Approved consolidated baseline and monitoring methodology ACM0020

"Co-firing of biomass residues for heat generation and/or electricity generation in grid connected power plants"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

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

- AM0085 "Co-firing of biomass residues for electricity generation in grid connected power plants";
- NM0304 "Co-firing of Biomass Residues for Electricity Generation", prepared by Central Termoeléctrica Andina S.A;
- NM0347 "Biomass residue co-firing at an existing or a new boiler(s)", prepared by PT. Carbon Partners Asiatica.

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 CO_2 emissions from fossil fuel combustion";
- "Tool to calculate the emission factor for an electricity system";
- "Tool to determine the baseline efficiency of thermal or electric energy generation systems".

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.

Heat is useful thermal energy that is generated in a heat generation facility (e.g. a boiler, a cogeneration plant, thermal solar panels, etc.) and transferred to a heat carrier (e.g. liquids, gases, steam, etc.) for utilization in thermal applications and processes, including electric power generation. For the purposes of this methodology, heat does not include waste heat, i.e. heat that is transferred to the environment without utilization, for example, heat in flue gas, heat transferred to cooling towers or any other heat losses. Note that heat refers to the *net* quantity of thermal energy that is transferred to a heat carrier at the heat generation facility. For example, in case of a boiler it refers to the difference of the enthalpy of the steam generated in the boiler and the enthalpy of the feed water and, if applicable, any condensate return.

Process heat is the heat that is not used for mechanical or electric power generation by end-users.

Heat generator / heat generation equipment is a facility that generates thermal energy by combustion of fuels. This includes, for example, a boiler that supplies steam or hot water, a heater that supplies hot oil or thermo fluid, or a furnace that supplies hot gas or combustion gases. Under this methodology, furnaces and dryers are not included.

Heat-only plant is a plant where the heat generated is not used to co-generate electricity.

Power plant is an installation that generates electric power through the conversion of heat to mechanical power using a heat engine. The heat is produced in a heat generator, through the combustion of fuels, and the electric power is generated in an electricity generator, coupled to the heat engine. The power plant includes all the equipment necessary to generate electric power, including, *inter alia*, heat generators, heat engines, electricity generators, gear boxes and speed reducers, instrumentation and control equipment, cooling equipment, pumps, fans, and also the systems required for the preparation, storage and transportation of fuels. A common example of power plant is a steam cycle plant, in which heat is produced in boilers through the combustion of fuels, transferred to steam which then drives steam turbines. The steam turbines are coupled, normally via speed reducers, to electricity generators which in turn finally generate the electric power. The steam leaving the turbines is directed to condensers, so that its residual heat content is transferred to the atmosphere via a cooling towers system.

Power-only plant is a power plant to which the following conditions apply:

(a) All heat engines of the power plant produce only electric power and do not co-generate heat; and

(b) The heat produced in equipment of the power plant (e.g. a boiler) is only used in heat engines (e.g. turbines or motors) and not for other processes (e.g. heating purposes or as feedstock in processes). For example, in the case of a power plant with a steam header, this means that *all* steam supplied to the steam header must be used in turbines.

Power-and-heat plant is a power plant which does not fulfil the conditions of a power-only plant. Power-and-heat plants encompass thus two broad categories of power plants: cogeneration plants and plants in which heat and electric power are produced at the same installation although not necessarily in

cogeneration mode, e.g. heat is extracted directly from a common heat header that also supplies heat to heat engines for electric power generation.

Cogeneration plant is a power-and-heat plant in which at least one heat engine simultaneously generates both heat and electric power.

Net quantity of electricity generation is the electricity generated by the power plant unit after exclusion of parasitic and auxiliary loads, i.e. the electricity consumed by the auxiliary equipment of the power plant unit (e.g. pumps, vans, flue gas treatment, control equipment, etc) and equipment related to fuel handling and preparation.

Applicability

This methodology is applicable to project activities that operate a single piece of biomass-residue co-fired heat generation equipment. The heat output of the heat generators may be used onsite to produce electric power in power-only plants, or cogenerate electric power in cogeneration plants. The project activity includes partial replacement of fossil fuels by biomass residues in existing or new heat generation equipment.

