Approved baseline and monitoring methodology AM0036

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

I. SOURCE AND APPLICABILITY

Source

This baseline and monitoring methodology is based on the 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 NM0134rev: "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.

For more information regarding this methodology and its consideration by the Executive Board please refer to the cases on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

This methodology also refers to the latest version of the "*Tool for the demonstration and assessment of additionality*"[1] and the "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*".

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 also 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 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*** refers to heat that is utilized (e.g. steam or hot gases used for processes). Waste heat is not covered under the definition of Heat for the purpose of this is methodology.

[1] Please refer to: < http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

Efficiency of heat generation is defined as 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 that is representative for different loads and operation modes, including start-ups (e.g. one year). In case of several boilers, the average efficiency of heat generation in these boilers corresponds respectively to the heat generated by all boilers divided by the quantity of fuel fired in all boilers (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 existing and, where applicable new, boilers. 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 boilers.** The project activity is the retrofit of (an) existing boiler(s). The retrofit is made to the boiler(s) 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 boilers without a retrofit or replacement of the boilers.
2	**Replacement of existing boilers.** The project activity involves the replacement of (an) existing boiler(s) by new boiler(s) that fire(s) mainly or solely biomass residues (some fossil fuels may be co-fired). 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 boilers without a retrofit or replacement of the boilers.
3	**Installation of new boilers.** The project activity is to increase of the heat generation capacity by installation of new boilers(s) that fire(s) mainly or solely biomass residues (some fossil fuels may be co-fired). 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 boiler(s) or the installation of a new boiler. The procedure to determine the most plausible baseline scenario results in that the same fossil fuel type(s), as used in the existing boiler(s), would be used in the new boiler(s) in the absence of the CDM project activity. The use of biomass residues in the new boiler(s) involves a significant additional capital investment in either a new dedicated biomass 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 in the boiler (i.e. enabling the use of biomass residues instead of fossil fuels).
4	**Installation of new boilers and retrofit and/or replacement of existing boilers.** The project activity involves : • (a) **<u>increase</u>** the heat generation capacity by installation of new boiler(s) that fire(s) mainly or solely biomass residues (some fossil fuels may be co-fired); and • (b) the retrofit of (an) existing boiler(s) and/or the replacement of (an) existing boiler(s) by new boiler(s) that fire(s) mainly or solely biomass residues (some fossil fuels may be co-fired). The use of biomass residues or an increase in the use of biomass residues beyond historical

Scenario	Description
	levels would not be technically possible without a retrofit or replacement of the existing boiler(s) or the installation of a new boiler. The procedure to determine the most plausible baseline scenario results in that the same fossil fuel type(s) as used in the existing boiler(s) would be used in the new boiler(s) in the absence of the CDM project activity. The use of biomass residues in the new boiler(s) involves a significant additional capital investment in either a new dedicated biomass 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 in the boiler (i.e. enabling the use of biomass residues instead of fossil fuels).

The project activity may be based on the operation of (a) heat generation boiler(s):

- In an agro-industrial plant generating the biomass residues, which is used in the activity; or
- In an independent plant where the biomass residues are procured from the nearby area or a market.

The methodology is applicable under the following conditions:

- The heat generated in the boiler(s) is
  - ❖ Not used for power generation; or
  - ❖ If power is generated with heat from the boilers, it is not increased as a result of the project activity, i.e,
    - a) site, the power generation capacity installed remains unchanged due to the implementation of the project activity and this power generation capacity is maintained at the pre-project level throughout the crediting perio; 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 replacements of existing boilers or the installation of new boilers;
  - ❖ Or in a new dedicated biomass 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).
- Existing boilers at the project site have used no biomass or have used only biomass residues (but no other type of biomass) for heat generation during the most recent three years[2] prior to the implementation of the project activity.
- No biomass types other than *biomass residues*, as defined above, are used in the boiler(s) during the crediting period (some fossil fuels may be co-fired);
- 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

[2] 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 boiler 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.

