Approved baseline and monitoring methodology AM0085

"Co-firing of biomass residues for electricity generation in grid connected power plants"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

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

- NM0304 "Co-firing of Biomass Residues for Electricity Generation", prepared by Central Termoeléctrica Andina S.A.

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

- Combined tool to identify the baseline scenario and demonstrate additionality;
- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion; and
- Tool to calculate the emission factor for an electricity system.

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".

and/or

"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:

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

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

Co-firing refers to the simultaneous combustion of both (i) biomass residues and (ii) fossil fuels in a single boiler.

Existing power plant. An *existing power plant*[1] is a power plant that has at least 3 years of operational history at the start of the project activity.

New power plant. A *new power plant* is a newly constructed power plant.

In addition, the definitions in the latest approved version of the "Tool to calculate the emission factor for an electricity system" apply.

Applicability

This methodology is applicable to project activities that generate electricity from the combustion of biomass residues in co-fired power plants. The project activity may include the following activities:

(a) The construction of a new co-fired power plant at a site where no power was generated prior to the implementation of the project activity (greenfield power projects); or
(b) The partial replacement of fossil fuels by co-firing biomass residues in an existing fossil fuel power plant connected to the grid (fuel switch projects).

The methodology is applicable under the following conditions:

- The project power plant supplies all electricity to the grid and not to any captive consumers;
- The project power plant generates only electricity and does not co-generate heat;
- No other biomass types than biomass residues, as defined above, are used in the project power plant;
- The amount of biomass residues co-fired in the project power plant shall not exceed 50% of the total fuel fired on an energy basis;[2]
- For project activities that use biomass residues from a production process (e.g. production of sugar or wood panel boards), the implementation of the project shall not result in an increase of the processing capacity of raw input (e.g. sugar, rice, logs, etc.) or in other substantial changes (e.g. product change) in this process;
- The biomass residues used by the project power plant should not be stored for more than one year; and
- No significant energy quantities, except from transportation or mechanical treatment of the biomass residues, are required to prepare the biomass residues for fuel combustion, i.e. projects that process the biomass residues prior to combustion (e.g. esterification of waste oils, gasification, etc.) are not eligible under this methodology.

In the case of fuel switch projects (i.e. where case (b) above applies), the following conditions also apply:

- The existing power plant did not co-fire any biomass prior to the implementation of the project activity.

[1] Power plant is defined as per the "Tool to calculate the emission factor for an electricity system".

[2] For project activities that co-fire more than 50% of biomass residues of the total fuel fired on an energy basis, the project developers may use the latest approved version of the consolidated methodology ACM0006.

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

- For power generation: scenarios P2 or P4;
- For biomass use: scenarios B1, B2, B3, B5, B6, B7 or B8, or a combination of any of those scenarios. However, note that for scenarios B5 to B8, leakage emissions should be accounted for as per the procedures of the methodology.

II. BASELINE METHODOLOGY PROCEDURE

Project boundary

The spatial extent of the project boundary encompasses:

- The project activity power plant;
- All power plants connected to the electricity system (grid) that the project plant is connected to; and
- The means of transportation of biomass residues to the project site;

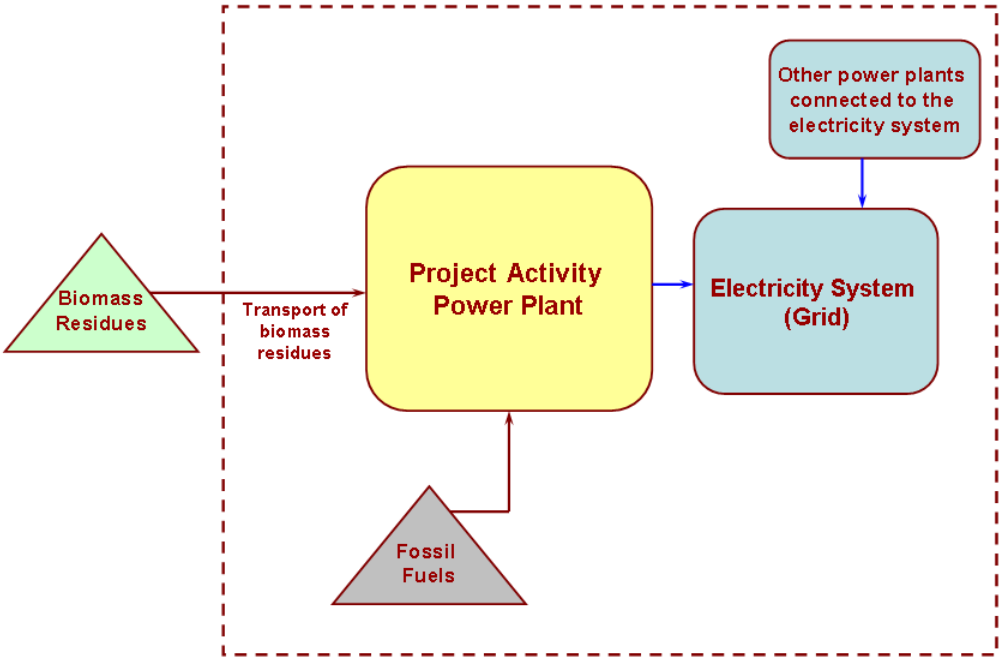

Figure 1: Project boundary

Table 1 illustrates which emission sources are included and which are excluded from the project boundary for the determination of both baseline and project emissions.