The methodology is applicable under the following conditions:

- No biomass types other than biomass residues are used in the project plant;[1]
- The amount of biomass residues co-fired in the project heat generation equipment 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 heat generation equipment should not be stored for more than one year;
- The biomass residues used by the project heat generation equipment/facility are not obtained from chemically processed biomass (e.g. through esterification, fermentation, hydrolysis, pyrolysis, bio- or chemical- degradation, etc.) prior to combustion. Moreover, the preparation of biomass-derived fuel do not involve significant energy quantities, except from transportation or mechanical treatment so as not to cause significant GHG emissions;
- The use of biomass residues is technically not possible at the project site without a capital investment in:
  - The retrofit or replacement of existing heat generators/boilers; or
  - The installation of new heat generators/boilers; or

[1] Refuse Derived Fuel (RDF) may be used in the project plant but all carbon in the fuel, including carbon from biogenic sources, shall be considered as fossil fuel.

[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.

- A new dedicated biomass residues supply chain established for the purpose of the project (e.g. collecting and cleaning contaminated new sources of biomass residues that could otherwise not be used for energy purposes); or
- Equipment for preparation and feeding of biomass residues.

- No biomass is co-fired in the identified baseline scenario and the same type of fossil fuel is fired in the identified baseline scenario as in the project activity.

Finally, the methodology is only applicable if the baseline heat generation equipment and electricity generation equipment are the same as the project equipment and 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 electric power generation: scenarios P2 to P5 and P7;
- For heat generation: Scenarios H2 to H5;
- 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 plant;
- All power plants connected to the electricity system (grid) that the project plant is connected to;
- The means of transportation of biomass residues to the project site; and
- The wastewater treatment facilities used to treat the wastewater produced from the treatment of biomass residues.

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
	Wastewater from the treatment 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. This emission source is assumed to be small
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be 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) If applicable, how electric power would be generated in the absence of the CDM; and

(b) If applicable, how heat would be generated in the absence of the CDM; and

(c) What would happen to the biomass residues in the absence of the CDM.

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

P1: The proposed project activity not undertaken as a CDM project activity;

P2: If applicable[3], the continuation of electric power generation in existing power plants at the project site. The existing plants would operate at the same conditions (e.g. installed capacities, average load factors, or average energy efficiencies, fuel mixes, and equipment configuration) as those observed in the most recent three years prior to the starting date of the project activity;

P3: If applicable[3], the continuation of electric power generation in existing power plants at the project site. The existing plants would operate with different conditions from those observed in the most recent three years prior to the starting date of the project activity;

P4: If applicable[3], the retrofitting of existing power plants at the project site.

P5: The installation of new power plants at the project site different from those installed under the project activity;

P6: The generation of electric power in specific off-site plants, excluding the power grid;

P7: The generation of electric power in the power grid.

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

H1: The proposed project activity not undertaken as a CDM project activity;

H2: If applicable[3], the continuation of heat generation in existing plants at the project site. The existing plants would operate at the same conditions (e.g. installed capacities, average load factors, or average energy efficiencies, fuel mixes, and equipment configuration) as those observed in the most recent three years prior to the project activity;

H3: If applicable[3], the continuation of heat generation in existing plants at the project site. The existing plants would operate with different conditions from those observed in the most recent three years prior to the project activity;

H4: If applicable[3], the retrofitting of existing plants at the project site;

H5: The installation of new plants at the project site different from those installed under the project activity;

[3] This alternative is only applicable if there are existing plants operating at the project site.

H6: The generation of heat in specific off-site plants;

H7: The production of heat from district heating.

