Approved consolidated baseline and monitoring methodology ACM0006

"Consolidated methodology electricity generation from biomass residues"

I. SOURCE AND APPLICABILITY

Sources

This consolidated methodology is based on elements from the following methodologies:

- AM0004: "Grid-connected Biomass Power-Generation that avoids uncontrolled burning of biomass" which is based on the A.T. Biopower Rice Husk Power Project in Thailand whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Mitsubishi Securities;
- AM0015: "Bagasse-based cogeneration connected to an electricity grid" which is based on the Vale do Rosário Bagasse Cogeneration project in Brazil, whose baseline study, monitoring and verification plan and project design document were prepared by Econergy International Corporation;
- NM0050: "Ratchasima SPP Expansion Project in Thailand" whose baseline study, monitoring and verification plan and project design document were prepared by Agrinergy Limited;
- NM0081: "Trupán biomass cogeneration project in Chile" whose baseline study, monitoring and verification plan and project design document were prepared by Celulosa Arauco y Constitutción S.A;
- NM0098: "Nobrecel Fossil-to-Biomass Fuel Switch Project in Brazil", whose baseline study, monitoring and verification plan and project design document were prepared by Nobrecel S.A.Celulose e Papel and Ecosecurities Ltd.

For more information regarding the proposals and their consideration by the Executive Board please refer to http://cdm.unfccc.int/goto/MPappmeth.

This methodology also refers to the latest approved version of:

- ACM0002 ("Consolidated baseline methodology for grid-connected electricity generation from renewable sources");
- "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site";
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"; and
- "Tool to calculate project emissions from electricity consumption.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"

or

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

Definitions

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

- **Biomass.** 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.** *Biomass residues* are defined as *biomass* that is a by-product, residue or waste stream from agriculture, forestry and related industries. This shall not include municipal waste or other wastes that contain fossilized and/or non-biodegradable material (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.** *Heat* is defined as useful thermal energy that is generated in a heat generation facility (e.g. a boiler, a cogeneration plant, thermal solar panels) and transferred to a heat carrier (e.g. hot liquids, gases or steam) for utilization in thermal applications and processes other than power generation. Heat does not include waste heat, i.e. heat that is transferred to the environment without utilization, including heat in the flue gas, heat transferred to cooling towers or any other heat losses. Note that heat refers to the *net* quantity of thermal energy that is transferred to a heat carrier at the heat generation facility. For example, in case of a boiler it refers to the difference of the enthalpy of the steam generated in the boiler and the enthalpy of the feed water and, if applicable, any condensate return.

- **Power plant.** A *power plant* is a facility for the generation of electric power from thermal energy from combustion of a fuel. Mechanical power is produced by a heat engine, which transforms the thermal energy from combustion of the fuel into rotational energy. The rotational energy is transformed into electric power in a generator. A power plant includes all equipment necessary to generate power from combustion of fuels, including, inter alia, the boiler in case of power generation from steam, the heat engine (e.g. a turbine or motor), the generator, any cooling equipment (e.g. a cooling tower). Power plants can include cogeneration plants and plants without cogeneration.

- **Cogeneration plant.** A *cogeneration plant* (also combined heat and power plant or CHP plant) is a power plant that simultaneously generates both electric power and *heat*. It includes the same components as a power plant and, where applicable, separate heat recovery equipment.

- **Net quantity of electricity generation.** The *net* quantity of electricity generation is the power generation by the relevant plant minus the auxiliary electricity required for the operation of the power plant (e.g. pumps, vans, flue gas treatment, control equipment, etc).

- **Efficiency.** *Efficiency of electricity generation* is defined as the net quantity of electricity ~~produced~~ generated per quantity of fuel fired in the relevant power plant (both expressed in the same energy units). In case of boilers or cogeneration plants, the *efficiency of heat generation* is defined as the quantity of heat generated per quantity of fuel fired in the boiler or cogeneration plant (both expressed in the same energy units). The *average* efficiency of electricity (or heat) generation refers to the efficiency 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 plants, the average efficiency of electricity (heat) generation in these plants corresponds respectively to the electricity (heat) generated by all plants divided by the quantity of fuel fired in all plants (both expressed in the same energy units).

Applicability

This consolidated methodology covers a number of different project types for power generation with biomass residues. Where a combination of project activity and baseline scenario is not covered by this methodology, project participants are encouraged to submit proposals for revision or further amendment of this consolidated methodology.

