCV_i	=	Net calorific value of fuel (MJ)

Project emissions from transport of solid waste from the manufacturing process to a disposal site ($PE_{CO2,SWTR,y}$)

The applicability conditions require that the char from the pyrolysis process is combusted. Should the ash left over not be disposed of directly at the project site, project participants shall determine CO_2 emissions resulting from transportation of this solid waste to the disposal site.

As above, project participants may choose between two different approaches to determine emissions: an approach based on distance and vehicle type (option 1) or on fuel consumption (option 2).

Option 1:

Emissions are calculated on the basis of distance and the number of trips (or the average truck load):

$$PE_{CO2,SWTR,y} = N_{SWTR,y} \cdot AVD_{SWTR,y} \cdot EF_{km,CO2,y} \qquad \textbf{(6)}$$

or

$$PE_{CO2,SWTR,y} = \frac{\sum_{k} SW_{k,y}}{TL_{SWTR,y}} \cdot AVD_{SWTR,y} \cdot EF_{km,CO2,y} \qquad \textbf{(7)}$$

Where:

$PE_{CO2,SWTR,y}$	=	Project emissions from transport of manufacturing waste to the disposal sites in year y (tCO_2e/yr)
$N_{SWTR,y}$	=	Number of round trips (from and to) truck(s) made for the delivery of solid waste during the year *y*
$AVD_{SWTR,y}$	=	Average round trip distance (from and to) between the site of the project activity and the solid waste disposal sites during the year *y* (km)
$EF_{km,CO2,y}$	=	Average CO_2 emission factor for the trucks measured during the year y (tCO_2/km)
$SW_{k,y}$	=	Quantity of solid waste type *k* produced during the project activity during the year *y*

(tons).

$TL_{SWTR,y}$	=	Average truck load of the trucks used to carry the solid waste (tons).

Option 2:

Emissions are calculated based on the actual quantity of fossil fuels consumed for transportation of solid waste.

$$PE_{CO2,SWTR,y} = \sum_i FC_{SWTR,i,y} \cdot NCV_i \cdot EF_{CO2,FF,i} \quad \textbf{(8)}$$

Where:

$FC_{SWTR,i,y}$	=	Fuel consumption of fuel type *i* in trucks for transportation of solid waste during the year *y* (mass or volume unit)

Project emissions in the off-gas from the pyrolysis process in year y ($PE_{Py,y}$)

There may be significant GHG emissions in the off-gas from the pyrolysis process. Emissions from this source are calculated with the following options:

Option 1: Based on direct measurement of pyrolysis gas

$$PE_{Py,y} = SG_y \times MC_{N2O,y} \times GWP_{N2O} + SG_y \times MC_{CH4,y} \times GWP_{CH4} \quad \textbf{(9)}$$

Where:

$PE_{Py,y}$	=	is the total emissions of N_2O and CH_4 after pyrolysis off-gas combustion in year y (tCO_2e)
SG_y	=	is the total volume of off-gas from the pyrolysis process in year y (m3/yr)
$MC_{N2O,,y}$	=	is the monitored content of nitrous oxide in the off-gas from pyrolysis in year y (tN_2O/m3)
GWP_{N2O}	=	is the Global warming potential of nitrous oxide (tCO_2e/tN_2O)
$MC_{CH4,y}$	=	is the monitored content of methane in the off-gas from pyrolysis in year y (tCH_4/m3)
GWP_{CH4}	=	is the Global warming potential of methane (tCO_2e /tCH_4)

Option 2: Based on IPCC factors for waste

$$PE_{Py,y} = BF_{PJ,k,y} \times (EF_{N2O} \times GWP_{N2O} + EF_{CH4} \times GWP_{CH4}) \times 10^{-3} \quad \textbf{(10)}$$

Where:

$BF_{PJ,k,y}$	=	Quantity of agricultural waste type *k* used for paper or bio-oil production as a result of the project activity during the year *y* (tons) For the purpose of determining $PE_{CO2,TR,y}$ this should include all agricultural waste (including those for the purpose of energy production).
EF_{N2O}	=	is the aggregate N_2O emission factor for waste combustion (kgN_2O/tonne of waste)
EF_{CH4}	=	is the aggregate CH_4 emission factor for waste combustion ($kgCH_4$/tonne of waste)

Tables 5.3 to 5.5 in chapter 5, volume 5 of IPCC 2006 guidelines should be used to estimate EF_{N2O} and EF_{CH4}.