When defining plausible and credible alternative scenarios for electric power or heat generation, in cases where alternative scenarios include the installation of new electric power or heat generation capacity at the project site other than the proposed project activity or retrofitting of existing heat or electric power capacity, the economically most attractive technology and fuel mix should be identified among those which provide the same service (i.e. the same electric power and heat quantity), that are technologically available and that are in compliance with relevant regulations. The type of technology, the efficiency of the plants and the fuel type should be selected in a conservative manner, i.e. where several technologies and/or fuel types could be used and are similarly economically attractive, the least carbon intensive fuel type/the most efficient technology should be considered. Ensure that the selected technology is not more carbon intensive than the common practice for new plants in the respective industry sector, in the country or region, excluding CDM registered projects;[4]

For the use of biomass residues, the alternative scenarios 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 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 electric power or heat generation at the project site in new and/or existing plants;

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

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

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: Biomass residues are purchased from a market, or biomass residues retailers, or the primary source of the biomass residues and/or their fate in the absence of the project activity cannot be clearly identified.

When defining plausible and credible alternative scenarios for the use of biomass residues, the guidance below should be 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 during the crediting period, and consistent with the alternative scenarios selected for electric power and heat generation (scenarios P and H above);

[4] In case all similar plants are registered as CDM project activities, this assessment of common practice is not required.

- 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);
- For example, consider a project activity which includes the installation of a new biomass-only power plant, and the retrofit of an existing co-fired biomass-fossil-fuel power plant, which has historically used rice husks, produced on-site. Suppose that the project activity will use two types of biomass residues, rice husks (historical use plus an additional amount) and diverse agricultural residues (as additional biomass residues compared to the historical situation). Further consider that the rice husks used in the project would come from two different sources, on-site production and off-site supply from an identified rice mill. Presumably, the rice husks produced on-site would have been partly used on-site for electricity generation and partly be dumped in the baseline. The rice husks procured off-site would have been dumped in the baseline. The diverse agricultural residues are purchased from a biomass retailer. For this example, four categories of biomass residues should be considered in the subsequent analysis, as illustrated in Table 2;
- Explain and document transparently in the CDM-PDD, using a table similar to Table 2, which quantities of which biomass residues categories are used 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. 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 the calculations of the emission reductions. 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 (*n*)	**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	On-site production	Electricity generation on-site (B4)	Electricity generation on-site (biomass-only boiler)	See comments above
2	Rice husks	On-site production	Dumped (B1)	Electricity generation on-site (biomass-only boiler)	See comments above

3	Rice husks	Off-site from an identified rice mill	Dumped (B1)	Electricity generation on-site (biomass-only boiler)	See comments above
4	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 scenarios B1, B2 or B3 is deemed a plausible baseline alternative, project participants shall demonstrate that this is a realistic and credible alternative scenario. Project participants may choose one among of the following procedures to demonstrate this:
  - Demonstrate that there is an abundant surplus of the type of biomass residue in the region of the project activity 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 demand;
  - 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 above is 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 are used in the project activity which were not listed at the validation stage, e.g. due to new sources of biomass residues being used, those biomass residues should be clearly identified and included in an updated version of Table 2, without prejudice to the registration of the project activity. Additionally, for new categories of biomass residues of the type B1, B2 or B3 the baseline scenario should be assessed using the procedures outlined above.

For the purpose of identifying relevant alternative scenarios, provide an overview of *other* technologies or practices that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity and that have been implemented previously or are currently underway in the relevant geographical area. The relevant geographical area should in principle be the host country of the proposed CDM project activity. A region within the country could be the relevant geographical area if the framework conditions vary significantly within the country. However, the relevant geographical area

should include preferably ten facilities (or projects) that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity. If less than ten facilities (or projects) that provide outputs or services with comparable quality, properties and applications as the proposed CDM project activity are found in the region/host country, the geographical area may be expanded to an area that covers if possible, ten such facilities (or projects). In cases where the above described requirements for geographical area are not suitable, the project proponents should provide an alternative definition of geographical area. Other registered CDM project activities are not to be included in this analysis.