This methodology is applicable to *biomass residue* fired electricity generation project activities, including cogeneration plants.

The project activity may include the following activities or combinations of these activities:

- The installation of a new biomass residue fired power plant at a site where currently no power generation occurs (**greenfield power projects**); or
- The installation of a new biomass residue fired power plant, which replaces or is operated next to existing power plants fired with either fossil fuels or the same type of biomass residue as in the project plant (**power capacity expansion projects**); or
- The improvement of energy efficiency of an existing power plant (**energy efficiency improvement projects**), e.g. by retrofitting the existing plant or by installing a more efficient plant that replaces the existing plant; or
- the replacement of fossil fuels by biomass residues in an existing power plant (**fuel switch projects**).

The project activity may be based on the operation of a power plant located in an agro-industrial plant generating the biomass residues or as an independent plant supplied by biomass residues coming from the nearby area or a market.

The methodology is applicable under the following conditions:

- No other biomass types than *biomass residues*, as defined above, are used in the project plant and these biomass residues are the predominant fuel used in the project plant (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 capacity of raw input (e.g. sugar, rice, logs, etc.) or in other substantial changes (e.g. product change) in this process;
- The biomass residues used by the project facility 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) ~~or that treat waste that results~~

~~from the preparation of the biomass residues (e.g. from drying the biomass mechanically) under anaerobic conditions are not eligible under this methodology~~.

It is further noted that the methodology is only applicable for the combinations of project activities and baseline scenarios identified in Table 2 below.

II. BASELINE METHODOLOGY

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

Project participants shall identify the most plausible baseline scenario and demonstrate additionality using the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality", agreed by the CDM Executive Board, available at the UNFCCC CDM web site.[1]

In applying Step 1 of the tool, realistic and credible alternatives should be separately determined regarding:

- How **power** would be generated in the absence of the CDM project activity;
- Wwhat would happen to the **biomass residues** in the absence of the project activity; and
- In case of cogeneration projects: how the **heat** would be generated in the absence of the project activity.

For **power** generation, the realistic and credible alternatives may include, *inter alia*:

P1 The proposed project activity not undertaken as a CDM project activity.

P2 The continuation of power generation in an existing biomass residue fired power plant at the project site, in the same configuration, without retrofitting and fired with the same type of biomass residues as (co-)fired in the project activity.

P3 The generation of power in an existing captive power plant, using only fossil fuels.

P4 The generation of power in the grid.

P5 The installation of a **new** biomass residue fired power plant, fired with the same type and with the same annual amount of biomass residues as the project activity, but with a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project plant and therefore with a lower power output than in the project case.

P6 The installation of a **new** biomass residue fired power plant that is fired with the same type but with a higher annual amount of biomass residues as the project activity and that has a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project activity. Therefore, the power output is the same as in the project case.

P7 The **retrofitting** of an existing biomass residue fired power, fired with the same type and with the same annual amount of biomass residues as the project activity, but with a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project plant and therefore with a lower power output than in the project case.

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

P8 The **retrofitting** of an existing biomass residue fired power that is fired with the same type but with a higher annual amount of biomass residues as the project activity and that has a lower efficiency of electricity generation (e.g. an efficiency that is common practice in the relevant industry sector) than the project activity.

P9 The installation of a **new** fossil fuel fired captive power plant at the project site.

If the proposed project activity is the **cogeneration** of power and heat, project participants shall define the most plausible baseline scenario for the generation of heat. For **heat** generation, realistic and credible alternative(s) may include, *inter alia*:

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

H2 The proposed project activity (installation of a cogeneration power plant), fired with the same type of biomass residues but with a different efficiency of heat generation (e.g. an efficiency that is common practice in the relevant industry sector)

H3 The generation of heat in an existing captive cogeneration plant, using only fossil fuels

H4 The generation of heat in boilers using the same type of biomass residues

H5 The continuation of heat generation in an existing biomass residue fired cogeneration plant at the project site, in the same configuration, without retrofitting and fired with the same type of biomass residues as in the project activity

H6 The generation of heat in boilers using fossil fuels

H7 The use of heat from external sources, such as district heat

H8 Other heat generation technologies (e.g. heat pumps or solar energy)

For the use of **biomass residues**, the realistic and credible alternative(s) 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[2] or left to decay on fields.

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

B4 The biomass residues are used for heat and/or electricity generation at the project site

B5 The biomass residues are used for power generation, including cogeneration, in other existing or new grid-connected power plants[3]

[2] 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.