If IPCC default emission factor is used, a conservativeness factor should be applied to account for the high uncertainty of the IPCC default values. The level of the conservativeness factor depends on the uncertainty range of the estimate for the IPCC default N_2O and CH_4 emission factor. Project participants shall select the appropriate conservativeness factor from Table 3 below and shall multiply the estimate for the N_2O / CH_4 emission factor with the conservativeness factor.

Table 3. Conservativeness factors

Estimated uncertainty range (%)	Assigned uncertainty band (%)	Conservativeness factor where higher values are more conservative
Less than or equal to 10	7	1.02
Greater than 10 and less than or equal to 30	20	1.06
Greater than 30 and less than or equal to 50	40	1.12
Greater than 50 and less than or equal to 100	75	1.21
Greater than 100	150	1.37

If flaring of gas generated from pyrolysis takes place ~~occurs~~, then "Tool to determine project emissions from flaring gases containing methane" should be used to estimate methane emissions.

Leakage

Leakage is calculated as follows:

$$LE_y = L_{y,disp} + L_{y,fossil} + L_{y,Me} \quad \textbf{(11)}$$

Where:

LE_y = Leakage in year y (tCO_2e/yr)
$L_{y,disp}$ = Leakage from possible disposition of recycled paper, or bio-oil production (tCO_2e/yr)
$L_{y,fossil}$ = Leakage from the increased use of fossil fuel due to the replacement of biomass fuel with fossil fuel
$L_{y,Me}$ = Leakage from the anaerobic breakdown of the bio-oil, produced in the project activity

Leakage from possible disposition of recycled paper or bio-oil ($L_{y,disp}$)

In the case of pulp and paper production, leakage can conceptually occur if the implementation of the project activity leads to a situation where other raw materials for pulp and paper production will be replaced by agricultural waste and eventually end up in a landfill and thus give rise to GHG emissions. This can be assumed not to occur under the following circumstances:

- There is negligible use of recycled paper in the region for the quality of paper produced by the project activity.
- When it can be clearly demonstrated (e.g. according to the category of paper produced) that the project activity will replace virgin pulp and paper from hard or soft wood.

In all other cases, leakage could occur since there is a possibility that the paper produced from the project activity replaces recycled paper, which in turn could be landfilled. For the purpose of estimating this leakage, if there is an increase in amount of collection and use of recycled paper for pulp and paper production in the country/region of the CDM project activity during the operation of the plant, then this type of leakage can be ignored. If there is a reduction in the amount of collection of paper for recycling in the country/region then the reduction in recycled amount (but not more than the production of the plant) must be calculated as leakage, and emissions calculated on the assumption that this amount of paper is landfilled.

In the case of bio-oil, leakage can conceptually occur in either of the following two cases:

- Bio-oil production in the project activity displaces agricultural waste-based bio-oil production elsewhere, potentially leading to the dumping of biomass feedstock no longer required by the displaced plant in a solid waste disposal site, which could result in methane emissions from subsequent anaerobic decay;
- Bio-oil produced by the plant displaces bio-oil produced elsewhere, potentially leading to the dumping of unused bio-oil in a solid waste disposal site, which could result in methane emissions from subsequent anaerobic decay. (Although this is highly unlikely to affect emission reductions as: i) if the plant whose production is being displaced is a CDM project, such dumping of unused bio-oil would result in a reduction of CERs issued to that project; or ii) if the plant whose production is being displaced is not a CDM project, it would no longer have an incentive to produce bio-oil, and would be likely to cease production soon after).