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, site where the project activity is implemented, should 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 boiler(s), all boiler(s) existing at the project site prior to the implementation of the project activity should be able to operate until the end of the crediting period without any retrofitting or replacement, i.e. the remaining technical lifetime of each existing boiler should at the start of the crediting period be larger than the duration of the crediting period (7 or 10 years as applicable). For the purpose of demonstrating this applicability condition, project participants should determine and document the typical average technical lifetime of boilers in the country and sector in a conservative manner, taking into account common practices in the sector and country. This may be done based on industry surveys, statistics, technical literature, historical replacement records of boilers in the company, etc. The age of the existing boiler(s) and the average technical lifetime of boilers in the country and sector should be documented in the CDM-PDD.

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; and
  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 available version of the "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*", in addition to the above listed applicability conditions, apply if:

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

Project activities covered by the methodology are classified in the following CDM project sectoral scope categories:

Sectoral scope 1: Energy industries (Renewable- / non-renewable sources)
Sectoral scope 4: Manufacturing industries

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 equipment, but shall not include fossil fuels co-fired in the boiler(s).
- CO_2 emissions from off-site transportation of biomass residues that are combusted in the boiler(s) to the project site.

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 boilers 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 boilers 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 boiler(s) and related equipment at the project site; and
- The means for transportation of biomass residues to the project site (e.g. vehicles), and,
- 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 in boilers for heat generation	CO_2	Yes	
		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	
		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	
		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.

STEP 1. 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 boiler(s) using the same fuel mix or less biomass residues as in the past
H3 Continued operation of the existing boiler(s) using a different fuel (mix)
H4 Improvement of the performance of the existing boiler(s)
H5 Continued operation of the existing boiler(s) using the same fuel mix or less biomass residues as in the past AND installation of (a) new boiler(s) that is/are fired with the same fuel type(s) and the same fuel mix (or a lower share of biomass) as the existing boiler(s)
H6 Replacement of the existing boiler(s) with new boiler(s)

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.
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

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 use 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[3] – 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 boilers.

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 version of the "*Tool for the demonstration and assessment of additionality*".

Since 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 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

[3] 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)"

attractive combination of alternatives for heat generation and use of biomass residues are deemed as the most plausible baseline scenario.

Additionality

Project participants should use the latest approved version of the "*tool for 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 boilers 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:

$$BE_y = BE_{HG,y} + BE_{BF,y} \quad \textbf{(1)}$$

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 boiler(s) (tCO_2 /yr)
$BE_{BF,y}$	=	Baseline emissions due to uncontrolled burning or decay of the biomass residues (tCO_2e/yr)

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

Baseline emissions from fossil fuel combustion in the boiler(s) 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 boiler(s), as follows:

$$BE_{HG,y} = \frac{HG_{PJ,biomass,y} \cdot EF_{FF,CO2,y}}{\eta_{boiler,FF}} \quad \textbf{(2)}$$

Where:

$BE_{HG,y}$	=	Baseline emissions from fossil fuel combustion for heat generation in the boiler(s) (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 (tCO_{2e} /GJ)
$\eta_{boiler,FF}$	=	Average net efficiency of heat generation in the boiler(s) when fired with fossil fuels

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 boilers at the project site during the most recent three years[2] prior to the implementation of the project activity and the fossil fuel types used in boilers at the project site during the year 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[2] 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 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 boiler(s), taking into account all biomass residue types *k* and fossil fuel types *i* fired in the project boilers during a year *y*, as follows:

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

Where:

$HG_{PJ,biomass,total,y}$	=	Total heat generated from firing biomass residues in all boilers at the project site during the year *y* (GJ/yr)
$HG_{PJ,total,y}$	=	Total heat generated in boilers 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 boiler(s) at the project site during the year *y* (tons of dry matter or liter)[4]
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 boiler(s) at the project site during the year y (mass or volume unit)[5]

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

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

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 boilers 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[2] prior to the implementation of the project activity, as follows:

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

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 boilers at the project site during the year y (GJ/yr)
$HG_{biomass,historic,n}$	=	Historical annual heat generation from firing biomass residues in boilers 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 boilers 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[2], as follows:

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

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 boilers at the project site during the year y (GJ/yr)
$HG_{PJ,total,y}$	=	Total heat generated in boilers 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 boilers 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 boilers 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 boiler(s) 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 boilers 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 boilers at the project site during the year *n* (GJ/yr)
$BF_{k,n}$	=	Quantity of biomass residue type *k* used in all boiler(s) at the project site during the historical year *n* (tons of dry matter or liter)[4]
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 boiler(s) at the project site during the historical year *n* (mass or volume unit)[5]
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[2] 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 boiler(s) 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)[4]
$BF_{k,y}$	=	Quantity of biomass residue type *k* fired in all boiler(s) at the project site during the year *y* (tons of dry matter or liter)[4]
$HG_{PJ,biomass,y}$	=	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 boilers 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)[4]
$BF_{k,y}$	=	Quantity of biomass residue type *k* fired in all boiler(s) at the project site during the year *y* (tons of dry matter or liter)[4]
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 boilers 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 (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)[4]
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)

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 $EF_{burning,CH4,k,y}$.[6]

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 3 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

[6] 2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.

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 to determine methane emissions avoided from dumping waste at a solid waste disposal site*". The variable $BE_{CH4,SWDS,y}$ calculated by the tool corresponds to $BE_{BF,y}$ in this methodology. Use the respective quantities of biomass residues that are prevented from anaerobic decay ($BF_{PJ,k,y}$ or fractions of it) as the waste quantities prevented from disposal ($W_{j,x}$) in the tool.
tool.

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 boiler(s) 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 boiler(s) (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 by multiplying the fossil fuels consumption with appropriate net calorific values and CO_2 emission factors, as follows:

$$PE_{CO2,FF,y} = \sum_i FC_{on-site,i,y} \cdot NCV_i \cdot EF_{CO2,FF,i} \quad \textbf{(11)}$$

Where:

$PE_{CO2,FF,y}$	=	CO_2 emissions from on-site fossil fuel combustion attributable to the project activity (tCO_2/yr)
$FC_{on-site,i,y}$	=	Quantity of fossil fuel type *i* combusted at the project site for purposes other than heat generation as a result of the project activity during the year *y* (mass or volume unit)[5]

NCV_i = Net calorific value of the fossil fuel type *i* (GJ / mass or volume unit)
$EF_{CO2,FF,i}$ = CO_2 emission factor for fossil fuel type *i* (tCO_2/GJ)
$FC_{on\text{-}site,i,y}$ should not include fossil fuels co-fired in the boiler(s) but should include all other fossil fuel consumption at the project site that is attributable to the project activity, such as for on-site transportation or treatment of the biomass residues.

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:

$$PE_{CO2,EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \quad \textbf{(12)}$$

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). Use ACM0002 to calculate the grid emission factor. If electricity consumption ($EC_{PJ,y}$) is less than 15 GWh/yr, the average grid emission factor (including all grid-connected power plants) may be used.

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

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. In many cases 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).

<u>Option 1:</u>

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

$$PE_{CO2,TR,y} = N_y \cdot AVD_y \cdot EF_{km,CO2} \quad \textbf{(13)}$$

or

$$PE_{CO2,TR,y} = \frac{\sum_k BF_{PJ,k,y}}{TL_y} \cdot AVD_y \cdot EF_{km,CO2,y} \quad \textbf{(14)}$$

Where:
$PE_{CO2,TR,y}$ = CO_2 emissions from off-site transportation of biomass residues to the project site (tCO_2/yr)
N_y = Number of truck trips during the year *y*

AVD_y = Average round trip distance (from and to) between the biomass fuel supply sites and the site of the project plant during the year *y* (km)
$EF_{km,CO2,y}$ Average CO_2 emission factor for the trucks measured during the year y (tCO_2/km)
$BF_{PJ,k,y}$ = Quantity of 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)[4]
TL_y = Average truck load of the trucks used (tons or liter)

Option 2:

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

$$PE_{CO2,TR,y} = \sum_i FC_{TR,i,y} \cdot NCV_i \cdot EF_{CO2,FC,i} \quad \textbf{(15)}$$

Where:
$PE_{CO2,TR,y}$ = CO_2 emissions from off-site transportation of biomass residues to the project site (tCO_2/yr)
$FC_{TR,i,y}$ = Fuel consumption of fuel type *i* in trucks for transportation of biomass residues during the year *y* (mass or volume unit)[5]
$EF_{CO2,FF,i}$ = CO_2 emission factor for fossil fuel type *i* (tCO_2/GJ)

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

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

$$PE_{CH4,BF,y} = EF_{CH4,BF} \cdot \sum_k BF_{PJ,k,y} \cdot NCV_k \quad \textbf{(16)}$$

Where:
$PE_{CH4,BF,y}$ = CH_4 emissions from combustion of biomass residues in the boiler(s) (tCH_4/yr)
$EF_{CH4,BF}$ = CH_4 emission factor for the combustion of the biomass residues in the boilers (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)[4]
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 2 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[7]

	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%

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.