Table 1: Overview on emission sources included in or excluded from the project boundary

	Source	Gas		Justification / Explanation
Baseline	Electricity generation	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Uncontrolled burning or decay of surplus biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project Activity	On-site fossil fuel consumption	CO_2	Included	May be an important emission source.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Off-site transportation of biomass residues	CO_2	Included	May be an important emission source.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Storage of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	Excluded for simplification. Since biomass residues are stored for not longer than one year, this emission source is assumed to be small.
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small.

Procedure for the selection of the baseline scenario and demonstration of additionality

The selection of the baseline scenario and the demonstration of additionality should be conducted using the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality". The following additional guidance should be used when applying the tool:

When applying "Sub-step 1a" of the tool, alternative scenarios should be separately determined regarding:

(a) How the electricity generated from the combustion of biomass residues under the project activity would be generated in the absence of the CDM project activity; and
(b) What would happen to the biomass residues used in the project activity in the absence of the CDM project activity.

In the following, guidance is provided on which alternative scenarios should be assessed in applying the tool.

Alternative scenarios for electricity generation

The alternative scenarios for electric power generation should include, but not be limited to, *inter alia*:

P1: The project activity not implemented as a CDM project;
P2: If applicable, the construction of the project activity power plant without co-firing biomass residues, i.e. using only fossil fuels for power generation;
P3: If applicable, the construction of one or several other fossil fuels only power plant(s) instead of the proposed project activity, including:

- Power generation using the same fossil fuel type as in the project activity, but technologies other than that used in the project activity;
- Power generation using fossil fuel types other than that used in the project activity;

P4: Only applicable in the case of existing power plants: the continuation of the current practice, i.e. continuation of generating electricity using the same fossil fuels and mix, as it has been used in the most recent three years prior to the implementation of the project activity, in the existing power plant;
P5: Generation of electricity in other power plants connected to the grid, including the possibility of new interconnections;
P6: The construction of one or several other power plant(s) instead of the proposed project activity using renewable power generation technologies;
P7: The "proposed project activity undertaken without being registered as a CDM project activity" carried out at a later point in time (e.g. due to change in fuel prices, existing regulations, end-of-life of existing equipment, financing aspects).

In establishing these scenarios, project participants should clearly identify and document which type of fuel would be used in each alternative, taking into account the requirements of the technology.

These alternatives do not need to consist solely of power plants of the same capacity, load factor and operational characteristics (e.g. several smaller plants, or the share of a larger plant may be a reasonable alternative to the project activity), however they should deliver similar services (e.g. peak vs. baseload power). Note further that the baseline scenario candidates identified may not be available to project participants, but could be other stakeholders within the grid boundary (e.g. other companies investing in

power capacity expansions). Ensure that all relevant power plant technologies that have recently been constructed or are under construction or are being planned (e.g. documented in official power expansion plans) are included as plausible alternatives. A clear description of each baseline scenario alternative, including information on the technology, such as the efficiency and technical lifetime, shall be provided in the CDM-PDD.

Alternative scenarios for the use of biomass residues

The alternative scenarios for the use of biomass residues should include, but not be limited to, *inter alia*:

B1: The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields;

B2: The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to landfills which are deeper than 5 meters. This does not apply to biomass residues that are stock-piled[3] or left to decay on fields;

B3: The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes;

B4: The biomass residues are used for electricity generation in power-only plant configuration at the project site in new and/or existing power plants;

B5: The biomass residues are used for power and/or heat generation in other existing or new power plants at other sites;

B6: The biomass residues are used for other energy purposes, such as the generation of bio-fuels;

B7: The biomass residues are used for non-energy purposes, e.g. as fertilizer or as feedstock in processes (e.g. in the pulp and paper industry);

B8: The primary source of the biomass residues and/or their fate in the absence of the project activity cannot be clearly identified.[4]

When defining plausible and credible alternative scenarios for the use of biomass residues, the guidance below should be strictly followed:

- The baseline scenario for the use of biomass residues should be separately identified for different categories of biomass residues, covering the whole amount of biomass residues supposed to be used in the project activity along the crediting period;
- A category of biomass residues is defined by three attributes: (1) its type (i.e. bagasse, rice husks, empty fruit bunches, etc.); (2) its source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, etc.); and (3) its fate in the absence of the project activity (scenarios B above);

[3] Further work is undertaken to investigate to which extent and in which cases methane emissions may occur from stock-piling biomass residues. Subject to further insights on this issue, the methodology may be revised.