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,[5] 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:

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

Where:

ER_y	=	Emissions reductions during year *y* (tCO2)
BE_y	=	Baseline emissions during year *y* (tCO2)
PE_y	=	Project emissions during year *y* (tCO2)
LE_y	=	Leakage emissions during year *y* (tCO2)

Baseline Emissions

Baseline emissions include two possible components: (1) the CO_2 emissions from the combustion of the fossil fuel required to produce, in the baseline scenario, the same amount of electricity as produced from the combustion of biomass residues under the project activity, and (2) the CO_2 emissions from the combustion of the fossil fuel required to produce, in the baseline scenario, the same amount of heat as

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

produced from the combustion of biomass residues under the project activity. In case of power-only plants, only the first component is included in the baseline emissions; in case of heat-only plants, only the second component.

$$BE_y = f_{BR,y} \times HC_{PJ,y} \times \frac{EF_{FF,y}}{\eta_{HG,FF}} + f_{BR,y} \times EG_{PJ,y} \times \min\left(EF_{EG,GR,y}, \frac{3.6 \times EF_{FF,y}}{\eta_{EG,FF,y}} \right) \quad (2)$$

Where:

BE_y	=	Baseline emissions in year *y* (tCO2)
$f_{BR,y}$	=	Fraction of biomass inputs in year *y*, taking into account the difference in the efficiencies of utilizing baseline fossil fuels or biomass residues (ratio)
$HC_{PJ,y}$	=	Quantity of process heat supplied by the project heat-only plant or heat-and-power plant in year *y* (GJ).
$EF_{FF,y}$	=	CO_2 emission factor for the fossil fuel in year *y* (tCO2/GJ)
$\eta_{HG,FF}$	=	Efficiency of heat generators using the fossil fuel only (ratio)
$EG_{PJ,y}$	=	Quantity of electricity supplied by the project heat engine in year *y* (MWh)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (tCO2/MWh)
$\eta_{EG,FF,y}$	=	Efficiency of electricity generators using the fossil fuel only in year *y* (ratio)

The parameter $EF_{EG,GR,y}$ should be determined as the combined margin CO_2 emission factor for the grid to which the project activity is connected in year *y*, calculated using the latest approved version of the "Tool to calculate the emission factor for an electricity system".

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.

Determination of $\eta_{HG,FF}$

The efficiencies of heat generators using the fossil fuel are estimated only if process heat is produced. In this case, the efficiencies should be calculated using one of the following options:

Option 1: **Default values.** Use Option F in the latest approved version of the "Tool to determine the baseline efficiency of thermal or electric energy generation systems".[6]

Option 2: **Manufacturer's data.** Use Option D in the latest approved version of the "Tool to determine the baseline efficiency of thermal or electric energy generation systems". The efficiency of the heat generator is determined based on manufacturer's data of the efficiency for the fossil fuel under optimal operating conditions.

Option 3: This option is applicable if the identified baseline scenario for heat generation is H2 and if heat generators were operated at the project site for at least three calendar years prior to the date of submission of the PDD for validation of the project activity. The efficiencies of heat generators and are determined based on the historical records, as follows:

[6] Where a default value is not provided for a technology a request for revision to this methodology may be submitted.

$$\eta_{HG,FF} = MAX\left\{\frac{HG_{FF,x}}{\sum_{x} FC_{x} \cdot NCV_{FF,f,x}}; \frac{HG_{FF,x-1}}{\sum_{x} FC_{x-1} \cdot NCV_{FF,f,x-1}}; \frac{HG_{FF,x-2}}{\sum_{x} FC_{x-2} \cdot NCV_{FF,f,x-2}}\right\} \quad (3)$$

Where:

$\eta_{HG,FF}$	=	Baseline fossil-fuel-based heat generation efficiency of heat generator (ratio)
$HG_{FF,x}$	=	Quantity of heat generated using fossil fuels in the heat generator in year *x* (GJ)
FC_x	=	Quantity of the fossil fuel fired in the heat generator in year *x* (mass or volume unit)
$NCV_{FF,x}$	=	Net calorific value of the fossil fuel in year *x* (GJ/mass or volume unit)
x	=	Last calendar year prior to the start of the crediting period

Determination of f_{BR}

The fraction of biomass inputs, taking into account the difference in the efficiencies of utilizing the fossil fuel or the biomass residues, should be calculated using the equation below:

$$f_{BR,y} = \frac{HG_{PJ,y} - FC_y \times NCV_{FF,y} \times \eta_{HG,FF}}{HG_{PJ,y}} \quad (4)$$