Project participants shall demonstrate that the use of the biomass residues does not result in increased use of fossil fuels or other GHG emissions elsewhere. For this purpose, project participants shall assess as part of the monitoring the supply situation for each types of biomass residue *k* used in the project plant. Table 6 below outlines the options that may be used to demonstrate that the biomass residues used in the plant did not increase fossil fuel consumption or other GHG emissions elsewhere.

Which approach should be used depends on the most plausible baseline scenario for the use of the biomass residues. Where scenarios B1, B2 or B3 apply, use approaches L_1, L_2 or L_3. Where scenario B4 applies, use approaches L_2 or L_3. Where scenario B5 applies, use approach L_4.

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

Table 6. Approaches to rule out leakage

L_1	Demonstrate that at the sites where the project activity is supplied from with biomass residues, 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 the implementation of the project activity. Demonstrate that this practice would continue in the absence of the CDM project activity, e.g. by showing that in the monitored period no market has emerged for the biomass residues considered or by showing that it would still not be feasible to utilize the biomass residues for any purposes (e.g. due to the remote location where the biomass residue is generated).
L_2	Demonstrate that there is an abundant surplus biomass residue of the in the region of the project activity which is not utilized. For this purpose, demonstrate that the quantity of available biomass residues of type *k* in the region is at least 25% larger than the quantity of biomass residues of type *k* that are utilized (e.g. for energy generation or as feedstock), including the project plant.
L_3	Demonstrate that suppliers of the type of biomass residue in the region of the project activity are not able to sell all of their biomass residues. For this purpose, project participants shall demonstrate that the ultimate supplier of the biomass residue (who supplies the project) and a representative sample of suppliers of the same type of biomass residue in the region had a surplus of biomass residues (e.g. at the end of the period during which biomass residues are sold), which they could not sell and which are not utilized.
L_4	Identify the consumer that would use the biomass residue in the absence of the project activity (e.g. the former consumer). Demonstrate that this consumer has substituted the biomass residue diverted to the project with other types of biomass residues (and not with fossil fuels or other types of biomass than biomass residues[8]) by showing that the former user only fires biomass residues for which leakage can be ruled out using approaches L_2 or L_3. Provide credible evidence and document the types and amounts of biomass residues used by the former user as replacement for the biomass residue fired in the project activity and apply approaches L_2 or L_3 to these types of biomass residues. Demonstrate that the substitution of the biomass residues used in the project activity with other types of biomass residues does not require a significant additional energy input except for the transportation of the biomass residues.

Where project participants wish to use approaches L_2, L_3 or L_4 to assess leakage effects, they shall clearly define the geographical boundary of the region and document it in the CDM-PDD. In defining the geographical boundary of the region, project participants should take the usual distances for biomass residue transports into account, i.e. if biomass residues are transported up to 50 km, the region may cover a radius of 50 km around the project activity. In any case, the region should cover a radius around the project activity of at least 20 km but not more than 200 km. Once defined, the region should not be changed during the crediting period(s).

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

[8] The generation of other types of biomass than biomass residues may be involved with significant GHG emissions, for example, from cultivation or harvesting.

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

$$LE_y = EF_{CO2,LE} \cdot \sum_n BF_{LE,n,y} \cdot NCV_n \quad \textbf{(17)}$$

Where:

LE_y	=	Leakage emissions during the year *y* (tCO_2/yr)
$EF_{CO2,LE}$	=	CO_2 emission factor of the most carbon intensive fuel used in the country (tCO_2/GJ)
$BF_{LE,n,y}$	=	Quantity of biomass residue type *n* used for heat generation as a result of the project activity during the year *y* and for which leakage can not be ruled out using one of the approaches L_1, L_2, L_3 or L_4 (tons of dry matter or liter)[4]
NCV_n	=	Net calorific value of the biomass residue type *n* (GJ/ton of dry matter or GJ/liter)
n	=	Biomass residue type *n* for which leakage can not be ruled out using one of the approaches L_1, L_2, L_3 or L_4

In case of approaches L_1, $BF_{LE,n,y}$ corresponds to the quantity of biomass residue type *n* that is obtained from the relevant source or sources.