[3] For example, this may be a likely scenario where the biomass has prior to the project implementation been sold in a market and where electricity generation with that biomass type is common practice in the respective region.

B6 The biomass residues are used for heat generation in other existing or new boilers at other sites[4]

B7 The biomass residues are used for other energy purposes, such as the generation of biofuels

B8 The biomass residues are used for non-energy purposes, e.g. as fertilizer or as feedstock in processes (e.g. in the pulp and paper industry)

Where the project activity uses different types of biomass residues, the baseline scenario should be identified for each type of biomass residue separately. Biomass residues from different sources should be considered as different types of biomass residues *k*. Similarly, biomass residues with different uses in the absence of the project activity should be considered as different types of biomass residues *k*. Explain and document transparently in the CDM-PDD for each type of biomass residue which quantities are used in which installations under the project activity and how these types and quantities of biomass residue would be used in the absence of the project activity, preferably using a table.

Subsequently, all credible **combinations** of baseline scenarios for power, heat and biomass use should be identified and documented as part of step 1 of the tool. These combinations should be considered in applying the following steps of the tool.

In cases where realistic and credible alternative(s) include the installation of **new** power and/or heat generation facilities at the project site – other than the proposed project activity – the economically most attractive technology and fuel type should be identified among those which provide the same service (i.e. the same heat quantity), technologically that are available and that are in compliance with relevant regulations. The efficiency of the technology and the fuel type should be selected in a conservative manner, i.e. where several technologies and/or fuel types could be used and are similarly economically attractive, the least carbon intensive fuel type / the most efficient technology should be considered.

This methodology is only applicable if one of the scenarios described in Table 2 below results to be the most plausible baseline scenario. Explain in the CDM-PDD the specific situation of the project activity and demonstrate that the project activity and the most plausible baseline scenario corresponds to the "description of the situation" in Table 2 and to the combination of baseline scenarios for power (P1 to P9), heat (H1 to H8) and biomass use (B1 to B8), as indicated under the respective scenario in Table 2 below. For this purpose, project participants should document in the CDM-PDD

- For each power plant that was operating at the project site during the most recent three years prior to the start of the project activity: the type and capacity of the power plant, types and quantities fuels have been used in the power plant during the most recent three years prior to the start of the project activity and whether the plant continues operation after the start of the project activity;
- For each boiler or other heat generation equipment that was operating at the project site during the most recent three years prior to the start of the project activity: the type and capacity of the boiler, types and quantities of fuels have been used in the boiler during the most recent three years prior to the start of the project activity and whether the boiler continues operation after the start of the project activity;
- For each boiler or power plant installed under the project activity: the type and capacity of boilers and/or power plants and which types and quantities of fuels are planned to be used;

[4] For example, this may be a likely scenario where the biomass has prior to the project implementation been sold in a market and where heat generation with that biomass type is common practice in the respective region.

- For each new boiler or power plant that would be installed in the absence of the project activity: the type and capacity of the new boilers and/or power plants and which types and quantities of fuels would be used.

In addition, project participants should check whether the procedures to calculate emission reductions work appropriately for the project specific context. If the equations do not fully fit with the context of the project, **a revision or deviation to this methodology should be requested.**

Table 1 below aims at facilitating project participants in identifying the scenario that may be applicable to their project activity. Note that only it is not possible to combine different scenarios but that only one single scenario can be applied for one CDM project activity.

Table 1: Indicative applicability of different scenarios

Scenario	Historic power generation			Cogeneration		Biomass use in the baseline			Heat generation in the baseline (in case of cogeneration projects)				
	no power generation	with biomass residues	with fossil fuels	Applicable to cogeneration projects	Applicable to projects without cogeneration	Dumped, left to decay or burned (B1, B2 or B3)	Use at the project site (B4)	Use at other sites (B5)	Cogeneration with biomass residues (H2 or H5)	Cogeneration with fossil fuels (H3)	Boiler with biomass residues (H4)	Boiler with fossil fuels (H6)	External sources or other technologies (H7 or H8)
1	x			x	x			x				x	x
2	x			x	x	x						x	x
3	x			x		x	x				x		
4	x			x	x		x		x				
5			x		x	x							
6			x		x			x					
7			x	x		x				x			
8			x	x				x		x			
9		x			x			x					
10		x		x	x	x						x	x
11		x		x	x		x		x				
12		x		x			x				x		
13		x		x	x		x		x				
14		x		x	x		x		x				
15			x	x	x	x				x			
16		x		x		x	x				x	x	
17			x	x		x						x	x
18		x		x			x		x				
19		x		x			x		x				
20	x			x		x	x				x	x	

