Approved baseline and monitoring methodology AM0036

"Fuel switch from fossil fuels to biomass residues in heat generation equipment"

I. SOURCE AND APPLICABILITY

Source

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

- NM0140-rev: "Methodology for heat generation from biomass residues", whose baseline and monitoring methodology is prepared by Mondi Business Paper, Richards Bay and SouthSouthNorth, and, some elements from the proposed new methodology NM0134-rev: "Steam generation from biomass residues displacing fossil fuels", whose baseline and monitoring methodology and project design document were prepared by Andean Center for Environmental Economics (CAEMA), Colombia.

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

- "Tool for the demonstration and assessment of additionality";[1]
- "Emissions from solid waste disposal sites";
- "Tool to calculate the emission factor for an electricity system";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "Tool to determine the baseline efficiency of thermal or electric energy generation systems";
- "Tool to determine the remaining lifetime of equipment".
- "Project and leakage emissions from road transportation of freight";
- "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of a crediting period".

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

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable".

Definitions

The following definitions apply for this methodology:

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.

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

Biomass residues is the biomass that is a by-product, residue or waste stream from agriculture, forestry and related industries. This shall not include municipal waste or other waste that contains fossilized and/or non-biodegradable material (small fractions of inert inorganic material like soil or sands may be included). Note that in case of solid biomass residue for all the calculations in this methodology, quantity of biomass residue refers to the dry weight of biomass residue.

Heat is useful thermal energy that is generated in heat generation equipment and transferred to a heat carrier (e.g. hot liquids, hot gases,[2] steam, etc.) for utilization in thermal applications and processes. 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 equipment. 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.

Heat generation equipment is a facility that generates thermal energy by combustion of fuels and supplies heat to thermal applications or processes. This includes, for example, a boiler that supplies steam or hot water, a heater that supplies hot oil or thermic fluid, or a furnace that supplies hot gas or combustion gases. When several heat generation equipments are included in one project activity, each heat generation equipment is referred to as **"unit"**.

Efficiency of heat generation is the quantity of heat generated per unit quantity of fuel fired (both expressed in terms of energy using the same units). The **average net efficiency of heat generation** refers to the efficiency of heat generation over a longer time interval (e.g. one year) that is representative for different loads and operation modes, including start-ups. When considering more than one unit, the average efficiency of heat generation corresponds respectively to the heat generated by all units divided by the quantity of fuel fired in the same units (both expressed in the same energy units).

Applicability

The methodology is applicable to project activities that switch from use of fossil fuels to biomass residues in heat generation equipment. The methodology is applicable to project activities described in Table 1.

Table 1: Project activities eligible for use of this methodology

Scenario	Description
1	**Retrofit of existing heat generation equipment.** The project activity is the retrofit of existing heat generation equipment. The retrofit is made to the equipment to enable (a) the use of biomass residues or (b) an increase in the use of biomass residues beyond historical levels, which would not be technically possible in any of the existing heat generation equipment without a retrofit or replacement
2	**Replacement of existing heat generation equipment.** The project activity involves the replacement of existing heat generation equipment by new heat generation equipment that fire(s) biomass residues and, where applicable, fossil fuels. The replacement shall (a) enable the use of biomass residues or (b) enable an increase in the use of biomass residues beyond historical levels, which would not be technically possible in any of the existing heat generation equipment without a retrofit or replacement

[2] Hot gases may include combustion gases from a furnace if the gases are used in the project scenario as heat carrier, without further combustion and not wasted in the absence of the project activity.

Scenario	Description
3	**Installation of new heat generation equipment.** The project activity is to increase the heat generation capacity by installation of new heat generation equipment that fire(s) biomass residues and, where applicable. The use of biomass residues or an increase in the use of biomass residues beyond historical levels would not be technically possible without a retrofit or replacement of the existing heat generation equipment or the installation of a new heat generation equipment. The procedure to determine the most plausible baseline scenario results in that the same fossil fuel type(s) as used in the existing heat generation equipment, would be used in the new heat generation equipment in the absence of the CDM project activity
4	**Installation of new heat generation equipment and retrofit and/or replacement of existing heat generation equipment.** The project activity involves: (a) An increase in the heat generation capacity by installation of new heat generation equipment that fire(s) biomass residues and, where applicable fossil fuels; and (b) The retrofit of existing heat generation equipment and/or the replacement of existing heat generation equipment by new heat generation equipment that fire(s) biomass residues and, where applicable fossil fuels. The use of biomass residues or an increase in the use of biomass residues beyond historical levels would not be technically possible without a retrofit or replacement of the existing heat generation equipment or the installation of new heat generation equipment. The procedure to determine the most plausible baseline scenario results in that the same fossil fuel type(s) as used in the existing heat generation equipment would be used in the new heat generation equipment in the absence of the CDM project activity

The biomass residues used in the project activity may be produced on-site (e.g. if the project activity is based on the operation of a power plant located in an (agro-)industrial plant generating the biomass residues), or they can be obtained off-site from the nearby area, specific suppliers or purchased from a market.

The methodology is applicable under the following conditions:

- The heat generated in the heat generation equipment is:
    - Not used for power generation; or
    - If power is generated using the heat generated by the heat generation equipment, it is not increased as a result of the project activity, i.e.:
        - (a) The power generation capacity installed remains unchanged due to the implementation of the project activity and is maintained at the pre-project level throughout the crediting period; and
        - (b) The annual power generation during the crediting period is not more than 10% larger than the highest annual power generation in the most recent three years prior to the implementation of the project activity.
- The use of biomass residues or increasing the use of biomass residues beyond historical levels is technically not possible at the project site without a significant capital investment in:
    - Either the retrofit or replacement of existing heat generation equipment or the installation of new heat generation equipment; or

  - Establishing a new dedicated biomass supply chain for the purpose of the project activity (e.g. collecting and cleaning contaminated new sources of biomass residues that could otherwise not be used for energy purposes).