In case of approaches L_2 or L_3, $BF_{LE,n,y}$ corresponds to the quantity of biomass residue type *k* used for heat generation as a result of the project activity during the year *y* ($BF_{LE,n,y} = BF_{PJ,k,y}$, where $n=k$).

In case of approach L_4, $\left(BF_{LE,n,y} \cdot NCV_n\right)$ corresponds to the lower value of

(a) The quantity of fuel types *m*, expressed in energy quantities, that are used by the former user of the biomass residue type *k* and for which leakage can not be ruled out because the fuels used are either (i) fuels types other than biomass residues (e.g. fossil fuels or biomass types other than biomass residues) or (ii) are biomass residues but leakage can not be ruled out for those types of biomass residues with approaches L_2 or L_3; as follows:

$$BF_{LE,n,y} \cdot NCV_n = \sum_m FC_{former\ user,m,y} \cdot NCV_m \quad \textbf{(18)}$$

Where:

$BF_{LE,n,y}$	=	Quantity of biomass residue type *n* used for heat generation as a result of the project activity during the year *y* and for which leakage can not be ruled out using approach L_4 (tons of dry matter or liter)[4]
NCV_n	=	Net calorific value of the biomass residue type *n* (GJ/ton of dry matter or GJ/liter)
n	=	Biomass residue type *n* for which leakage can not be ruled out using approach L_4
$FC_{former\ user,m,y}$	=	Quantity of fuel type *m* used by the former user of the biomass residue type *n* during the year *y* (mass or volume unit)[5]
NVC_m		Net calorific value of fuel type *m* (GJ/ton of dry matter or GJ/liter)
m	=	Fuel type *m*, being 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

(b) The quantity of biomass residue type *k*, expressed in energy quantities, used for heat generation as a result of the project activity during the year *y* ($BF_{LE,n,y} = BF_{PJ,k,y}$, where $n=k$).

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(19)}$$

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 2nd and 3rd crediting periods

Consistent with guidance by the Executive Board, project participants shall assess the continued validity of the baseline and update the baseline.

In order to assess the continued validity of the baseline, project participants should apply the procedure to determine the most plausible baseline scenario, as outlined above, for both heat generation and the use of biomass residues. The crediting period may only be renewed if the application of the procedure results in that the baseline scenarios determined for heat generation and the use of biomass residues in the CDM-PDD still apply.

Furthermore, in case of project activities that involve the replacement or retrofit of existing boiler(s), the crediting period shall only be renewed if the boiler(s) existing at the project site prior to the implementation of the project activity are still able to operate until the end of the crediting period for which renewal is requested without any retrofitting or replacement, i.e. the remaining technical lifetime of each existing boiler at the start of the project activity, as documented in the CDM-PDD, should be larger than the duration of the previous crediting period(s) and the crediting period for which renewal is requested (14 or 21 years).

No other data needs to be updated at the renewal of the crediting period.

Data and parameters not monitored

Data / parameter:	$\eta_{boiler,FF}$
Data unit:	-
Description:	Average net efficiency of heat generation in the boiler(s) when fired with fossil fuels
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 boiler 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:	$\mathbf{HG_{biomass,historic,n}}$ / $\mathbf{HG_{biomass,historic,n-1}}$ / $\mathbf{HG_{biomass,historic,n-2}}$
Data unit:	GJ
Description:	Historical annual heat generation from firing biomass residues in boilers 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 water generated by the boiler(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:	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 boiler 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:	$\mathbf{BF_{k,n}}$ / $\mathbf{BF_{k,n-1}}$ / $\mathbf{BF_{k,n-2}}$
Data unit:	Tons of dry matter or liter[4]
Description:	Quantity of biomass residue type *k* fired in all boiler(s) 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, a boiler 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:	$\mathbf{FC_{i,n}}$ / $\mathbf{FC_{i,n-1}}$ / $\mathbf{FC_{i,n-2}}$
Data unit:	Mass or volume unit[5]
Description:	Quantity of fossil fuel type *i* fired in all boiler(s) 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, a boiler 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:	$\mathbf{EF_{CO2,FF,I}}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor for 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 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):	
Any comment:	

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:	$\mathbf{EF_{FF,CO2,y}}$
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 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:	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 boilers at the project site due the year *y*.