Table 2: Combinations of project types and baseline scenarios applicable to this methodology

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
1	P4	B5	H6 or H7 or H8[5]	The project activity involves the installation of a new biomass residue fired power plant at a site where no power was generated prior to the implementation of the project activity. The power generated by the project plant is fed into the grid or would in the absence of the project activity be purchased from the grid. The biomass residues would in the absence of the project activity be used in power plants at other sites. This may apply, for example, if the biomass residues are purchased from a market or would be sold to a market in the absence of the project activity and if power generation is the main use of biomass residues in the country/region. In case of cogeneration plants, the heat would in the absence of the project activity be generated in boilers fired with fossil fuels, or by other means not involving the biomass residues. This may apply, for example, where prior to the project implementation heat has been generated in boilers using fossil fuels.
2	P4	B1 or B2 or B3	H6 or H7 or H8[5]	The project activity involves the installation of a new biomass residue fired power plant at a site where no power was generated prior to the implementation of the project activity. The power generated by the project plant is fed into the grid or would in the absence of the project activity be purchased from the grid. The biomass residues would in the absence of the project activity be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. In case of cogeneration plants, the heat would in the absence of the project activity be generated in boilers fired with fossil fuels, or by other means not involving the biomass residues. This may apply, for example, where prior to the project implementation heat has been generated in boilers using fossil fuels.