- Existing heat generation equipment at the project site has either not used any biomass or has used only biomass residues (but no other type of biomass) for heat generation during the most recent three years[3] prior to the implementation of the project activity;
- No biomass types other than biomass residues, as defined above, are used in the heat generation equipment during the crediting period. Fossil fuels may be co-fired in the heat generation equipment, however the amount of fossil fuels co-fired shall not exceed 50% of the total fuel fired on an energy basis. Refuse Derived Fuel (RDF) and Refuse Plastic Fuel (RPF) can also be co-fired in the equipment, but for the purpose of this methodology they shall be considered as fossil fuels;[4]
- For projects 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 at the project site, i.e. the site where the project activity is implemented, are not be stored for more than one year;
- 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) are not eligible under this methodology;
- The biomass residues are directly generated at the project site or transported to the project site by trucks;
- In case of project activities that involve the replacement or retrofit of existing heat generation equipment, emission reductions may only be accounted until the time when the existing equipment would have reached the end of its technical time in the crediting period, i.e. after the point in time when the existing equipment would have to be replaced due to the expiry of its technical lifetime in the baseline scenario, emission reductions cannot be accounted. For the purpose of demonstrating this applicability condition, project participants should determine and document the remaining lifetime of each unit of the existing heat generation equipment in accordance with the "Tool to determine the remaining lifetime of equipment". In the case of several existing units with a different remaining lifetime, the shortest lifetime among the units should be used to determine the point in time until which CERs can be claimed.

[3] If the three most recent historical years prior to the implementation of the project activity are not representative for the situation at the project site (e.g. a drought in one year, a unit or plant not operating during a certain year for technical reasons, etc), project participants may alternatively select the five most recent historical years from which one year may be excluded if deviating significantly from other years. The selection by project participants should be documented in the CDM-PDD and be applied to all relevant provisions and equations throughout this methodology in a consistent manner, including the applicability condition.

[4] In the absence of a composition analysis of the Refuse Derived Fuel (RDF) and Refuse Plastic Fuel (RPF), it is conservative to assume that all the RDF/RPF is non-biodegradable, and therefore qualified as a fossil fuel. This is in line with the IPCC definition (See 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, section 1.4.1.1, Fuel Definitions, Table 1.1). If the project participants want to claim emission reduction for the biodegradable component in RDF, a revision to this methodology shall be required.

Furthermore, this methodology is only applicable if the most plausible baseline scenario(s):

- For heat generation is either case H2 or case H5; and
- For the use of biomass residues is case B1, B2, B3, B4 and/or B5. If case B5 is the most plausible scenario, the methodology is only applicable if:
  (a) The plant where the biomass residues would be used as feedstock in the absence of the project activity can be clearly identified throughout the crediting periods;
  (b) The fuels used as substitutes for the biomass residues at that plant can be monitored by project participants.

The applicability conditions outlined in the latest approved version of the tool "Emissions from solid waste disposal sites", in addition to the above listed applicability conditions, apply if:

- CH_4 emissions, from the treatment of biomass residues, in the baseline are included;
- Where case B2 is identified as the most plausible baseline scenario for the use of biomass residues.

In addition, the applicability conditions of all other tools apply.

II. BASELINE METHODOLOGY

Project boundary

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

- CO_2 emissions from on-site fossil fuel and electricity consumption that is attributable to the project activity. This may include fossil fuels or electricity used for on-site transportation or preparation of the biomass residues, e.g. the operation of shredders or other processing equipment, but shall not include fossil fuels co-fired in the heat generation equipment;
- CO_2 emissions from off-site transportation of biomass residues that are combusted in the project activity.

For the purpose of determining the **baseline**, project participants shall include the following emission sources:

- CO_2 emissions from fossil fuel fired for heat generation in the heat generation equipment that are displaced by heat generation with biomass residues.

Where the most likely baseline scenario for the use of the biomass residues is that the biomass residues would be dumped or left to decay under aerobic or anaerobic conditions (cases B1 or B2) or would be burnt in an uncontrolled manner without utilizing it for energy purposes (case B3), project participants may decide whether to include CH_4 emissions from the treatment of biomass residues in the baseline and from combustion of biomass residues in the heat generation equipment in the project boundary. Project participants shall either include CH_4 emissions for both project and baseline emissions or exclude them in both cases, and document their choice in the CDM-PDD.

The spatial extent of the project boundary encompasses:

- The heat generation equipment and related equipment at the project site;
- The means for transportation of biomass residues to the project site (e.g. vehicles);

- The site where the biomass residues would have been left for decay under anaerobic conditions. This is applicable only to cases where the biomass residues would in the absence of the project activity be dumped under anaerobic conditions.

Table 2: Summary of gases and sources included in the project boundary and justification/explanation where gases and sources are not included

Source		Gas	Included?	Justification / Explanation
Baseline	Fossil fuel combustion for heat generation	CO_2	Yes	Important emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Uncontrolled burning or decay of the biomass residues	CO_2	No	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	To be decided by PPs	Project participants may decide to include this emission source, where cases B1, B2 or B3 are identified as the most likely baseline scenario for the use of the biomass residues
		N_2O	No	Excluded for simplification. This is conservative
Project Activity	On-site fossil fuel and electricity consumption	CO_2	Yes	Important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Off-site transportation of biomass residues	CO_2	Yes	Important emission source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Combustion of biomass residues for heat generation	CO_2	No	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	To be decided by PPs	This emission source must be included if project participants decide to include CH_4 emissions from uncontrolled burning or decay of the biomass residues in the baseline scenario
		N_2O	No	Excluded for simplification. This emission source is assumed to be small
	Biomass storage	CO_2	No	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	No	Excluded for simplification. Since biomass residues are stored for not longer than one year, this emission source is assumed to be small
		N_2O	No	Excluded for simplification. This emissions source is assumed to be very small

Procedure for the selection of the most plausible baseline scenario

For identification of the most plausible baseline scenario, project participants shall use the following step-wise procedure.

Step1: Identification of alternative scenarios to the proposed CDM project activity that are consistent with current laws and regulations

Identify all realistic and credible alternatives to the project activity that are consistent with current laws and regulations. Realistic and credible alternatives should be separately determined for the following two components of the project activity:

- Heat generation in the absence of the project activity;
- What would happen to the biomass residues in the absence of the project activity.

The alternatives to be analyzed for **heat generation** may include, *inter alia*:

H1: The proposed project activity not undertaken as a CDM project activity (heat generation with biomass residues);

H2: Continued operation of the existing heat generation equipment using the same fuel mix or less biomass residues as in the past;

H3: Continued operation of the existing unit(s) using a different fuel (mix);

H4: Improvement of the performance of the existing heat generation equipment;

H5: Continued operation of the existing unit(s) using the same fuel mix or less biomass residues as in the past AND installation of new heat generation equipment that is/are fired with the same fuel type(s) and the same fuel mix (or a lower share of biomass) as the existing equipment;

H6: Replacement of the existing heat generation equipment with new heat generation equipment.