[4] For example, this scenario can be used if biomass residues are purchased from a market, or biomass residues retailers.

- Explain and document transparently in the CDM-PDD, using a table similar to Table 2, which quantities of which biomass residues categories are used in which installation(s) under the project activity and what is their baseline scenario.[5] The last column of Table 2 corresponds to the quantity of each category of biomass residues (tonnes). For the selection of the baseline scenario and demonstration of additionality, at the validation stage, an *ex ante* estimation of these quantities should be provided. These quantities should be updated every year of the crediting period as part of the monitoring plan so as to reflect the actual use of biomass residues in the project scenario. These updated values should be used for emissions reductions calculations. Along the crediting period, new categories of biomass residues (i.e. new types, new sources, with different fate) can be used in the project activity. In this case, a new line should be added to the table.

Table 2: Example of a table for biomass residues categories

Biomass residues category (*k*)	**Biomass residues type**	**Biomass residues source**	**Biomass residues fate in the absence of the project activity**	**Biomass residues use in project scenario**	**Biomass residues quantity (tonnes)**
1	Rice husks	Off-site from an identified rice mill	Dumped (B1:)	Electricity generation on-site (co-fired boiler 1)	See comments above
2	Agricultural residues	Off-site from a biomass residues retailer	Unidentified (B8:)	Electricity generation on-site (co-fired boiler)	See comments above

- For biomass residues categories for which scenario B1:, B2: or B3: is deemed a plausible baseline alternative, project participants shall demonstrate that this is a realistic and credible alternative scenario. To this end, for each biomass residues category, one of the following procedures should be applied:

  (a) Demonstrate that there is an abundant surplus of the type of biomass residue in the region of the biomass supply which is not utilized. For this purpose, demonstrate that the quantity of that type of biomass residues available in the region is at least 25% larger than the quantity of biomass residues of that type which is utilized in the region (e.g. for energy generation or as feedstock), including the project plant;

[5] For example, consider a project activity which includes the installation of a new co-fired biomass-fossil-fuel power plant. Suppose that the project activity will use two types of biomass residues, rice husks and diverse agricultural residues. Further consider that the rice husks used in the project would come from an identified rice mill and would have been dumped in the baseline. The diverse agricultural residues are purchased from a biomass retailer. For this example, two categories of biomass residues should be considered in the subsequent analysis, as illustrated in Table 2.

(b) Demonstrate for the sites from where biomass residues are sourced that the biomass residues have not been collected or utilized (e.g. as fuel, fertilizer or feedstock) but have been dumped and left to decay, land-filled or burnt without energy generation (e.g. field burning) prior to their use under the project activity. This approach is only applicable to biomass residues categories for which project participants can clearly identify the site from where the biomass residues are sourced.

The scenarios B1:, B2: or B3: can only be regarded as a plausible baseline scenario for a certain category of biomass residues, if the project participants can demonstrate that at least one of the two approaches (a) or (b) are fulfilled. Otherwise, the baseline scenario for this particular biomass residues category should be considered as B8:, and a leakage penalty will be applied when calculating leakage emissions.

If during the crediting period, new categories of biomass residues for which the baseline scenario is identified as B1:, B2: or B3: are used in the project activity which were not listed at the validation stage, e.g. due to new sources of biomass residues, the baseline scenario for those categories of biomass residues should be assessed using the procedures outlined in this guidance for each category of biomass residues. This is to be confirmed by the DOE.

In case that an investment analysis is applied

If Step 3 of the tool is applied, i.e. an investment analysis is conducted, while calculating the financial indicator all relevant costs shall be included (for example, the investment costs, fuel costs, operation and maintenance costs), as well as all revenues (including sales of electricity to the grid, subsidies/fiscal incentives,[6] ODA, etc. where applicable), and, as appropriate, non-market costs and benefits in the case of public investors.

If the project activity is a greenfield plant, the costs of the project activity should consider the whole investment costs and operation costs of the new power plant (for both the biomass residues as well as the fossil fuel component). If the project activity is a fuel switch in an existing plant, only the changes in capital and operational costs and revenues associated with the fuel switch should be considered as investment under the project activity.

The fuel mix between biomass residues and fossil fuels under the project activity should be chosen in a conservative manner. For example, if the use of biomass residues is less costly than the use of fossil fuels, it should be assumed that biomass residues are used at the upper end of the possible range of biomass residue use.

Emission Reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(1)}$$

[6] Note the guidance by EB 22 on national and/or sectoral policies and regulations.

Where:

ER_y = Emissions reductions during year *y* (tCO_2)
BE_y = Baseline emissions during year *y* (tCO_2)
PE_y = Project emissions during year *y* (tCO_2)
LE_y = Leakage emissions during year *y* (tCO_2)

Baseline Emissions

Baseline emissions include the CO_2 emissions from the combustion of the fossil fuels required to produce, in the baseline scenario, the same amount of electricity as produced from the combustion of biomass residues under the project activity.