[5] Note that procedures to calculate baseline emissions are only provided for option H6. As a simple and conservative assumption, project participants may still use this methodology for options H7 and H8 assuming conservatively that baseline emissions from heat generation are zero.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
3	P4	(B1 or B2 or B3) and B4	H4	The project activity involves the installation of a new biomass residue fired cogeneration plant at a site where no power was generated prior to the implementation of the project activity. The power generated by the project plant is fed into the grid or would in the absence of the project activity be purchased from the grid. The biomass residues would in the absence of the project activity (a) be used for heat generation in boilers at the project site and (b) be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. This may apply, for example, where the quantity of biomass residues that was not needed for heat generation was dumped, left to decay or burnt in an uncontrolled manner prior to the project implementation. The heat generated by the new cogeneration plant would in the absence of the project activity be generated in boilers using the biomass residues that are fired in the cogeneration plant.
4	P5 and P4	B4	H2	The project activity involves the installation of a new biomass residue fired power plant at a site where no power was generated prior to the implementation of the project activity. In the absence of the project activity, a new biomass residue fired power plant (in the following referred to as "reference plant") would be installed instead of the project activity at the same site and with the same thermal firing capacity but with a lower efficiency of electricity generation as the project plant (e.g. by using a low-pressure boiler instead of a high-pressure boiler). The same type and quantity of biomass residues as in the project plant would be used in the reference plant. Consequently, the power generated by the project plant would in the absence of the project activity be generated (a) in the reference plant and – since power generation is larger in the project plant than in the reference plant – (b) partly in power plants in the grid. In case of cogeneration projects, the following conditions apply: The reference plant would also be a cogeneration plant; the heat generated by the project plant would in the absence of the project activity be generated in the reference plant; the efficiency of heat generation in the project plant is smaller or the same compared to the reference plant.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
5	P3 and P4	B1 or B2 or B3	NA	The project activity involves the installation of a new biomass residue fired power plant (no cogeneration plant) at a site where prior to the implementation of the project activity an existing fossil fuel fired power plant (no cogeneration plant) has been operated. After the implementation of the project activity, the existing fossil fuel fired power plant either (a) continues to be operated next to the new biomass residue fired power plant (e.g. as back-up plant) or (b) could continue to be operated (i.e. it is fully operational and has a remaining technical lifetime) but is retired due to the installation of the new biomass residue fired power plant. The power generated by the project plant (a) would in the absence of the project activity be generated in the existing fossil fuel fired plant and may partly (b) be fed into the grid or be purchased from the grid in the absence of the project activity. The biomass residues are only used in the project plant and would in the absence of the project activity be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes.
6		B5	NA	The project activity involves the installation of a new biomass residue fired power plant (no cogeneration plant) at a site where prior to the implementation of the project activity an existing fossil fuel fired power plant (no cogeneration plant) has been operated. After the implementation of the project activity, the existing fossil fuel fired power plant either (a) continues to be operated next to the new biomass residue fired power plant (e.g. as back-up plant) or (b) could continue to be operated (i.e. it is fully operational and has a remaining technical lifetime) but is retired due to the installation of the new biomass residue fired power plant. The power generated by the project plant (a) would in the absence of the project activity be generated in the existing fossil fuel fired plant and may partly (b) be fed into the grid or be purchased from the grid in the absence of the project activity. The biomass residues that are used in the project plant would in the absence of the project activity be used in power plants at other sites. This may apply, for example, if the biomass residues are purchased from a market or would be sold to a market in the absence of the project activity and if power generation is the main use of biomass residues in the country/region.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
7	P3 and P4	B1 or B2 or B3	H3	The project activity involves the installation of a new biomass residue fired cogeneration plant at a site where prior to the implementation of the project activity an existing fossil fuel fired cogeneration plant has been operated. After the implementation of the project activity, the existing fossil fuel fired cogeneration plant either (a) continues to be operated next to the new biomass residue fired cogeneration plant (e.g. as back-up plant) or (b) could continue to be operated (i.e. it is fully operational and has a remaining technical lifetime) but is retired due to the installation of the new biomass residue fired cogeneration plant. The power generated by the project plant (a) would in the absence of the project activity be generated in the existing fossil fuel fired plant and may partly (b) be fed into the grid or be purchased from the grid in the absence of the project activity. The heat generated by the project plant would in the absence of the project activity be generated in the existing fossil fuel fired cogeneration plant (the thermal efficiency of the project plant and the existing fossil fuel fired cogeneration plant is similar, i.e. the difference is less than 5%). The biomass residues are only used in the project plant and would in the absence of the project activity be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes.
8		B5	H3	The project activity involves the installation of a new biomass residue fired cogeneration plant at a site where prior to the implementation of the project activity an existing fossil fuel fired cogeneration plant has also been operated. After the implementation of the project activity, the existing fossil fuel fired cogeneration plant either (a) continues to be operated next to the new biomass residue fired cogeneration plant (e.g. as back-up plant) or (b) could continue to be operated (i.e. it is fully operational and has a remaining technical lifetime) but is retired due to the installation of the new biomass residue fired cogeneration plant. The power generated by the project plant (a) would in the absence of the project activity be generated in the existing fossil fuel fired plant and may partly (b) be fed into the grid or be purchased from the grid in the absence of the project activity. The heat generated by the project plant would in the absence of the project activity be generated in the existing fossil fuel fired cogeneration plant (the thermal efficiency of the project plant and the existing fossil fuel fired cogeneration plant is similar, i.e. the difference is less than 5%). The biomass residues that are used in the project plant would in the absence of the project activity be used in power plants at other sites. This may apply, for example, if the biomass residues are purchased from a market or would be sold to a market in the absence of the project activity and if power generation is the main use of biomass residues in the country/region.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
9	P4	B5	NA	The project activity involves the installation of a new biomass residue fired power plant (no cogeneration), which is operated next to (an) existing biomass residue fired power plant(s) (no cogeneration plants). The existing plants(s) are only fired with biomass residues and continue to operate after the installation of the new power plant. The power generated by the new power plant is fed into the grid or would in the absence of the project activity be purchased from the grid. The biomass residues would in the absence of the project activity be used in power plants at other sites. This may apply, for example, if the biomass residues are purchased from a market or would be sold to a market in the absence of the project activity and if power generation is the main use of biomass residue in the country/region.