The alternatives (including combinations) to be analyzed for **use of biomass residues** may include, *inter alia*:

B1: The biomass residues are dumped or left to decay under mainly 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 deep landfills with more than 5 meters. This does not apply to biomass residues that are stock-piled[5] or left to decay on fields;

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

B4: The biomass residues are sold to other consumers in the market and the predominant use of the biomass residues in the region/country is for energy purposes (heat and/or power generation);

B5: The biomass residues are used as feedstock in a process (e.g. in the pulp and paper industry);

B6: The biomass residues are used as fertilizer;

B7: The proposed project activity not undertaken as a CDM project activity (use of the biomass residues for heat generation);

B8: Any other use of the biomass residues.

[5] 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.

If biomass residues have already been used for heat generation at the project site prior to the implementation of the project activity, the most plausible baseline scenario for the use of the biomass residues should only be determined for the additional biomass residues used over and above the historical levels.

Where different types or sources of biomass residues are used in the project activity, the most plausible baseline scenario for the use of biomass residues should be determined for each type and source of biomass separately. The respective biomass residue types, quantities and sources should be documented transparently in the CDM-PDD.

The alternatives to the project activity shall be in compliance with all applicable legal and regulatory requirements – taking into account EB decisions with respect to national and/or sectoral policies and regulations in determining a baseline scenario[6] – even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution. For example, such requirements could include a regulation on energy efficiency or emission standards for heat generation equipment.

If an alternative does not comply with all applicable legislation and regulations, then show that, based on an examination of current practice in the country or region in which the law or regulation applies, those applicable legal or regulatory requirements are systematically not enforced and that non-compliance with those requirements is widespread in the country. If this cannot be shown, then eliminate the alternative from further consideration.

Step 2: Barrier analysis to eliminate alternatives to the project activity that face prohibitive barriers

Establish a complete list of barriers that would prevent alternative scenarios for heat generation or for the use of biomass residues to occur in the absence of the CDM, using the guidance in Step 3 of the latest approved version of the "Tool for the demonstration and assessment of additionality".

As the "proposed project activity not being registered as a CDM project activity" shall be one of the considered alternatives, any barrier that may prevent the project activity to occur shall be included in that list. Show which alternatives for heat generation and the use of biomass residues are prevented by at least one of the barriers previously identified and eliminate those alternatives from further consideration. All alternatives shall be evaluated for a common set of barriers.

If there is only one alternative for heat generation and one scenario for the use of biomass residues that is not prevented by any barrier then these alternatives are identified as the baseline scenario. Where more than one credible and plausible alternative for heat generation or for the use of biomass residues remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario, or conduct an investment analysis (Step 3).

Step 3: Investment analysis (optional)

Conduct an investment analysis, consistent with the guidance in Step 2 of the latest approved version of the "Tool for the demonstration and assessment of additionality" for all combinations of alternatives for heat generation and the use of biomass residues that are remaining after the previous step. The economically most attractive combination of alternatives for heat generation and use of biomass residues are deemed as the most plausible baseline scenario.

[6] Annex 3 of the 22nd EB meeting report: "Clarifications on the treatment of national and/or sectoral policies and regulations (paragraph 45(e)) of the CDM Modalities and Procedures) in determining a baseline scenario (version 2)".

Additionality

Project participants should use the latest approved version of the "Tool for the demonstration and assessment of additionality", consistent with the guidance provided above on the selection of the most plausible baseline scenario.

Baseline emissions

Baseline emissions include CO_2 emissions from fossil fuel combustion in the heat generation equipment in the absence of the project activity and, if included in the project boundary, CH_4 emissions from the treatment of biomass residues in the absence of the project activity:

$$BE_y = BE_{HG,y} + BE_{BF,y} \tag{1}$$

Where:

BE_y	=	Baseline emissions during the year *y* (tCO_2e/yr)
$BE_{HG,y}$	=	Baseline emissions from fossil fuel combustion for heat generation in the heat generation equipment in year *y* (tCO_2/yr)
$BE_{BF,y}$	=	Baseline emissions due to uncontrolled burning or decay of the biomass residues in year *y* (tCO_2e/yr)

(a) Baseline emissions from fossil fuel combustion for heat generation ($BE_{HG,y}$)

Baseline emissions from fossil fuel combustion in the heat generation equipment are determined by multiplying the heat generated with fossil fuels that are displaced by biomass residues with the CO_2 emission factor of the least carbon-intensive fossil fuels that would be used in the absence of the project activity and by dividing by the average net efficiency of heat generation in the heat generation equipment, as follows:

$$BE_{HG,y} = \frac{HG_{PJ,biomass,y} \cdot EF_{FF,CO2,y}}{\eta_{heat,FF}} \tag{2}$$

Where:

$BE_{HG,y}$	=	Baseline emissions from fossil fuel combustion for heat generation in the heat generation equipment in year *y* (tCO_2e/yr)
$HG_{PJ,biomass,y}$	=	Heat generated with incremental biomass residues used as a result of the project activity during the year *y* (GJ/yr)
$EF_{FF,CO2,y}$	=	CO_2 emission factor of the fossil fuel type displaced by biomass residues for the year *y* (tCO_2e/GJ)
$\eta_{heat,FF}$	=	Average net efficiency of the heat generation equipment if fired with fossil fuels in the baseline (ratio)

Determination of $EF_{FF,CO2,y}$

For the purpose of determining $EF_{FF,CO2,y}$, as a conservative approach, the least carbon intensive fuel type (i.e. the fuel type with the lowest CO_2 emission factor per GJ) should be used among the fossil types used in the heat generation equipment at the project site during the most recent three years[3] prior to the implementation of the project activity and the fossil fuel types used in the heat generation equipment at the project site during the year *y*.

The average net efficiency of the heat generation equipment if fired with fossil fuels in the baseline shall be determined using the latest approved version of the "Tool to determine the baseline efficiency of thermal or electric energy generation systems".

Determination of $HG_{PJ,biomass,y}$

The determination of $HG_{PJ,biomass,y}$ depends on whether only fossil fuels would be used for heat generation in the absence of the project activity (case A) or whether along with fossil fuels some biomass residues also would be used in the absence of the project activity (case B).

The guidance under case A should be followed if:

- No biomass has been used for heat generation at the project site during the most recent three years[3] prior to the implementation of the project activity; and
- The most plausible baseline scenario is that heat would continue to be generated only with fossil fuels.

The guidance under case B should be followed if:

- Biomass residues have already been used in heat generation equipment for heat generation at the project site prior to the implementation of the project activity; and
- The most plausible baseline scenario is that heat would continue to be generated partly with fossil fuels and partly with biomass residues.

Case A: No use of biomass for heat generation in the absence of the project activity

In this case, $HG_{PJ,biomass,y}$ corresponds to the *total* quantity of heat generated from firing biomass residues ($HG_{PJ,biomass,y} = HG_{PJ,biomass,total,y}$).