Data / parameter:	$\mathbf{HG_{PJ,total,y}}$
Data unit:	GJ/yr
Description:	Total heat generated in all boilers at the project site, firing 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 water generated by the boiler(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.

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:	

Data / parameter:	**$BF_{k,y}$**
Data unit:	Tons of dry matter or liter[4]
Description:	Quantity of biomass residue type *k* fired in all boiler(s) 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:	Continuously, mean values calculated at least annually
QA/QC procedures:	
Any comment:	In case of dry biomass, monitoring of this parameter is not necessary.

Data / parameter:	**$FC_{i,y}$**
Data unit:	Mass or volume unit[5]
Description:	Quantity of fossil fuel type *i* fired in all boiler(s) 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:	**$FC_{on\text{-}site,i,y}$**
Data unit:	Mass or volume unit[5]
Description:	Quantity of fossil fuel type *i* combusted at the project site for other purposes than

	heat generation as a result of project activity during the year *y*
Source of data:	On-site measurements or purchase receipts
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).
Monitoring frequency:	At least annually
QA/QC procedures:	
Any comment:	$FC_{on-site,i,y}$ should not include fossil fuels co-fired in the boiler(s) but should include all other fossil fuel consumption at the project site that is attributable to the project activity, such as for on-site transportation or treatment of biomass residues.

Data / parameter:	$\mathbf{EC_{PJ,y}}$
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:	$\mathbf{EF_{grid,y}}$
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor for electricity used from the grid
Source of data:	Use ACM0002 to calculate the grid emission factor. If electricity consumption ($EC_{PJ,y}$) is less than 15 GWh/yr, the average grid emission factor (including all grid-connected power plants) may be used.
Measurement procedures (if any):	
Monitoring frequency:	Either once at the start of the project activity or updated annually, consistent with guidance in ACM0002
QA/QC procedures:	Apply procedures in ACM0002
Any comment:	All data and parameters to determine the grid electricity emission factor, as required by ACM0002, shall be included in the monitoring plan.

Data / parameter:	$\mathbf{N_y}$
Data unit:	-
Description:	Number of truck trips during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	Check consistency of the number of truck trips with the quantity of biomass combusted.
Any comment:	Project participants have to monitor either this parameter or the average truck

	load TL_y.

Data / parameter:	**TL_y**
Data unit:	Tons or liter
Description:	Average truck load of the trucks used
Source of data:	On-site measurements
Measurement procedures (if any):	Determined by averaging the weights of each truck carrying biomass to the project plant
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	-
Any comment:	Project participants have to monitor either the number of truck trips N_y or this parameter.

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

Data / parameter:	**$FC_{TR,i,y}$**
Data unit:	Mass or volume unit[5]
Description:	Fuel consumption of fuel type *i* in trucks for transportation of biomass residues during the year *y*
Source of data:	Fuel purchase receipts or fuel consumptions meters in the trucks
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	Cross-checked the resulting CO_2 emissions for plausibility with a simple calculation based on the distance approach (option 1).
Any comment:	This parameter only needs to be monitored if option 2 is chosen to estimate CO_2 emissions from transportation.

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

Data / parameter:	**$EF_{CH4,BF}$**
Data unit:	tCH_4/GJ
Description:	CH_4 emission factor for the combustion of the biomass residues in the boilers
Source of data:	On-site measurements or default values, as provided in Table 2.

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:	$\mathbf{EF_{burning,CH4,k,y}}$
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:	$\mathbf{EF_{CO2,LE}}$
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[5]
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_m**
Data unit:	GJ/ton of dry matter or GJ/liter
Description:	Net calorific value of fuel type *m*
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:	
Any comment:	Monitoring of this parameter is applicable if approach L_4 is used to rule out leakage

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.