In either case, if either of the following can be shown, then this type of leakage can be ignored:

- There is currently little or no bio-oil production in the country;
- It can be shown that over the three years prior to the beginning of each crediting period, there has been a year on year increase in bio-oil production.

If there is a reduction in the production of bio-oil in the country then the reduction in bio-oil production (but not more than the production of the plant) must be calculated as leakage, and emissions calculated on the assumption that this amount of bio-oil is landfilled.

For calculation of the leakage the first order decay model should be used as prescribed in the latest version of the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”.

Leakage from increased fossil fuel use due to the replacement of biomass fuel with fossil fuel ($L_{y,fossil}$)

Another potential source of leakage for this project activity is an increase in emissions from fossil fuel combustion due to diversion of agricultural waste from other uses to the project plant as a result of the project activity. Changes in carbon pools in the LULUCF sector are expected to be insignificant since this methodology is limited to agricultural waste, as defined in the applicability conditions above.

Where the most likely baseline scenario is that the agricultural wastes are dumped or left to decay project participants shall demonstrate that the use of the agricultural wastes does not result in increased fossil fuel consumption elsewhere. For this purpose, project participants shall assess as part of the monitoring the supply situation for the types of agricultural waste used in the project plant. The following options may be used to demonstrate that the agricultural waste used in the plant did not increase fossil fuel consumption elsewhere:

L_1 Demonstrate that there is an abundant surplus of the agricultural waste in the region of the project activity, which is not utilized. For this purpose, demonstrate that the quantity of available agricultural waste in the region is at least 25% larger than the quantity of agricultural waste that is utilized (e.g. for energy generation or as feedstock), including the project plant.

L_2 Demonstrate that suppliers of the agricultural waste in the region of the project activity are not able to sell all of their agricultural waste. For this purpose, project participants shall demonstrate that the ultimate supplier of agricultural waste (who supplies the project) and a representative sample of agricultural waste suppliers in the region had a surplus of agricultural waste (e.g. at the end of the period during which the agricultural waste is sold), which they could not sell and which is not utilized.

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

Project participants shall apply a leakage penalty to the quantity of biomass, for which project participants cannot demonstrate with one of the approaches above that the use of the agricultural waste does not result in leakage. The leakage penalty aims at adjusting emission reductions for leakage effects in a conservative manner, assuming that this quantity of biomass is substituted by the most carbon intensive fuel in the country/region.

If for a certain type of biomass *i* used in the project activity, leakage effects cannot be ruled out with one of the approaches above, leakage effects for the year *y* shall be calculated as follows:

$$L_{y,fossil} = EF_{CO2,CI} \cdot \sum_{j} BF_{j,y} \cdot NCV_j \qquad \textbf{(12)}$$

Where:

$L_{y,fossil}$	=	are the leakage emissions from increased use of fossil fuels during the year y in tons of CO_2
$EF_{CO2,CI}$	=	is the CO_2 emission coefficient (per an energy unit) of the most carbon intensive fuel used in the country
$BF_{j,y}$	=	is the quantity of agricultural waste type j used as feedstock in the project plant during the year *y* in a volume or mass unit
J	=	are the types of biomass for which leakage effects could not be ruled out with one of the approaches L_1, L_2 above
NCV_j	=	is the net calorific value of the agricultural waste type j (per volume or mass).

In the case that negative overall emission reductions arise in a year through application of the leakage penalty, CERs are not issued to project participants for the year concerned and in subsequent years, until emission reductions from subsequent years have compensated the quantity of negative emission reductions from the year concerned. (For example: if negative emission reductions of 30 tCO_2e occur in the year t and positive emission reductions of 100 tCO_2e occur in the year t+1, only 70 CERs are issued for the year t+1.)

Leakage from the anaerobic breakdown of the bio-oil produced in the project activity ($L_{y,Me}$)

Leakage can conceptually occur if the implementation of the project activity leads to a situation where the bio-oil produced in the bio-oil plant is disposed of in a way that leads to their anaerobic breakdown. If invoices are provided proving the sale of the bio-oil, this leakage can be omitted.