$HG_{PJ,biomass,total,y}$ is determined based on the fraction of biomass residues that are used for heat generation in the heat generation equipment, taking into account all biomass residue types *k* and fossil fuel types *i* fired in the project heat generation equipment during a year *y*, as follows:

$$HG_{PJ,biomass,total,y} = HG_{PJ,total,y} \cdot \frac{\sum_k BF_{k,y} \cdot NCV_k}{\sum_k BF_{k,y} \cdot NCV_k + \sum_i FC_{i,y} \cdot NCV_i} \quad (3)$$

Where:

$HG_{PJ,biomass,total,y}$	=	Total heat generated from firing biomass residues in all heat generation equipment at the project site during the year *y* (GJ/yr)
$HG_{PJ,total,y}$	=	Total heat generated in the heat generation equipment at the project site, using both biomass residues and fossil fuels, during the year *y* (GJ/yr)
$BF_{k,y}$	=	Quantity of biomass residue type *k* fired in all units of heat generation equipment at the project site during the year *y* (tons of dry matter or liter)[7]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$FC_{i,y}$	=	Quantity of fossil fuel type *i* fired in all heat generation equipment at the project site during the year *y* (mass or volume unit)[8]
NCV_i	=	Net calorific value of the fossil fuel type *i* (GJ/mass or volume unit)

[7] Use tons of dry matter for solid biomass residues and liter for liquid biomass residues.
[8] Preferably use a mass unit for solid fuels and a volume unit for liquid and gaseous fuels.

Case B: Use of some biomass residues for heat generation in the absence of the project activity

In this case, only the use of biomass residues beyond historical levels should be attributed to the CDM project activity. Hence, $HG_{PJ,biomass,y}$ refers to the additional (i.e. additional to the baseline scenario) quantity of heat generated from the combustion of biomass residues, as a result of the CDM project activity.

As the level of biomass residue use in the absence of the project activity is associated with significant uncertainty, use, as a conservative approach, for $HG_{PJ,biomass,y}$ the minimum value among the following two options:

(a) The difference between the total quantity of heat generated from biomass residues in all heat generation equipment at the project site in the year y ($HG_{PJ,biomass,total,y}$) and the highest annual historical heat generation with biomass residues among the most recent three years[3] prior to the implementation of the project activity, as follows:

$$HG_{PJ,biomass,y} = HG_{PJ,biomass,total,y} - MAX\left\{HG_{biomass,historic,n}; HG_{biomass,historic,n-1}; HG_{biomass,historic,n-2}\right\} \quad (4)$$

Where:

$HG_{PJ,biomass,y}$	=	Heat generated with incremental biomass residues used in the project activity during the year y (GJ/yr)
$HG_{PJ,biomass,total,y}$	=	Total heat generated from firing biomass residues in all heat generation equipment at the project site during the year y (GJ/yr)
$HG_{biomass,historic,n}$	=	Historical annual heat generation from firing biomass residues in the heat generation equipment at the project site during the year n (GJ/yr)
N	=	Year prior to the implementation of the project activity

(b) The difference between the total quantity of heat generated from biomass residues in all heat generation equipment in the year y ($HG_{PJ,biomass,total,y}$) and the total heat generation during the year y ($HG_{PJ,total,y}$) multiplied with the highest historical fraction of heat generation with biomass residues from the most recent three years[3], as follows:

$$HG_{PJ,biomass,y} = HG_{PJ,biomass,total,y} - HG_{PJ,total,y} \cdot MAX\left\{\frac{HG_{biomass,historic,n}}{HG_{total,historic,n}}; \frac{HG_{biomass,historic,n-1}}{HG_{total,historic,n-1}}; \frac{HG_{biomass,historic,n-2}}{HG_{total,historic,n-2}}\right\} \quad (5)$$

Where:

$HG_{PJ,biomass,y}$	=	Heat generated with incremental biomass residues used as a result of the project activity during the year y (GJ/yr)
$HG_{PJ,biomass,total,y}$	=	Total heat generated from firing biomass residues in all heat generation equipment at the project site during the year y (GJ/yr)
$HG_{PJ,total,y}$	=	Total heat generated in heat generation equipment at the project site, using both biomass residues and fossil fuels, during the year y (GJ/yr)
$HG_{biomass,historic,n}$	=	Historical annual heat generation from using biomass residues in heat generation equipment at the project site during the year n (GJ/yr)
$HG_{total,historic,n}$	=	Historical annual total heat generation, from using biomass residues and fossil fuels, in heat generation equipment at the project site during the year n (GJ/yr)
n	=	Year prior to the implementation of the project activity

The historical fraction of heat generation with biomass residues can be determined based on the quantities of biomass residue types *k* and fossil fuel types *i* used historically in the heat generation equipment operated at the project site, as follows:

$$\frac{HG_{biomass,historic,n}}{HG_{total,historic,n}} = \frac{\sum_k BF_{k,n} \cdot NCV_k}{\sum_k BF_{k,n} \cdot NCV_k + \sum_i FC_{i,n} \cdot NCV_i} \quad \textbf{(6)}$$

Where:

$HG_{biomass,historic,n}$	=	Historical annual heat generation from using biomass residues in heat generation equipment at the project site during the year *n* (GJ/yr)
$HG_{total,historic,n}$	=	Historical annual total heat generation, from using biomass residues and fossil fuels, in heat generation equipment at the project site during the year *n* (GJ/yr)
$BF_{k,n}$	=	Quantity of biomass residue type *k* used in all heat generation equipment at the project site during the historical year *n* (tons of dry matter or liter)[7]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$FC_{i,n}$	=	Quantity of fossil fuel type *i* fired in all heat generation equipment at the project site during the historical year *n* (mass or volume unit)[8]
NCV_i	=	Net calorific value of the fossil fuel type *i* (GJ/mass or volume unit)
n	=	Year prior to the implementation of the project activity

(b) Baseline emissions due to uncontrolled burning or decay of the biomass residues

If included in the project boundary, baseline emissions due to uncontrolled burning or decay of the biomass residues ($BE_{BF,y}$) should be determined consistent with the most plausible baseline scenario for the use of the biomass residues, following the procedures for the respective baseline scenario, as outlined below. Where different baseline scenarios apply to different types or quantities of biomass residues, the procedures as outlined below should be applied respectively to the different quantities and types of biomass residues.

As under (a) above, if biomass residues have already been used for heat generation at the project site prior to the implementation of the project activity and if the most plausible baseline scenario is that heat would continue to be generated partly with fossil fuels and partly with biomass residues, only the use of biomass residues over and above the historical use levels should be attributed to the CDM project activity and consequently be considered when determining $BE_{BF,y}$.