10	P4	B1 or B2 or B3	H6 or H7 or H8[5]	The project activity involves the installation of a new biomass residue fired power plant, which is operated next to (an) existing biomass residue fired power plant(s). The existing plant(s) are only fired with biomass residues and continue to operate after the installation of the new power plant. The power generated by the new power plant is fed into the grid or would in the absence of the project activity be purchased from the grid. The biomass residues would in the absence of the project activity be dumped or left to decay or burned in an uncontrolled manner without utilizing it for energy purposes. In case of cogeneration plants, the heat would in the absence of the project activity be generated in on-site boilers fired with fossil fuels, or by other means not involving the biomass residues. This may apply, for example, where prior to the project implementation heat has been generated in boilers using fossil fuels.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
11	P4 and P2	B4	H5	The project activity involves the installation of a new biomass residue fired power plant, which is operated next to (an) existing biomass residue fired power plant(s). The existing power plant(s) are only fired with biomass residues. After the implementation of the project activity, the existing power plant(s) either (a) continue to operate next to the new power plant (e.g. as back-up plant) or (b) could continue to be operated (i.e. the plant(s) are fully operational and have a remaining technical lifetime) but are retired due to the installation of the new biomass residue fired power plant. The efficiency of electricity generation is higher in the new power plant than in the existing plant(s). The biomass residues would in the absence of the project activity be used in the existing power plant(s) at the project site. Consequently, the power generated by the new power plant would in the absence of the project activity be generated (a) in the existing plant(s) and – since power generation is more efficient in the project plant than in the existing plant(s) – (b) partly in power plants in the grid. In case where the project plant is a cogeneration plant, the following conditions apply: The existing power plant(s) are also cogeneration plants; the heat generated by the project plant would in the absence of the project activity be generated in the existing cogeneration plant(s); the efficiency of heat generation in the project plant is smaller or the same compared to the existing cogeneration plant(s).
12	P4	B4	H4	The project activity involves the installation of a new biomass residue fired cogeneration plant, which is operated next to (an) existing biomass residue fired power plant(s). The existing plant(s) are only fired with biomass residues and continue to operate after the installation of the new cogeneration plant. The power generated by the new cogeneration plant is fed into the grid or would in the absence of the project activity be purchased from the grid. The biomass residues fired in the project plant would in the absence of the project activity be used for heat generation in boilers at the project site. This may apply, for example, where the biomass residues haves been used for heat generation in boilers at the project site prior to the project implementation. The heat generated by the new cogeneration plant would in the absence of the project activity mainly be generated in boilers at the project site.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
13	P5 and P4	B4	H2	The project activity involves the installation of a new biomass residue fired power plant, which is operated next to (an) existing biomass residue fired power plant(s). The existing plant(s) are only fired with biomass residues and continue to operate after the installation of the new power plant. In the absence of the project activity, a new biomass residue fired power plant (in the following referred to as "reference plant") would be installed instead of the project activity at the same site and with the same thermal firing capacity but with a lower efficiency of electricity generation as the project plant (e.g. by using of a low-pressure boiler instead of a high-pressure boiler). The same type and quantity of biomass residues as in the project plant would be used in the reference plant. Consequently, the power generated by the project plant would in the absence of the project activity be generated (a) in the reference plant and – since power generation is larger in the project plant than in the reference plant – (b) partly in power plants in the grid. In case of cogeneration projects, the following conditions apply: The reference plant would also be a cogeneration plant; the heat generated by the project plant would in the absence of the project activity be generated in the reference plant; the efficiency of heat generation in the project plant is smaller or the same compared to the reference plant.
14	P4 and P2	B4	H5	The project activity involves the improvement of energy efficiency of an existing biomass residue fired power plant by retrofit or replacement of the existing biomass residue fired power plant at a site where no other power plants are operated. The retrofit or replacement increases the power generation capacity, while the thermal firing capacity is maintained. In the absence of the project activity, the existing power plant would continue to operate without significant changes. The same type and quantity of biomass residues as in the project plant would in the absence of the project activity be used in the existing plant. Consequently, the power generated by the project plant would in the absence of the project activity be generated (a) in the same plant (without project implementation) and – since power generation is larger due to the energy efficiency improvements – (b) partly in power plants in the grid. In case of cogeneration plants, the heat generated by the project plant would in the absence of the project activity be generated in the same plant. The efficiency of heat generation is smaller or the same after the implementation of the project activity.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
15	P3	B1 or B2 or B3	H3	The project activity involves the partial or complete fuel switch from fossil fuels to biomass residues at an existing power plant at the project site. Prior to the implementation of the project activity, only fossil fuels have been used in the existing power plant. The biomass residues are not used in any other facilities at the project site for power or heat generation and would in the absence of the project activity be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. The power and, in case of cogeneration plants, heat generated by the project plant would in the absence of the project activity be generated in the same plant, only using fossil fuels.
16	P4 (and P2)[6]	B4 (and B1 or B2 or B3)[7]	H4 and / or H6	The project activity involves the installation of a new biomass residue fired cogeneration plant, which is operated next to (an) existing biomass residue fired power plant(s). The existing plant(s) are only fired with biomass residues and continue to operate in the same manner after installation of the new power plant. The power generated by the project plant would in the absence of the project activity be generated (a) mostly in power plants in the grid (i.e. the power generated by the new power plant is fed into the grid or would in the absence of the project activity be purchased from the grid) and may (b) to a small extent be generated in the existing power plant(s). The biomass residues would in the absence of the project activity (partly) be used for heat generation in boilers at the project site and may, in addition, partly be used in the existing power plant(s) and/or partly be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. This may apply, for example, where prior to the project implementation the biomass residues were used in boilers for heat generation and in power plants for electricity generation and where the project activity involves the use of additional biomass residue quantities that would in the absence of the project activity be dumped, left to decay or burnt in an uncontrolled manner. The heat generated by the project plant would in the absence of the project activity be generated in on-site boilers fired (a) partly with the biomass residues that are used in the project plant and (b) partly with fossil fuels. This may apply, for example, where prior to the implementation of the project activity heat has been generated in boilers using both fossil fuels and biomass residues.