For amount of bio-oil produced for which no sale invoices can be provided leakage emissions should be accounted as per the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", considering $W_{j,x}$ would be the amount of bio-oil from which no invoice has been presented.

Emission Reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(13)}$$

Where:

ER_y	=	Emission reductions during the year *y* (tCO_2/yr)
BE_y	=	Baseline emissions during the year *y* (tCO_2/yr)
PE_y	=	Project emissions during the year *y* (tCO_2/yr)
LE_y	=	Leakage emissions during the year *y* (tCO_2/yr)

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

At the renewal of the crediting period, the procedure to update the data should follow the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".

This revision is not necessary if the project proponent has developed specific values for the raw material used in the project.

Data and parameters not monitored

The data and parameters not monitored tables used in the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", "Tool to calculate project emissions from electricity consumption" and the "Tool to determine project emissions from flaring gases containing methane", if applicable, should be applied.

Parameter:	EF_{N2O}
Data unit:	kg N_2O/tonne of waste
Description:	Aggregate N_2O emission factor for agricultural waste combustion
Source of data:	2006 IPCC guidelines
Measurement	Tables 5.3 to 5.5 in chapter 5, volume 5 of IPCC 2006 guidelines should be used

procedures (if any):	
Any comment:	

Parameter:	EF_{CH4}
Data unit:	kg CH_4/tonne of waste
Description:	Is the aggregate CH_4 emission factor for waste combustion
Source of data:	2006 IPCC guidelines
Measurement procedures (if any):	Tables 5.3 to 5.5 in chapter 5, volume 5 of IPCC 2006 guidelines should be used
Any comment:	

Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global Warming Potential of methane valid for the commitment period
Source of data:	IPCC 1996
Measurement procedures (if any):	21 for the first commitment period
Any comment:	

Parameter:	GWP_{N2O}
Data unit:	tCO_2e/tN_2O
Description:	Global Warming Potential of nitrous oxide valid for the commitment period
Source of data:	IPCC 1996
Measurement procedures (if any):	310 for the first commitment period
Any comment:	

III. MONITORING METHODOLOGY

Monitoring procedures

Monitoring involves an annual assessment of the conditions at the solid waste disposal site (SWDS) where the waste would in the absence of the project activity be dumped.

The monitoring will also include measuring the amounts of raw material used as feedstock under the project activity ~~for the pulp and paper production~~. Where relevant, the energy produced on site and the amount of agricultural waste utilised as fuel should be monitored.

Describe and specify in the CDM-PDD all monitoring procedures, including the type of measurement instrumentation used, the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. Meters should be installed, maintained and calibrated according to equipment manufacturer instructions and be in line with national standards, or, if these are not available, international standards (e.g. IEC, ISO).

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 differently in the comments in the tables below.

Data and parameters monitored

Data / parameter:	MB_y
Data unit:	tCO_2e
Description:	Methane produced in the landfill in the absence of the project activity in year ‘y’.
Source of data:	Calculated as per the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”.
Measurement procedures (if any):	As per the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”.
Monitoring frequency:	As per the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”.
QA/QC procedures:	As per the “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”.
Any comment:	

Data / parameter:	$PE_{FC,j,y}$
Data unit:	tCO_2
Description:	Project emissions from fossil fuel combustion in process *j* during the year *y* .
Source of data:	Calculated as per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”
Measurement procedures (if any):	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”
Monitoring frequency:	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”
QA/QC procedures:	As per the “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.
Any comment:	

Data / parameter:	$PE_{EC,y}$
Data unit:	tCO_2
Description:	Project emissions from electricity consumption by the project activity during the year y .
Source of data:	Calculated as per the “Tool to calculate project emissions from electricity consumption”
Measurement procedures (if any):	As per the “Tool to calculate project emissions from electricity consumption”
Monitoring frequency:	As per the “Tool to calculate project emissions from electricity consumption”
QA/QC procedures:	As per the “Tool to calculate project emissions from electricity consumption”
Any comment:	

Data / parameter:	$N_{AW,y}$
Data unit:	-
Description:	Number of round trips (from and to) truck(s) made for the delivery of agricultural waste during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	Check consistency of the number of round trips of truck with the quantity of agricultural waste used in paper production.
Any comment:	Project participants have to monitor either this parameter or the average truck load TLy.