For this purpose, determine for each biomass residue type *k* the quantity of biomass residue used for heat generation as a result of the project activity ($BF_{PJ,k,y}$) as follows:

- If **no biomass** has been used for heat generation at the project site during the most recent three years[3] prior to the implementation of the project activity and if the most plausible baseline scenario is that heat would continue to be generated only with fossil fuels, use $BF_{PJ,k,y} = BF_{k,y}$ for all biomass residue types *k*;
- If only **one type of biomass residue** *k* has been used for heat generation at the project site prior to the implementation of the project activity and if only this type of biomass residue is used during the year y after implementation of the project activity, use for $BF_{PJ,k,y}$ the product of the quantity of biomass residue type *k* fired in all heat generation equipment at the project site during the year *y* ($BF_{k,y}$) and the fraction of heat generated with biomass residues as a result of the project activity, as follows:

$$BF_{PJ,k,y} = BF_{k,y} \cdot \frac{HG_{PJ,biomass,y}}{HG_{PJ,biomass,total,y}} \quad \textbf{(7)}$$

Where:

$BF_{PJ,k,y}$	=	Quantity of biomass residue type *k* used for heat generation as a result of the project activity during the year *y* (tons of dry matter or liter)[7]
$BF_{k,y}$	=	Quantity of biomass residue type *k* fired in all units of heat generation equipment at the project site during the year *y* (tons of dry matter or liter)[7]
$HG_{PJ,biomass,y}$	=	Heat generated with incremental biomass residues used as a result of the project activity during the year *y* (GJ/yr)
$HG_{PJ,biomass,total,y}$	=	Total heat generated from firing biomass residues in all heat generation equipment at the project site during the year *y* (GJ/yr)

- In all **other cases** (use of more than one type of biomass residue), determine $BF_{PJ,k,y}$ based on the specific circumstances of the project activity, thereby ensuring that the total quantity of all biomass residues types *k* used for heat generation as a result of the project activity is related to the increase in heat generation as a result of the project activity, as follows:

$$\sum_k BF_{PJ,k,y} \cdot NCV_k \overset{!}{=} \sum_k BF_{k,y} \cdot NCV_k \cdot \frac{HG_{PJ,biomass,y}}{HG_{PJ,biomass,total,y}} \quad \textbf{(8)}$$

Where:

$BF_{PJ,k,y}$	=	Quantity of biomass residue type *k* used for heat generation as a result of the project activity during the year *y* (tons of dry matter or liter)[7]
$BF_{k,y}$	=	Quantity of biomass residue type *k* fired in all units of heat generation equipment at the project site during the year *y* (tons of dry matter or liter)[7]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$HG_{PJ,biomass,y}$	=	Heat generated with incremental biomass residues used as a result of the project activity during the year *y* (GJ/yr)
$HG_{PJ,biomass,total,y}$	=	Total heat generated from firing biomass residues in all heat generation equipment at the project site during the year *y* (GJ/yr)

Uncontrolled burning or aerobic decay of the biomass residues (cases B1 and B3)

If the most likely baseline scenario for the use of the biomass residues is either that the biomass residues would be dumped or left to decay under mainly aerobic conditions (B1) or burnt in an uncontrolled manner without utilizing them for energy purposes (B3), baseline emissions are calculated assuming, for both scenarios viz., natural decay and uncontrolled burning, that the biomass residues would be burnt in an uncontrolled manner.

Baseline emissions are calculated by multiplying the quantity of biomass residues that would not be used in the absence of the project activity with the net calorific value and an appropriate emission factor, as follows:

$$BE_{BF,y} = GWP_{CH4} \cdot \sum_k BF_{PJ,k,y} \cdot NCV_k \cdot EF_{burning,CH4,k,y} \quad \textbf{(9)}$$

Where:

$BE_{BF,y}$	=	Baseline emissions due to uncontrolled burning or decay of the biomass residues in year *y* (tCO_2e/yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
$BF_{PJ,k,y}$	=	Quantity of biomass residue type *k* used for heat generation as a result of the project activity during the year *y* (tons of dry matter or liter)[7]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$EF_{burning,CH4,k,y}$	=	CH_4 emission factor for uncontrolled burning of the biomass residue type *k* during the year *y* (tCH_4/GJ)
k	=	Types of biomass residues for which the identified baseline scenario is B1 or B3

To determine the CH_4 emission factor, project participants may undertake measurements or use referenced default values. In the absence of more accurate information, it is recommended to use 0.0027 t CH_4 per ton of biomass as default value for the product of NCV_k and $EF_{burning,CH4,k,y}$.[9]

The uncertainty of the CH_4 emission factor is in many cases relatively high. In order to reflect this and for the purpose of providing conservative estimates of emission reductions, a conservativeness factor must be applied to the CH_4 emission factor. The level of the conservativeness factor depends on the uncertainty range of the estimate for the CH_4 emission factor. Appropriate conservativeness factors from Table 2 below shall be chosen and multiplied with the estimate for the CH_4 emission factor. For example, if the default CH_4 emission factor of 0.0027 t CH_4/t biomass is used, the uncertainty can be deemed to be greater than 100%, resulting in a conservativeness factor of 0.73. Thus, in this case an emission factor of 0.001971 t CH_4/t biomass should be used.

Table 3: Conservativeness factors

Estimated uncertainty range (%)	Assigned uncertainty band (%)	Conservativeness factor where lower values are more conservative
Less than or equal to 10	7	0.98
Greater than 10 and less than or equal to 30	20	0.94
Greater than 30 and less than or equal to 50	40	0.89
Greater than 50 and less than or equal to 100	75	0.82
Greater than 100	150	0.73

Anaerobic decay of the biomass residues (case B2)

If the most likely baseline scenario for the use of the biomass residues is that the biomass residues would decay under clearly anaerobic conditions (case B2), project participants shall calculate baseline emissions using the latest approved version of the tool “Emissions from solid waste disposal sites”. The variable $BE_{CH4,SWDS,y}$ calculated by the tool corresponds to $BE_{BF,y}$ in this methodology. Use as waste quantities prevented from disposal ($W_{j,x}$) in the tool those quantities of biomass residues ($BF_{PJ,k,y}$) for which B2 has been identified as the most plausible baseline scenario.

[9] 2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.

Use for energy or feedstock purposes (cases B4 or B5)

The biomass residues would not decay or be burnt in an uncontrolled manner and $BE_{BF,y} = 0$.