Where:

$f_{BR,y}$	=	Fraction of biomass inputs in year *y* (ratio)
$HG_{PJ,y}$	=	Quantity of heat generated in year *y* (GJ).
FC_y	=	Quantity of the fossil fuel fired in heat generator in year *y* (mass or volume unit)
$NCV_{FF,y}$	=	Net calorific value of the fossil fuel in year y (GJ/mass or volume unit)
$\eta_{HG,FF}$	=	Baseline fossil-based heat generation efficiency (ratio)

Determination of $\eta_{EG,FF}$

The efficiencies of electricity generator, $\eta_{HG,FF,y}$ are estimated only if electric power is produced. In this case, the efficiencies should be calculated using the following equation:

$$\eta_{EG,FF,y} = \frac{EG_{PJ,y} \times 3.6}{FC_y \div \left(1 - f_{BR,y}\right) \times NCV_{FF,y} - HC_{PJ,y} \div \eta_{HG,FF}} \quad (5)$$

Where:

$\eta_{EG,FF,y}$	=	Efficiency of electricity generators using the fossil fuel only in year *y* (ratio)
$EG_{PJ,y}$	=	Quantity of electricity supplied by the project heat engine in year *y* (MWh)
FC_y	=	Quantity of the fossil fuel fired in heat generator in year *y* (mass or volume unit)
$f_{BR,y}$	=	Fraction of biomass inputs in year *y* (ratio)
$NCV_{FF,y}$	=	Net calorific value of the fossil fuel in year y (GJ/mass tonne or volume unit)
$HC_{PJ,y}$	=	Quantity of process heat supplied by the project heat-only plant or heat-and-power plant in year *y* (GJ).
$\eta_{HG,FF}$	=	Efficiency of heat generators using the fossil fuel only (ratio)

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;
- CO_2 emissions from off-site transportation of biomass residues that are combusted in the project plant; and
- If applicable, emissions from anaerobic treatment of wastewater originating from the treatment of the biomass residues prior to their combustion.

Project emissions are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{TR,y} \qquad \textbf{(6)}$$

Where:

PE_y	=	Project emissions during year *y* (tCO2e)
$PE_{FF,y}$	=	Emissions during the year *y* due to on-site fossil fuel consumption attributable to the project activity (tCO2)
$PE_{TR,y}$	=	Emissions during the year *y* due to transport of the biomass residues to the project plant (tCO2)

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):

$$PE_{TR,y} = N_y \cdot AVD_y \cdot EF_{km,y} \quad \textbf{(7)}$$

or

$$PE_{TR,y} = \frac{BR_{TR,y}}{TL_y} \cdot AVD_y \cdot EF_{km,y} \quad \textbf{(8)}$$

Where:

$PE_{TR,y}$	=	CO_2 emissions during the year *y* due to transport of the biomass residues to the project plant (tCO2)
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* (tCO2/km)
$BR_{TR,y}$	=	Quantity of biomass residues that has been transported to the project site during the year *y* (tonne)
TL_y	=	Average vehicle load of the vehicles used (tonne) during the year *y*

Option 2

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

$$PE_{TR,y} = \sum_i FC_{TR,i,y} \cdot NCV_{i,y} \cdot EF_{FF,i,y} \quad \textbf{(9)}$$

Where:

$PE_{TR,y}$	=	CO_2 emissions during the year *y* due to transport of the biomass residues to the project plant (tCO2)
$FC_{TR,i,y}$	=	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* (tCO2/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:

$$LE_y = EF_{CO2,LE} \cdot \sum_n BR_{PJ,n,y} \cdot NCV_{n,y} \quad \textbf{(10)}$$

Where:

LE_y	=	Leakage emissions in year *y* (tCO2)
$EF_{CO2,LE}$	=	CO_2 emission factor of the most carbon intensive fossil fuel used in the country (tCO2/GJ)
$BR_{PJ,n,y}$	=	Quantity of biomass residues of category *n* that are fired in the project power plant in year *y* (tonne on dry-basis)
$NCV_{n,y}$	=	Net calorific value of the biomass residues category n in year *y* (GJ/tonne 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 tCO2e 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:	FC_x
Data unit:	Mass or volume unit
Description:	Quantity of the fossil fuel fired in the heat generator in year *x*
Source of data:	On-site measurements