Baseline emissions are calculated based on the quantity of electricity generated from the combustion of biomass residues at the project site under the project activity ($EG_{PJ,BR,y}$), and a baseline emission factor ($EF_{BL,EL,y}$) that expresses the CO_2 intensity of electricity generation in the baseline, as follows:

$$BE_y = EG_{PJ,BR,y} \cdot EF_{BL,EL,y} \quad \textbf{(2)}$$

Where:

BE_y = Baseline emissions in year *y* (tCO_2)
$EG_{PJ,BR,y}$ = Quantity of electricity generated from the combustion of biomass residues in the project power plant in year *y* (MWh)
$EF_{BL,EL,y}$ = Emission factor for electricity generation in the baseline in year *y* (tCO_2/MWh)

For this methodology, it is assumed that transmission and distribution losses in the electricity grid are not influenced significantly by the project activity and are therefore not accounted for.

Step 1: Determination of $EG_{PJ,BR,y}$

The quantity of electricity generated from the combustion of biomass residues at the project site ($EG_{PJ,BR,y}$) is determined as:

$$EG_{PJ,BR,y} = \frac{1}{3.6} \cdot \sum_n \eta_{PJ,BR,n} \cdot BR_{PJ,n,y} \cdot NCV_{n,y} \quad \textbf{(3)}$$

Where:

$EG_{PJ,BR,y}$ = Net quantity of electricity generated from the combustion of biomass residues at the project site in year *y* (MWh)
$\eta_{PJ,BR,n}$ = Efficiency of electricity generation of the project power plant if fired only with biomass residues category *n* (ratio)
$BR_{PJ,n,y}$ = Quantity of biomass residues of category *n* that are fired in the project power plant in year *y* (tonnes on dry-basis)
$NCV_{n,y}$ = Net calorific value of biomass residues of category *n* in year *y* (GJ/tonnes on dry-basis)
n = Biomass residues category

Guidance on the monitoring of $BR_{PJ,n,y}$

The determination of $BR_{PJ,n,y}$ shall be based on the monitored amounts of biomass residues used in the project power plant. The biomass residue quantities used should be monitored separately for each biomass residues category; i.e. each type of biomass residue (e.g. wood, rise husk), each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.), and fate in the baseline scenario. This categorization should be made consistently with Table 2 above, as provided for the project activity in the CDM-PDD.

Determination of $\eta_{PJ,BR,n}$

The efficiency of electricity generation of the project power plant if fired only with biomass residue category *n* ($\eta_{PJ,BR,n}$) should be determined for each relevant biomass residue type separately, using one of the following options:

- **Option A: *Ex ante* direct measurement.** This option can be applied if it is technically possible to fire only the relevant biomass residue type in the project plant (i.e. without co-firing any other fuels). In this case, conduct a measurement prior to the start of the project activity and measure the efficiency of electricity generation when firing only the relevant biomass residue type.

- **Option B: *Ex ante* indirect measurement.** This option should only be applied if Option A is technically not possible. In this case, determine the efficiency based on the efficiency when co-firing the relevant biomass residue type and fossil fuels ($\eta_{PJ,co\text{-}firing,n}$) and the efficiency when using only fossil fuels ($\eta_{PJ,FF,n}$), as follows:[7]

$$\eta_{PJ,BR,n} = \frac{\eta_{PJ,co\text{-}firing,n} - \left(1 - x_{BR,n}\right) \cdot \eta_{PJ,FF}}{x_{BR,n}} \quad \textbf{(4)}$$

with

$$x_{BR,n} = \frac{BR_{n,co\text{-}firing} \cdot NCV_n}{BR_{n,co\text{-}firing} \cdot NCV_n + \sum_i FF_{i,co\text{-}firing} \cdot NCV_i} \quad \textbf{(5)}$$

$$\eta_{PJ,co\text{-}firing,n} = 3.6 \cdot \frac{EG_{co\text{-}firing}}{BR_{n,co\text{-}firing} \cdot NCV_n + \sum_i FF_{i,co\text{-}firing} \cdot NCV_i} \quad \textbf{(6)}$$

[7] Equation (4) is derived from the equation below, which assumes that the average efficiency of the co-fired power plant ($\eta_{PJ,co\text{-}firing,n}$) is composed of the efficiency when using only biomass ($\eta_{PJ,BR,n}$) and the efficiency when using only fossil fuels ($\eta_{PJ,FF}$), weighted by the share of fuels used:

$$\eta_{PJ,co\text{-}firing,n} = \eta_{PJ,BR,n} \cdot x_{BR,n} + \eta_{PJ,FF} \cdot x_{FF,n}$$

$$\eta_{PJ,FF} = 3.6 \cdot \frac{EG_{FF}}{\sum_i FF_{i,FF} \cdot NCV_i} \quad (7)$$

Where:

$\eta_{PJ,BR,n}$ = Efficiency of electricity generation of the project power plant if fired only with biomass residues category *n* (ratio)