Project emissions

Project emissions include CO_2 emissions from on-site fossil fuel and electricity consumption that is attributable to the project activity ($PE_{CO2,FF,y}$ and $PE_{CO2,EC,y}$), CO_2 emissions from off-site transportation of biomass residues that are combusted in the heat generation equipment to the project site ($PE_{CO2,TR,y}$), and, if included in the project boundary, CH_4 emissions from combustion of biomass residues for heat generation ($PE_{CH4,BF,y}$):

$$PE_y = PE_{CO2,FF,y} + PE_{CO2,EC,y} + PE_{CO2,TR,y} + GWP_{CH4} \cdot PE_{CH4,BF,y} \quad \textbf{(10)}$$

Where:

PE_y	=	Project emissions during the year y (tCO_2/yr)
$PE_{CO2,FF,y}$	=	CO_2 emissions from on-site fossil fuel combustion attributable to the project activity (tCO_2/yr)
$PE_{CO2,EC,y}$	=	CO_2 emissions from on-site electricity consumption attributable to the project activity (tCO_2/yr)
$PE_{CO2,TR,y}$	=	CO_2 emissions from off-site transportation of biomass residues to the project site (tCO_2/yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
$PE_{CH4,BF,y}$	=	CH_4 emissions from combustion of biomass residues in the heat generation equipment (tCH_4/yr)

(a) CO_2 emissions from on-site fossil fuel combustion ($PE_{CO2,FF,y}$)

CO_2 emissions from on-site fossil fuel combustion that is attributable to the project activity ($PE_{CO2,FF,y}$) are calculated in accordance with the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". The parameter $PE_{CO2,FF,y}$ corresponds to $PE_{FC,j,y}$ in the tool, where j should include all processes of fuel combustion that are attributable to the project activity, such as for on-site transportation or treatment of the biomass residues. This should not include fossil fuels co-fired in the project heat generation equipment.

(b) CO_2 emissions from on-site electricity consumption ($PE_{CO2,EC,y}$)

CO_2 emissions from on-site electricity consumption ($PE_{CO2,EC,y}$) are calculated by multiplying the electricity consumption by an appropriate grid emission factor, as follows:

$$PE_{CO2,EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \quad \textbf{(11)}$$

Where:

$PE_{CO2,EC,y}$	=	CO_2 emissions from on-site electricity consumption attributable to the project activity (tCO_2/yr)
$EC_{PJ,y}$	=	On-site electricity consumption attributable to the project activity during the year y (MWh)
$EF_{grid,y}$	=	CO_2 emission factor for electricity used from the grid (tCO_2/MWh)

The CO_2 emission factor for electricity used from the grid *($EF_{grid,y}$)* shall be determined in accordance with the "Tool to calculate the emission factor for an electricity system".

(c) CO_2 emissions from transportation of biomass residues to the project site ($PE_{CO2,TR,y}$)

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 using the latest version of the tool "Project and leakage emissions from road transportation of freight". $PE_{TR,m}$ in the tool corresponds to the parameter $PE_{CO2,TR,y}$ in this methodology and the monitoring period *m* is one year.

(d) CH_4 emissions from combustion of biomass residues in the heat generation equipment ($PE_{CH4,BF,y}$)

If this source has been included in the project boundary, emissions are calculated as follows:

$$PE_{CH4,BF,y} = EF_{CH4,BF} \cdot \sum_k BF_{PJ,k,y} \cdot NCV_k \tag{12}$$

Where:

$PE_{CH4,BF,y}$	=	CH_4 emissions from combustion of biomass residues in the heat generation equipment (tCH_4/yr)
$EF_{CH4,BF}$	=	CH_4 emission factor for the combustion of the biomass residues in the heat generation equipment (tCH_4/GJ)
$BF_{PJ,k,y}$	=	Quantity of biomass residue type *k* used for heat generation as a result of the project activity during the year *y* (tons of dry matter or liter)[7]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)

To determine the CH_4 emission factor, project participants may conduct measurements at the plant site or use IPCC default values, as provided in Table 4 below. The uncertainty of the CH_4 emission factor is in many cases relatively high. In order to reflect this and for the purpose of providing conservative estimates of emission reductions, a conservativeness factor must be applied to the CH_4 emission factor. The level of the conservativeness factor depends on the uncertainty range of the estimate for the CH_4 emission factor. Appropriate conservativeness factor from Table 5 below shall be chosen to multiply with the estimate for the CH_4 emission factor.

For example, where the default CH_4 emission factor of 30 kg/TJ from Table 4 below is used, the uncertainty is estimated to be 300%, resulting in a conservativeness factor of 1.37. Thus, in this case a CH_4 emission factor of 41.1 kg/TJ should be used.

Table 4: Default CH_4 emission factors for combustion of biomass residues[10]

	Default emission factor (kg CH_4 / TJ)	Assumed uncertainty
Wood waste	30	300%
Sulphite lyes (Black Liquor)	3	300%
Other solid biomass residues	30	300%
Liquid biomass residues	3	300%

[10] Values are based on the 2006 IPCC Guidelines, Volume 2, Chapter 2, Tables 2.2 to 2.6.

Table 5: Conservativeness factors

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

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 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: 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 B4, B5, B6, B7 or B8, project participants shall calculate leakage emissions as follows:

$$LE_y = EF_{CO2,LE} \cdot \sum_k BF_{PJ,k,y} \cdot NCV_k \quad \textbf{(13)}$$

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)
$BF_{PJ,k,y}$	=	Quantity of biomass residue type *k* used for heat generation as a result of the project activity during the year *y* (tons of dry matter or liter)
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
k	=	Categories of biomass residues for which B4, B5, B6, B7 or B8, has been identified as the baseline scenario

The determination of $BF_{PJ,k,y}$ 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 tCO_2e occur in the year t+1, only 70 CERs are issued for the year t+1.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \tag{14}$$

Where:

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

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

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

Consistent with guidance by the Executive Board, project participants shall assess the continued validity of the baseline and update the baseline applying the latest version of the tool “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of a crediting period”.