Data / parameter:	$TL_{AW,y}$
Data unit:	Tons or litre
Description:	Average truck load of the trucks used
Source of data:	On-site measurements
Measurement procedures (if any):	Determined by averaging the weights of each truck carrying agricultural waste to the project plant
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	-
Any comment:	Project participants have to monitor either the number of truck trips Ny or this parameter.

Data / parameter:	$AVD_{AW,y}$
Data unit:	Km
Description:	Average round trip distance (from and to) between the agricultural waste supply sites and the site of the project plant during the year *y*
Source of data:	Records by project participants on the origin of the agricultural waste
Measurement procedures (if any):	
Monitoring frequency:	Continuous, aggregated annually
QA/QC procedures:	Check consistency of distance records provided by the truckers by comparing recorded distances with other information from other sources (e.g. maps).
Any comment:	If agricultural waste is supplied from different sites, this parameter should correspond to the mean value of km travelled by trucks that supply the agricultural waste to the plant.

Data / parameter:	$FC_{TR,i,y}$
Data unit:	Mass or volume unit
Description:	Fuel consumption of fuel type *i* in trucks for transportation of agricultural waste during the year *y*
Source of data:	Fuel purchase receipts or fuel consumptions meters in the trucks
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated annually

QA/QC procedures:	Cross-checked the resulting CO_2 emissions for plausibility with a simple calculation based on the distance approach (option 1).
Any comment:	This parameter only needs to be monitored if option 2 is chosen to estimate CO_2 emissions from transportation.

Data / parameter:	$EF_{km,CO2,y}$
Data unit:	tCO_2/km
Description:	Average CO_2 emission factor per km for the trucks during the year *y*
Source of data:	Conduct sample measurements of the fuel type, fuel consumption and distance travelled for all truck types. Calculate CO_2 emissions from fuel consumption by multiplying with appropriate net calorific values and CO_2 emission factors. For net calorific values and CO_2 emission factors, use reliable national default values or, if not available, (country-specific) IPCC default values. Alternatively, choose emission factors applicable for the truck types used from the literature in a conservative manner (i.e. the higher end within a plausible range).
Measurement procedures (if any):	
Monitoring frequency:	At least annually
QA/QC procedures:	Cross-check measurement results with emission factors referred to in the literature.
Any comment:	

Data / parameter:	NCV_i
Data unit:	MJ/mass or volume units of fuel
Description:	Net calorific value of fuel
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Measurement procedures (if any):	
Monitoring frequency:	Annually or *ex-ante*
QA/QC procedures:	
Any comment:	

Data / parameter:	$EF_{CO2,FF,i}$
Data unit:	tCO_2/MJ
Description:	CO_2 emission factor for fossil fuel type *i*
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Measurement procedures (if any):	
Monitoring frequency:	Annually or ex-ante.
QA/QC procedures:	

Any comment:	

Data / parameter:	$N_{SWTR,y}$
Data unit:	-
Description:	Number of round trips (from and to) truck(s) made for the delivery of manufacturing waste to the dump sites during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	Check consistency of the number of round trips of truck with the quantity of manufacturing waste produced.
Any comment:	Project participants have to monitor either this parameter or the average truck load TLwaste,y.