$\eta_{PJ,co\text{-}firing,n}$ = Efficiency of electricity generation of the project power plant when co-firing the share $x_{BR,n}$ of biomass residues category *n* during the *ex ante* co-firing measurement (ratio)

$\eta_{PJ,FF}$ = Efficiency of electricity generation of the project power plant when firing only fossil fuels during the *ex ante* measurement where only fossil fuels are used (ratio)

$x_{BR,n}$ = Fraction of biomass residue category *n* fired during the *ex ante* co-firing measurement on an energy basis (ratio)

$BR_{n,co\text{-}firing}$ = Quantity of biomass residues of category *n* that are fired in the project power plant during the *ex ante* co-firing measurement (tonnes on dry-basis)

$FF_{i,co\text{-}firing}$ = Quantity of fossil fuel type *i* that is fired in the project power plant during the *ex ante* co-firing measurement (mass or volume unit)

$FF_{i,FF}$ = Quantity of fossil fuel type *i* that is fired in the project power plant during the *ex ante* measurement where only fossil fuels are used (mass or volume unit)

NCV_n = Net calorific value of biomass residues of category *n* used during the *ex ante* co-firing measurement (GJ/tonnes on dry-basis)

NCV_i = Net calorific value of fossil fuel type *i* used during the *ex ante* measurement (GJ/mass or volume unit)

$EG_{co\text{-}firing}$ = Quantity of electricity generated in the project power plant during the *ex ante* co-firing measurement (MWh)

EG_{FF} = Quantity of electricity generated in the project power plant during the *ex ante* measurement where only fossil fuels are used (MWh)

n = Biomass residues categories

i = Fossil fuel types used

$\eta_{PJ,co\text{-}firing,n}$ and $\eta_{PJ,FF,n}$ should be determined at the same load of the plant. The load used at the *ex ante* measurement should be chosen in a conservative manner, taking into account the load range at which the plant will operate during the crediting period. $x_{BR,n}$ should be chosen at the upper end of the range that the biomass residue will be used in the plant. Document the approaches and results of the *ex ante* measurement transparently in the CDM-PDD.

- **Option C: Conservative default values.** The following conservative default values may be used:
  - For new power plants: $\eta_{PJ,BR,n} = 0.20$;
  - For existing power plants: $\eta_{PJ,BR,n} = 0.15$.

Step 2: Determination of $EF_{BL,EL,y}$

In the case of co-fired power plants it can depend on several factors whether the project displaces electricity generation in the grid or on-site electricity generation with fossil fuels. Key factors are, for example, technical constraints in using biomass residues and the prices for biomass residues, fossil fuels and electricity. These factors change over time and may influence the future dispatch of the plant. Therefore, there is a high uncertainty as to what extent power generation in the grid or on-site would have been displaced in the baseline scenario. In order to address this uncertainty in a conservative manner, project participants shall use for the $EF_{BL,EL,y}$ the lower emission factor among the following two:

- The combined margin emission factor, calculated according to "Tool to calculate the emission factor for an electricity system";
- The emission factor of the project power plant if fired only with fossil fuels, calculated as follows:

$$EF_{BL,EL,y} = \frac{EF_{BL,CO2,FF}}{\eta_{PJ,FF}} \cdot 3.6 \quad \textbf{(8)}$$

Where:

$EF_{BL,EL,y}$ = Emission factor for electricity generation in the baseline in year *y* (tCO_2/MWh)

$EF_{BL,CO2,FF}$ = CO_2 emission factor of the fossil fuel type that would be used for power generation at the project site in the baseline (tCO_2/GJ)

$\eta_{PJ,FF}$ = Efficiency of electricity generation of the project power plant when firing only fossil fuels during the ex-ante measurement where only fossil fuels are used (ratio)

This determination will be made once at the validation stage based on an *ex ante* assessment.

Project emissions

For the purpose of determining project emissions, project participants shall include the following emissions sources:

- Emissions from on-site fossil fuel consumption attributable to the project activity; and
- CO_2 emissions from off-site transportation of biomass residues that are combusted in the project plant.

Project emissions are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{TR,y} \quad \textbf{(9)}$$

Where:

PE_y = Project emissions during year *y* (tCO_2e)

$PE_{FF,y}$ = Emissions during the year *y* due to on-site fossil fuel consumption attributable to the project activity (tCO_2)

$PE_{TR,y}$ = Emissions during the year *y* due to transport of the biomass residues to the project plant (tCO_2)

Determination of $PE_{FF,y}$

To calculate the project emissions from on-site fossil fuel combustion that are attributable to the project activity ($PE_{FF,y}$), apply the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". The parameter $PE_{FF,y}$ corresponds to $PEFC,j,y$ in the tool, where j are the processes that fire fossil-fuels attributable to the project activity. $FC_{i,j,y}$ in the tool should not include fossil fuels co-fired in the project activity power plant but should include all other fossil fuels consumption at the project site that is attributable to the project activity, e.g. for on-site transportation or treatment of the biomass residues.