Data and parameters not monitored

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e/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:	---

Data / Parameter:	$\eta_{heat,FF}$
Data unit:	Ratio
Description:	Average net efficiency of the heat generation equipment if fired with fossil fuels in the baseline
Source of data:	Either use the higher value among (a) the measured efficiency prior to the implementation of the project activity and (b) manufacturer’s information on the efficiency OR assume an efficiency of 100% as a conservative default value

Measurement procedures (if any):	Use recognized standards for the measurement of the efficiency, such as the "*British Standard Methods for Assessing the thermal performance of boilers for steam, hot water and high temperature heat transfer fluids*" (BS845). Where possible, use preferably the direct method (dividing the net heat generation by the energy content of the fuels fired during a representative time period), as it is better able to reflect average efficiencies during a representative time period compared to the indirect method (determination of fuel supply or heat generation and estimation of the losses). Document measurement procedures and results and manufacturer's information transparently in the CDM-PDD
Any comment:	-

Data / Parameter:	$HG_{biomass,historic,n}$/$HG_{biomass,historic,n-1}$/$HG_{biomass,historic,n-2}$
Data unit:	GJ/yr
Description:	Historical annual heat generation from firing biomass residues at the project site during the year *n*, *n-1* or *n-2*, where *n* corresponds to the year prior to the implementation of the project activity
Source of data:	Onsite measurements
Measurement procedures (if any):	Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases, blow-down and any condensate returns. 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 In case of equipment that produces hot water/oil this is expressed as difference in the enthalpy between the hot water/oil supplied to and returned by the plant In case of equipment that produces hot gases or combustion gases, this is expressed as difference in the enthalpy between the hot gas produced and all streams supplied to the plant. The enthalpy of all relevant streams shall be determined based on the mass flow, temperature, pressure, density and specific heat of the gas
Any comment:	If the three most recent historical years prior to the implementation of the project activity are not representative for the situation at the project site (e.g. a drought in one year, an equipment or plant not operating during a certain year for technical reasons, etc), project participants may alternatively select the five most recent historical years from which one year may be excluded if deviating significantly from other years. The selection by project participants should be documented in the CDM-PDD and be applied to all relevant provisions and equations throughout this methodology in a consistent manner, including the applicability condition

Data / Parameter:	$BF_{k,n}/BF_{k,n-1}/BF_{k,n-2}$
Data unit:	Tons of dry matter or liter[7]
Description:	Quantity of biomass residue type *k* fired in all heat generation equipment at the project site during the historical year *n*, *n-1* or *n-2*, where *n* corresponds to the year prior to implementation of the project activity
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight or volume meters. Adjust for the moisture content in order to determine the quantity of dry biomass. The quantity shall be cross-checked with the quantity of heat generated and any fuel purchase receipts (if available)
Any comment:	If the three most recent historical years prior to the implementation of the project activity are not representative for the situation at the project site (e.g. a drought in one year, equipment not operating during a certain year for technical reasons, etc), project participants may alternatively select the five most recent historical years from which one year may be excluded if deviating significantly from other years. The selection by project participants should be documented in the CDM-PDD and be applied to all relevant provisions and equations throughout this methodology in a consistent manner, including the applicability condition

Data / Parameter:	$FC_{i,n}/FC_{i,n-1}/FC_{i,n-2}$
Data unit:	Mass or volume unit[8]
Description:	Quantity of fossil fuel type *i* fired in all heat generation equipment at the project site during the historical year *n*, *n-1* or *n-2*, where *n* corresponds to the year prior to implementation of the project activity
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight or volume meters. The quantity shall be cross-checked with the quantity of heat generated and any fuel purchase receipts (if available)
Any comment:	If the three most recent historical years prior to the implementation of the project activity are not representative for the situation at the project site (e.g. a drought in one year, an equipment not operating during a certain year for technical reasons, etc), project participants may alternatively select the five most recent historical years from which one year may be excluded if deviating significantly from other years. The selection by project participants should be documented in the CDM-PDD and be applied to all relevant provisions and equations throughout this methodology in a consistent manner, including the applicability condition

Data / Parameter:	-
Data unit:	MWh
Description:	Highest historical electricity generation at the project site during the most recent three years prior to the implementation of the project activity
Source of data:	On-site measurements
Measurement procedures (if any):	-
Any comment:	Required to assess the applicability condition referring to power generation at the project site

III. MONITORING METHODOLOGY

Monitoring procedures

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.

Data and parameters monitored

Data / Parameter:	$EF_{FF,CO2,y}$
Data unit:	tCO_2e/GJ
Description:	CO_2 emission factor of the fossil fuel type displaced by biomass residues for the 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 annual data
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, collect additional information or conduct additional measurements
Any comment:	For the purpose of determining $EF_{FF,CO2,y}$, as a conservative approach, the least carbon intensive fuel type should be used among the fossil fuels types used at the project site during the most recent 3 years prior to the implementation of the project activity and the fossil fuels used in the equipment at the project site due the year *y*

Data / Parameter:	$HG_{PJ,total,y}$
Data unit:	GJ/yr
Description:	Total heat generated in all heat generation equipment at the project site, using both biomass residues and fossil fuels, during the year *y*
Source of data:	On-site measurements

Measurement procedures (if any):	Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases blow-down and any condensate returns. 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 In case of equipment that produces hot water/oil this is expressed as difference in the enthalpy between the hot water/oil supplied to and returned by the plant. In case of equipment that produces hot gases or combustion gases, this is expressed as difference in the enthalpy between the hot gas produced and all streams supplied to the plant. The enthalpy of all relevant streams shall be determined based on the monitored mass flow, temperature, pressure, density and specific heat of the gas
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	The consistency of metered net heat generation should be cross-checked with the quantity of biomass and/or fossil fuels fired (e.g. check whether the net heat generation divided by the quantity of fuel fired results in a reasonable thermal efficiency that is comparable to previous years)
Any comment:	The parameters mass flow, temperature, pressure, density and specific heat of the gas, shall be monitored

Data / Parameter:	$BF_{k,y}$
Data unit:	Tons of dry matter or liter[7]
Description:	Quantity of biomass residue type *k* fired in all units of heat generation equipment at the project site during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight or volume meters. Adjust for the moisture content in order to determine the quantity of dry biomass. The quantity shall be crosschecked with the quantity of heat generated and any fuel purchase receipts (if available)
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	The quantity of biomass combusted should be collected separately for all types of biomass

Data / Parameter:	Moisture content of the biomass residues
Data unit:	% Water content
Description:	Moisture content of each biomass residue type *k*
Source of data:	On-site measurements
Measurement procedures (if any):	-

Monitoring frequency:	The moisture content should be monitored for each batch of biomass of homogeneous quality The weighted average should be calculated for each monitoring period and used in the calculations
QA/QC procedures:	-
Any comment:	In case of dry biomass, monitoring of this parameter is not necessary

Data / Parameter:	$FC_{i,y}$
Data unit:	Mass or volume unit[8]
Description:	Quantity of fossil fuel type *i* fired in all heat generation equipment at the project site during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	The quantity of fossil fuels combusted should be collected separately for all types of fossil fuels