Data / parameter:	$AVD_{SWTR,y}$
Data unit:	Km
Description:	Average round trip distance (from and to) between the site of the project activity and the disposal sites during the year *y*
Source of data:	Records by project participants on the destination for manufacturing waste
Measurement procedures (if any):	Record of distance travelled kept by truck company
Monitoring frequency:	Continuous, aggregated annually
QA/QC procedures:	Check consistency of distance records provided by the truckers by comparing recorded distances with other information from other sources (e.g. maps).
Any comment:	If manufacturing waste is distributed to different sites, this parameter should correspond to the mean number of km travelled by trucks that distribute the waste.

Data / parameter:	$SW_{k,y}$
Data unit:	Tons
Description:	Quantity of solid waste type *k* produced during the project activity during the year y
Source of data:	Project specific measurements
Measurement procedures (if any):	Measure the weight of the ash from the combusted char.
Monitoring frequency:	Aggregated monthly, calculated annually
QA/QC procedures:	Checked against data on average truck load and number of trips.
Any comment:	

Data / parameter:	$TL_{SWTR,y}$
Data unit:	Tons or litres
Description:	Average truck load of the trucks used to carry the solid waste.
Source of data:	On-site measurements
Measurement procedures (if any):	Determined by averaging the weights of each truck carrying manufacturing waste to the disposal sites

Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	-
Any comment:	Project participants have to monitor either the number of truck trips $N_{SWTR,y}$ or this parameter.

Data / parameter:	$FC_{SWTR,i,y}$
Data unit:	Mass or volume unit
Description:	Fuel consumption of fuel type *i* in trucks for transportation of solid waste during the year y
Source of data:	Actual project data
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	
Any comment:	

Data / parameter:	$SG_{,y}$
Data unit:	m^3/year
Description:	The total volume of off-gas produced in pyrolysis
Source of data:	Actual project data.
Measurement procedures (if any):	Measured with a continuous flow meter
Monitoring frequency:	Continuously, aggregated annually.
QA/QC procedures:	
Any comment:	

Data / parameter:	$MC_{CH4,y}$
Data unit:	Fraction
Description:	Monitored content of methane in the off-gas from pyrolysis
Source of data:	Measurements of off-gas
Measurement procedures (if any):	A gas analyser should be used to analyse the methane content of the off-gas in different phases of the bio-oil production plant's operations
Monitoring frequency:	At least quarterly
QA/QC procedures:	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
Any comment:	More frequent sampling is encouraged.

Data / parameter:	$MC_{N2O,y}$
Data unit:	Fraction
Description:	Monitored content of nitrous oxide in the off-gas from pyrolysis
Source of data:	Measurements of off-gas
Measurement procedures (if any):	A gas analyser should be used to analyse the nitrous oxide content of the off-gas in different phases of the bio-oil production plant's operations
Monitoring frequency:	At least quarterly

QA/QC procedures:	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
Any comment:	More frequent sampling is encouraged.

Data / Parameter:	L_{dep}
Data unit:	Tons
Description:	Tonnes of paper collected and recycled in the country
Source of data:	Authoritative market survey
Measurement procedures (if any):	N/A
Monitoring frequency:	Annually, using the most updated information available
QA/QC procedures:	Compare with data from the previous year and ascertain that the methodology and data are comparable
Any comment:	Use for evaluation of possible leakage by replacing recycled paper (option L_{dep1})

Data / Parameter:	$BF_{PJ,k,y}$
Data unit:	tons
Description:	Quantity of agricultural waste type *k* used for paper production as a result of the project activity during the year *y* For the purpose of determining $PE_{CO2,TR,y}$, this should include all agricultural waste (including those for the purpose of energy production).
Source of data:	Measurements by project participants
Measurement procedures (if any):	The agricultural waste going into the pulp and paper production plant.
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	The weighing equipment will be calibrated according to procedures to be established in operations manual for the plant. Measurements using mass meters at the plant site should be verified with an annual mass balance of the pulp and paper production plant that is based on purchased quantity and stock changes.
Any comment:	