Determination of $PE_{TR,y}$

In cases where the biomass residues are not generated directly at the project site, project participants shall determine CO_2 emissions resulting from transportation of the biomass residues to the project plant. Where transportation is undertaken by vehicles, 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 vehicle load):

$$PE_{TR,y} = N_y \cdot AVD_y \cdot EF_{km,y} \quad \textbf{(10)}$$

or

$$PE_{TR,y} = \frac{BR_{TR,y}}{TL_y} \cdot AVD_y \cdot EF_{km,y} \quad \textbf{(11)}$$

Where:

$PE_{TR,y}$	=	CO_2 emissions during the year y due to transport of the biomass residues to the project plant (tCO_2)
N_y	=	Number of vehicle trips during the year y
AVD_y	=	Average round trip distance (from and to) between the biomass residues fuel supply sites and the site of the project plant during the year y (km)
$EF_{km,y}$	=	Average CO_2 emission factor for the vehicles measured during the year y (tCO_2/km)
$BR_{TR,y}$	=	Quantity of biomass residues that has been transported to the project site during the year y (tonnes of dry matter)
TL_y	=	Average vehicle load of the vehicles used (tonnes) during the year y

Option 2

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

$$PE_{TR,y} = \sum_i FC_{TR,i,y} \cdot NCV_{i,y} \cdot EF_{FF,i,y} \quad \textbf{(12)}$$

Where:

$PE_{TR,y}$	=	CO_2 emissions during the year *y* due to transport of the biomass residues to the project plant (tCO_2)
$FC_{TR,i,y}$	=	Fuel consumption of fuel type *i* in vehicles for transportation of biomass residues during the year *y* (mass or volume unit)
$NCV_{i,y}$	=	Net calorific value of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{FF,i,y}$	=	CO_2 emission factor for fossil fuel type *i* in year *y* (tCO_2/GJ)
i	=	Fossil fuel types used for transportation of the biomass residues to the project plant in year *y*

Leakage

The main potential source of leakage for this project activity is an increase in emissions from fossil fuel combustion or other sources due to diversion of biomass residues from other uses to the project plant as a result of the project activity. Changes in carbon stocks in the LULUCF sector are expected to be insignificant since this methodology is limited to biomass residues, as defined in the applicability conditions above. The baseline scenarios for biomass residues for which this potential leakage is relevant are B5:, B6:, B7: and B8:.

The actual leakage emissions in each of these cases may differ significantly and depend on the specific situation of each project activity. For that reason, a simplified approach is used in this methodology; i.e. it is assumed that an equivalent amount of fossil fuels, on energy basis, would be used if biomass residues are diverted from other users, no matter what the use of biomass residues would be in the baseline scenario.

Therefore, for the categories of biomass residues whose baseline scenario has been identified as B5:, B6:, B7: or B8:, project participants shall calculate leakage emissions as follows:

$$LE_y = EF_{CO2,LE} \cdot \sum_n BR_{PJ,n,y} \cdot NCV_{n,y} \quad \textbf{(13)}$$

Where:

LE_y	=	Leakage emissions in year *y* (tCO_2/yr)
$EF_{CO2,LE}$	=	CO_2 emission factor of the most carbon intensive fossil fuel used in the country (tCO_2/GJ)
$BR_{PJ,n,y}$	=	Quantity of biomass residues of category *n* that are fired in the project power plant in year *y* (tonnes on dry-basis/yr)
$NCV_{n,y}$	=	Net calorific value of the biomass residues category n in year *y* (GJ/ton of dry matter)
n	=	Categories of biomass residues for which B5:, B6:, B7: or B8: has been identified as the baseline scenario

The determination of $BR_{PJ,n,y}$ shall be based on the monitored amounts of biomass residues used in power plants included in the project boundary.

In the case that negative overall emission reductions arise in a year through application of the leakage emissions, 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 tCO2e occur in the year t+1, only 70 CERs are issued for the year t+1.

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:	$\eta_{PJ,BR,n}$
Data unit:	ratio
Description:	Efficiency of electricity generation of the project power plant if fired only with biomass residues category *n*
Source of data:	As per procedure in the baseline methodology
Measurement procedures (if any):	As described in the baseline methodology. Determine the efficiency of the energy generation system based on performance tests following national/international standards (e.g., ASME PTC-6 or IEC 60953-3, ASME PTC-4 or BS 845 or EN 12952-15 or other equivalent international and national standards)
Any comment:	In case Option A or B is applied (ex-ante measurement), the measurement must take place before the start of the crediting period, however it may take place after validation in the case that the power plant construction is not finished at the time of submission of the CDM-PDD for validation