Data / Parameter:	$EC_{PJ,y}$
Data unit:	MWh
Description:	On-site electricity consumption attributable to the project activity during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use electricity meters. The quantity shall be cross-checked with electricity purchase receipts
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Cross-check measurement results with invoices for purchased electricity if available
Any comment:	-

Data / Parameter:	$EF_{grid,y}$
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor for electricity used from the grid
Source of data:	Use the "Tool to calculate the emission factor for an electricity system" to calculate the grid emission factor
Measurement procedures (if any):	-
Monitoring frequency:	Either once at the start of the project activity or updated annually, consistent with guidance provided in the tool
QA/QC procedures:	As per the guidance provided in the tool
Any comment:	All data and parameters to determine the grid electricity emission factor, as required by the tool, shall be included in the monitoring plan

Data / Parameter:	NCV_i
Data unit:	GJ/mass or volume unit
Description:	Net calorific value of fossil fuel type *i*
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 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, collect additional information or conduct additional measurements
Any comment:	-

Data / Parameter:	NCV_k
Data unit:	GJ/ton of dry matter or GJ/liter
Description:	Net calorific value of biomass residue type *k*
Source of data:	Measurements/calculations
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards. Measure/calculate the NCV based on dry biomass
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:	$EF_{CH4,BF}$
Data unit:	kg CH_4 / TJ
Description:	CH_4 emission factor for the combustion of the biomass residues in the heat generation equipment
Source of data:	On-site measurements or default values, as provided in Table 4
Measurement procedures (if any):	The CH_4 emission factor may be determined based on a stack gas analysis using calibrated analyzers
Monitoring frequency:	At least quarterly, taking at least three samples per 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
Any comment:	Monitoring of this parameter for project emissions is only required if CH_4 emissions from biomass combustion are included in the project boundary. Note that a conservative factor shall be applied, as specified in the baseline methodology

Data / Parameter:	$EF_{burning,CH4,k,y}$
Data unit:	tCH_4/GJ
Description:	CH_4 emission factor for uncontrolled burning of the biomass residue type *k* during the year *y*
Source of data:	Undertake measurements or use referenced and reliable default values (e.g. IPCC)
Measurement procedures (if any):	-
Monitoring frequency:	Review of default values: annually Measurements: once at the start of the project activity
QA/QC procedures:	Cross-check the results of any measurements with IPCC default values. If there is a significant difference, check the measurement method and increase the number of measurements in order to verify the results
Any comment:	Monitoring of this parameter for project emissions is only required if CH_4 emissions from biomass combustion are included in the project boundary. Note that a conservative factor shall be applied, as specified in the baseline methodology

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:	-

Data / Parameter:	-
Data unit:	-
Description:	Demonstration that the biomass residue type *k* from a specific source would continue not to be collected or utilized, e.g. by an assessment whether a market has emerged for that type of biomass residue (if yes, leakage is assumed not be ruled out) or by showing that it would still not be feasible to utilize the biomass residues for any purposes
Source of data:	Information from the site where the biomass is generated
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Monitoring of this parameter is applicable if approach L_1 is used to rule out leakage

Data / Parameter:	-
Data unit:	Tons
Description:	Quantity of biomass residues of type *k* or *m* that are utilized (e.g. for energy generation or as feedstock) in the defined geographical region
Source of data:	Surveys or statistics
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Monitoring of this parameter is applicable if approach L_2 is used to rule out leakage or if approach L_4 is used in combination with approach L_2 to rule out leakage for the substituted biomass residue type *m*

Data / Parameter:	-
Data unit:	Tons
Description:	Quantity of available biomass residues of type *k* or *m* in the region
Source of data:	Surveys or statistics
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Monitoring of this parameter is applicable if approach L_2 is used to rule out leakage or if approach L_4 is used in combination with approach L_2 to rule out leakage for the substituted biomass residue type *m*

Data / Parameter:	-
Data unit:	-
Description:	Availability of a surplus of biomass residue type *k* or *m* (which can not be sold or utilized) at the ultimate supplier to the project (or, in case of L_4, the former user of the biomass residue type *k*) and a representative sample of other suppliers in the defined geographical region
Source of data:	Surveys
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Monitoring of this parameter is applicable if approach L_3 is used to rule out leakage or if approach L_4 is used in combination with approach L_3 to rule out leakage for the substituted biomass residue type *m*

Data / Parameter:	$FC_{former\ user,m,y}$
Data unit:	Mass or volume unit[8]
Description:	Quantity of fuel type *m* used by the former user of the biomass residue type *n* during the year *y*, where the fuel type m is either (i) a fuel type other than a biomass residue (e.g. fossil fuel or biomass other than biomass residues) or (ii) a biomass residues for which leakage can not be ruled out with approaches L_2 or L_3
Source of data:	Former consumer of the biomass residue type *k*
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Monitoring of this parameter is applicable if approach L_4 is used to rule out leakage

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:	On-site measurements
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant 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:	-
Data unit:	MWh
Description:	Electricity generation during the year *y* at the project site
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Monitoring of this parameters is only required if power is generated at the project site. In this case, monitoring is needed to assess whether the applicability condition referring to power generation at the project site is met

IV. REFERENCES AND ANY OTHER INFORMATION

Not applicable.

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History of the Document

Version	Date	Nature of revision(s)
04.0.0	EB 66, Annex 38 2 March 2012	Revision in order to incorporate reference to the tools: • "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of a crediting period"; • "Tool for project and leakage emissions from road transportation of freight". In addition, the leakage section was modified, providing for a simpler procedure, and some minor editorial improvements were made.
03	EB 51, Annex 6 04 December 2009	Revision to: • Revise the applicability of the methodology to cover a broader range of heat generation equipment in addition to boilers; • References to the latest approved methodological tools were included; • To insert the correct sectoral scopes; • To clarify monitoring requirement of moisture of biomass; • To clarify that NCV of biomass can be calculated and need not only be measured; • Several minor editorial revisions were made.
02.2	EB 48, Annex 8 17 July 2009	Editorial revision to clarify that: (i) in the case of fossil fuels co-fired with biomass, the fossil fuel amount shall not exceed 50% of the total fuel fired on an energy basis; and (ii) for the purpose of this methodology, refuse derived fuel / refuse plastic fuel (RDF/RPF) should be considered as fossil fuels.
02.1	EB 41, Paragraph 26(g) 02 August 2008	The title of the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" changes to "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
02	EB 33, Annex 9 27 July 2007	Revision to correct an oversight where in the avoidance of methane emissions from anaerobic decay of biomass is credited even for that fraction of biomass, which is identified as not being surplus and thus would not have been dumped and thereby not causing methane emissions.

01	EB 26, Annex 3 29 September 2006	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		