Data / parameter:	-
Data unit:	
Description:	Demonstration that the agricultural waste type *k* from a specific source would continue not to be collected or utilized, e.g. by an assessment whether a market has emerged for that type of agricultural waste (if yes, leakage is assumed not be ruled out) or by showing that it would still not be feasible to utilize the agricultural waste for any purposes.
Source of data:	Information from the site where the agricultural waste is generated
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Compare with data from the previous year and ascertain that the methodology and data are comparable
Any comment:	Monitoring of this parameter is applicable if approach L1 is used to rule out

	leakage

Data / Parameter:	-
Data unit:	Tons
Description:	Quantity of agricultural waste of type k that are utilized (used for energy generation) in the defined geographical region
Source of data:	Survey or statistics
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Compare with data from the previous year and ascertain that the methodology and data are comparable
Any comment:	Monitoring of this parameter is applicable for approach L_2 is used to rule out leakage

Data / Parameter:	-
Data unit:	Tons
Description:	Quantity of available agricultural waste type k in the region
Source of data:	Survey or statistics
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Compare with data from the previous year and ascertain that the methodology and data are comparable
Any comment:	Monitoring of this parameter is applicable for approach L_2 is used to rule out leakage

Data / Parameter:	-
Data unit:	
Description:	Availability of a surplus of agricultural residue type *k* (which can not be sold or utilized) at the ultimate supplier to the project and a representative sample of other suppliers in the defined geographical region.
Source of data:	Surveys
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	Compare with data from the previous year and ascertain that the methodology and data are comparable
Any comment:	Monitoring of this parameter is applicable if approach L_3 is used to rule out Leakage

Data / parameter:	NCV_j
Data unit:	GJ/ton of dry matter or GJ/liter
Description:	Net calorific value of agricultural waste type *j*
Source of data:	Measurements
Measurement	Measurements shall be carried out at reputed laboratories and according to

procedures (if any):	relevant international standards. Measure the NCV based on dry agricultural.
Monitoring frequency:	At least every six months, taking at least three samples for each measurement.
QA/QC procedures:	Check the consistency of the measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Ensure that the NCV is determined on the basis of dry agricultural.
Any comment:	

Data / parameter:	$EF_{CO2,CI}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of the most carbon intensive fuel used in the country
Source of data:	Identify the most carbon intensive fuel type from the national communication, other literature sources (e.g. IEA). Possibly consult with the national agency responsible for the national communication / GHG inventory. If available, use national default values for the CO_2 emission factor. Otherwise, IPCC default values may be used.
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / parameter:	$BF_{j,y}$
Data unit:	volume or mass unit
Description:	Quantity of agricultural waste type *j* used as feedstock in the project plant during the year *y*
Source of data:	The weighing equipment will be calibrated according to procedures to be established in operations manual for the plant. Measurements using mass meters at the plant site should be verified with an annual mass balance of the pulp and paper production plant that is based on purchased quantity and stock changes.
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	
Any comment:	j are the types of agricultural for which leakage effects could not be ruled out with one of the approaches L_1, L_2 or L_3.e

Data / parameter:	Moisture content of the biomass residues
Data unit:	% Water content
Description:	Moisture content of each biomass residue type *k*
Source of data:	On-site measurements
Measurement procedures (if any):	
Monitoring frequency:	Continuously, mean values calculated at least annually

QA/QC procedures:	
Any comment:	In case of dry biomass, monitoring of this parameter is not necessary.

Data / parameter:	Amount of bio-oil sold in the crediting year
Data unit:	Tons
Description:	Project Proponents shall monitor the amount of the bio-oil sold for use outside of the project boundary.
Source of data:	Project Site
Measurement procedures (if any):	Sale invoices of the bio-oil should be kept at the project site. They should contain Customer contact details, physical location of delivery, type, amount (in tons) and purpose of bio-oil. A list of customers and delivered bio-oil amount should be kept at the project site.
Monitoring frequency:	Weekly
QA/QC procedures:	
Any comment:	This parameter is monitored for the purpose of estimating the leakage emissions for the quantity of bio-oil which is produced but not sold in a particular crediting year. It is assumed that this quantity is landfilled and therefore landfill related emissions are estimated.

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