Data / Parameter:	$\eta_{PJ,FF}$
Data unit:	ratio
Description:	Efficiency of electricity generation of the project power plant when firing only fossil fuels during the ex-ante measurement where only fossil fuels are used
Source of data:	Measurement by the project participants
Measurement procedures (if any):	As described in the baseline methodology. Determine the efficiency of the energy generation system based on performance tests following national/international standards (e.g., ASME PTC-6 or IEC 60953-3, ASME PTC-4 or BS 845 or EN 12952-15 or other equivalent international and national standards)
Any comment:	The measurement must take place before the start of the crediting period, however it may take place after validation in the case that the power plant construction is not finished at the time of submission to validation

Data / Parameter:	$\eta_{PJ,co\text{-}firing,n}$
Data unit:	ratio
Description:	Efficiency of electricity generation of the project power plant when co-firing the share $x_{BR,n}$ of biomass residues category *n* during the *ex ante* co-firing measurement
Source of data:	Measurement by the project participants
Measurement procedures (if any):	As described in the baseline methodology. Determine the efficiency of the energy generation system based on performance tests following national/international standards (e.g., ASME PTC-6 or IEC 60953-3, ASME PTC-4 or BS 845 or EN 12952-15 or other equivalent international and national standards)
Any comment:	The measurement must take place before the start of the crediting period, however it may take place after validation in the case that the power plant construction is not finished at the time of submission to validation

Data / Parameter:	$BR_{n,co\text{-}firing}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues of category *n* that are fired in the project power plant during the *ex ante* co-firing measurement
Source of data:	Measurement by the project participants
Measurement procedures (if any):	Use a weight or volume measuring device. If volume meters are used convert to mass units using the density of each category of biomass residues. Adjust for the moisture content in order to determine the quantity of dry biomass
Any comment:	-

Data / Parameter:	$FF_{i,co\text{-}firing}$
Data unit:	mass or volume unit
Description:	Quantity of fossil fuel type *i* that is fired in the project power plant during the *ex ante* co-firing measurement
Source of data:	Measurement by the project participants
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$FF_{i,FF}$
Data unit:	mass or volume unit
Description:	Quantity of fossil fuel type *i* that is fired in the project power plant during the ex-ante measurement where only fossil fuels are used
Source of data:	Measurement by the project participants
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	NCV_n
Data unit:	GJ/tonnes on dry-basis
Description:	Net calorific value of biomass residues of category *n* used during the *ex ante* co-firing measurement
Source of data:	Measurement by the project participants
Measurement procedures (if any):	Measurements shall be carried out at certified laboratories and according to relevant national or international standards. Measure the NCV on dry-basis
Any comment:	-

Data / Parameter:	NCV_i
Data unit:	GJ/tonnes on dry-basis
Description:	Net calorific value of fossil fuel type *i* used during the *ex ante* measurement
Source of data:	Measurement by the project participants
Measurement procedures (if any):	Measurements shall be carried out at certified laboratories and according to relevant national or international standards. Measure the NCV on dry-basis
Any comment:	-

Data / Parameter:	$EG_{co\text{-}firing}$
Data unit:	MWh
Description:	Quantity of electricity generated in the project power plant during the *ex ante* co-firing measurement
Source of data:	Measurement by the project participants
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	EG_{FF}
Data unit:	MWh
Description:	Quantity of electricity generated in the project power plant during the ex-ante measurement where only fossil fuels are used
Source of data:	Measurement by the project participants
Measurement procedures (if any):	-
Any comment:	-

III. MONITORING METHODOLOGY

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. All meters and instruments should be calibrated regularly as per industry practices.

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.

In addition, the monitoring provisions in the tools referred to in this methodology apply.

Data and parameters monitored

Data / Parameter:	n
Data unit:	- Type (i.e. bagasse, rice husks, empty fruit bunches, etc.); - Source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, etc.); - Fate in the absence of the project activity (scenarios B); - Use in the project scenario (scenarios P); - Quantity (tonnes on dry-basis)
Description:	Biomass residues categories
Source of data:	On-site assessment of biomass residues categories and quantities
Measurement procedures (if any):	*Ex ante*: Explain and document transparently in the CDM-PDD, using a table similar to Table 2, which quantities of which biomass residues categories are used in which installation(s) under the project activity and what is their baseline scenario. The last column of Table 2 corresponds to the quantity of each category of biomass residues (tonnes). For the selection of the baseline scenario and demonstration of additionality, at the validation stage, an *ex ante* estimation of these quantities should be provided *Ex post*: These types and quantities should be updated every year of the crediting period as part of the monitoring plan so as to reflect the actual use of biomass residues in the project scenario. Along the crediting period, new categories of biomass residues (i.e. new types, new sources, with different fate) can be used in the project activity. When a new category of biomass residues is used, a new line should be added to the table
Monitoring frequency:	Annually
QA/QC procedures:	QA/QC for biomass residue quantities during the crediting period as per the requirements for $BR_{PJ,n,y}$
Any comment:	This parameter is related to the procedure for the selection of the baseline scenario selection and assessment of additionality

Data / Parameter:	$BR_{PJ,n,y}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues of category *n* that are fired in the project power plant in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use a weight or volume measuring device. If volume meters are used convert to mass units using the density of each category of biomass residues. Adjust for the moisture content in order to determine the quantity of dry biomass
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes. Check the consistency of measurements *ex post* with annual data on electricity generation and fossil fuels used and the efficiency of electricity generation as determined *ex ante*
Any comment:	The biomass residue quantities used should be monitored separately for (a) each type of biomass residue (e.g.) and each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.)