Measurement procedures (if any):	• Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift); • Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance; • In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions
Any comment:	---

Data / Parameter:	$NCV_{FF,x}$
Data unit:	GJ/mass or volume unit
Description:	Net calorific value of the fossil fuel in year *x*
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 net calorific values (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the values in a conservative manner and justify the choice
Measurement procedures (if any):	Measurements shall be carried out at certified laboratories and according to relevant national or international standards
Any comment:	---

Data / Parameter:	$HG_{FF,x}$
Data unit:	GJ
Description:	Quantity of heat generated using fossil fuels in the heat generator in year *x*
Source of data:	On-site measurements
Measurement procedures (if any):	This parameter should be determined as the difference of the enthalpy of the heat (steam or hot water) generated by the heat generators(s) minus the enthalpy of the feed-water, the boiler blow-down and any condensate return. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure
Any comment:	in absence of temperature and pressure records, use the default values from equipment as reference

Data / Parameter:	GWP_{CH4}
Data unit:	$tCO2e/tCH_4$
Description:	GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO2/tCH4)
Source of data:	IPCC
Measurement procedures (if any):	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions
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. All 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:	$EG_{PJ,y}$
Data unit:	MWh
Description:	Quantity of electricity supplied by the project heat engine in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated electricity meters
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	The consistency of metered electricity generation should be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years). Calibration shall be performed every year.
Any comment:	---

Data / Parameter:	$HC_{PJ,y}$
Data unit:	GJ
Description:	Quantity of process heat supplied by the project heat-only plant or heat-and-power plant in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	This parameter should be determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generators. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure
Monitoring frequency:	Calculated based on continuously monitored data and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	---

Any comment:	---

Data / Parameter:	$HG_{PJ,y}$
Data unit:	GJ
Description:	Quantity of heat generated in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	This parameter should be determined as the difference of the enthalpy of the heat (steam or hot water) generated by the heat generators(s) [in the project activity, monitored during year *y*,] minus the enthalpy of the feed-water, the boiler blow-down and any condensate return. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure
QA/QC procedures:	---
Any comment:	In absence of temperature and pressure records, use the default values from equipment

Data / Parameter:	FC_y
Data unit:	Mass or volume unit
Description:	Quantity of the fossil fuel fired in heat generator in year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	• Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift); • Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance; • In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records
Any comment:	---

Data / Parameter:	$EF_{CO2,LE}$
Data unit:	tCO2/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:	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 and assessment of additionality

Data / Parameter:	$BR_{PJ,n,y}$
Data unit:	tonne 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/tonne 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:	-

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{i,y,}$ $NCV_{FF,y}$</td></tr>
<tr><td>Data unit:</td><td>GJ/mass or volume unit</td></tr>
<tr><td>Description:</td><td>Net calorific value of fossil fuel type i in year y, including the fossil fuel used in the heat generation equipment</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper 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</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Monitoring frequency:</td><td>For a) 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</td></tr>
<tr><td>QA/QC procedures:</td><td>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</td></tr>
<tr><td>Any comment:</td><td>Note that for the NCV the same basis (pressure and temperature) should be used as for the fuel consumption</td></tr>
</table>

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:	tCO2/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:	tonne
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.
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 (Adjust for the moisture content in order to determine the quantity of dry biomass)
Any comment:	-

Data / Parameter:	TL_y
Data unit:	tonne
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:	$EF_{FF,i,y}$, $EF_{FF,y}$
Data unit:	tCO2/GJ
Description:	CO_2 emission factor for the fossil fuel type *i* in year *y*, including the fossil fuel used in the heat generation equipment
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:	-

IV. REFERENCES AND ANY OTHER INFORMATION

Not applicable.

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History of the document

Version	Date	Nature of revision(s)
01.0.0	EB 63, Annex 9 29 September 2011	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		