Data / Parameter:	$NCV_{n,y}$
Data unit:	GJ/tonnes on dry-basis
Description:	Net calorific value of biomass residues of category *n* in year *y*
Source of data:	Measurements
Measurement procedures (if any):	Measurements shall be carried out at certified laboratories and according to relevant national or international standards. Measure the NCV on dry-basis
Monitoring frequency:	At least every six months, taking at least three samples for each measurement
QA/QC procedures:	Check the consistency of the measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Ensure that the NCV is determined on the basis of dry biomass
Any comment:	-

Data / Parameter:	$EF_{BL,CO2,FF}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of the fossil fuel type that would be used for power generation at the project site in the baseline
Source of data:	Use the fossil fuel type with the lowest CO_2 emission factor among all fossil fuel types used in the project power plant in (a) the most recent three years prior to the implementation and the year y (in the case of existing plants) or (b) in the year y and any preceding years since the start of the project activity (in the case of new plants). Start-up fuels can be excluded from this consideration. Either conduct measurements or use accurate and reliable local or national data where available. Where such data is not available, use IPCC default emission factors (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the value in a conservative manner and justify the choice
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards
Monitoring frequency:	In case of measurements: At least every six months, taking at least three samples for each measurement In case of other data sources: Review the appropriateness of the data annually
QA/QC procedures:	Check consistency of measurements and local/national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements
Any comment:	-

Data / Parameter:	$NCV_{i,y}$
Data unit:	TJ/mass or volume unit
Description:	Net calorific value of fossil fuel type *i* 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) 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 or lower limit, the one that is the most conservative one, 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
Monitoring frequency:	For a) and b): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated For c): Review appropriateness of the values annually For d): Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures:	Verify if 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 fall below 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
Any comment:	Note that for the NCV the same basis (pressure and temperature) should be used as for the fuel consumption

Data / Parameter:	N_y
Data unit:	-
Description:	Number of vehicle trips for the transportation of biomass
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Check consistency of the number of vehicle trips with the quantity of biomass combusted, e.g. by the relation with previous years
Any comment:	-

Data / Parameter:	AVD_y
Data unit:	km
Description:	Average round trip distance (from and to) between biomass fuel supply sites and the project site
Source of data:	Records by project participants on the origin of the biomass
Measurement procedures (if any):	-
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Check consistency of distance records provided by the transporters by comparing recorded distances with other information from other sources (e.g. maps)
Any comment:	Applicable if option 1 is chosen to estimate CO_2 emissions from transportation. If biomass is supplied from different sites, this parameter should correspond to the mean value of km traveled by vehicles that supply the biomass plant

Data / Parameter:	$EF_{km,y}$
Data unit:	tCO_2/km
Description:	Average CO_2 emission factor for the vehicles during the year *y*
Source of data:	Conduct sample measurements of the fuel type, fuel consumption and distance traveled for all vehicle 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 vehicle 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:	$BR_{TR,y}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues that has been transported to the project site during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight or volume meters. If volume meters are used convert to mass units using the density of each category of biomass residues. Adjust for the moisture content in order to determine the quantity of dry biomass
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	-

Data / Parameter:	TL_y
Data unit:	tonnes
Description:	Average vehicle load of the vehicles used for transportation of biomass
Source of data:	On-site measurements
Measurement procedures (if any):	Determined by averaging the weights of each vehicle carrying biomass to the project plant
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$FC_{TR,i,y}$
Data unit:	Mass or volume unit
Description:	Fuel consumption of fuel type i in vehicles for transportation of biomass residues during the year *y*
Source of data:	Fuel purchase receipts or fuel consumptions meters in the vehicles
Measurement procedures (if any):	-
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
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:	Applicable if option 2 is chosen to estimate CO_2 emissions from transportation

Data / Parameter:	$EF_{FF,i,y}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor for fossil fuel type *i* in year *y*
Source of data:	Either conduct measurements or use accurate and reliable local or national data where available. Where such data is not available, use IPCC default emission factors (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the value in a conservative manner and justify the choice
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards
Monitoring frequency:	In case of measurements: At least every six months, taking at least three samples for each measurement In case of other data sources: Review the appropriateness of the data annually
QA/QC procedures:	Check consistency of measurements and local/national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements
Any comment:	-

Data / Parameter:	$EF_{CO2,LE}$
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:	-

IV. REFERENCES AND ANY OTHER INFORMATION

Not applicable.

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History of the document

Version	Date	Nature of revision(s)
01	EB 51, Annex 5 04 December 2009	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		