[6] Scenario P2only applies if biomass generated in the existing power plant would be diverted to the project plant or if steam generated with the existing plant would be diverted to the project plant as a result of the project activity.
[7] Scenarios B1, B2 or B3 only apply if biomass is fired in the project plant that would in the absence of the project activity be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
17	P3 and P4	B1 or B2 or B3	H6 or H7 or H8[5]	The project activity involves the installation of a new biomass residue fired cogeneration plant at a site where prior to the implementation of the project activity an existing fossil fuel fired power plant (no cogeneration plant) has been operated. After the implementation of the project activity, the existing fossil fuel fired power plant either (a) continues to be operated next to the new biomass residue fired cogeneration plant (e.g. as back-up plant) or (b) could continue to be operated (i.e. it is fully operational and has a remaining technical lifetime) but is retired due to the installation of the new biomass residue fired power plant. The power generated by the project plant (a) would in the absence of the project activity be generated in the existing fossil fuel fired plant and may partly (b) be fed into the grid or be purchased from the grid in the absence of the project activity. The biomass residues are only used in the project plant and would in the absence of the project activity be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. The heat would in the absence of the project activity be generated in on-site boilers fired with fossil fuels, or by other means not involving the biomass residues. This may apply, for example, where prior to the project implementation heat has been generated in boilers using fossil fuels.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
18	P5 and P4	B4	H2	The project activity involves the replacement of an existing biomass residue fired power plant by a new biomass residue fired power plant. The replacement increases the power generation capacity. In the absence of the project activity, the existing plant would also be replaced by a new biomass residue fired power plant (referred to as "reference plant"), however, this reference plant would have a lower efficiency of electricity generation than the project plant (e.g. by using a low-pressure boiler instead of a high-pressure boiler). The same type and quantity of biomass residues as in the project plant would be used in the reference plant. Consequently, the power generated by the project plant would in the absence of the project activity be generated (a) in the reference plant and – since power generation is larger in the project plant than in the reference plant – (b) partly in power plants in the grid. The new project plant has the same technical lifetime as the reference plant. In case of cogeneration projects, the following conditions apply: The reference plant would also be a cogeneration plant; the heat generated by the project plant would in the absence of the project activity be generated in the reference plant; the efficiency of heat generation in the project plant is smaller or the same compared to the reference plant.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
19	P7 and P4	B4	H2	The project activity involves the improvement of energy efficiency by retrofitting an existing biomass residue fired power plant by retrofit. The retrofit increases the power generation capacity. In the absence of the project activity, the existing plant would also be retrofitted, but resulting in a lower efficiency of electricity generation than in the project case (e.g. by using a low-pressure boiler instead of a high-pressure boiler). The retrofitted plant in the baseline is referred to as “reference plant”. In the reference plant, the same type and quantity of biomass residues would be used as in the project plant. Consequently, the power generated by the project plant would in the absence of the project activity be generated (a) in the retrofitted baseline plant and – since power generation is larger in the project plant than in the baseline plant – (b) partly in power plants in the grid. The remaining technical lifetime of the project plant and the baseline plant is the same, i.e. the retrofit in the project case and in the baseline case do not affect the remaining lifetime of the plant or affect it similarly. In case of cogeneration projects, the following conditions apply: The reference plant would also be a cogeneration plant; the heat generated by the project plant would in the absence of the project activity be generated in the reference plant; the efficiency of heat generation in the project plant is smaller or the same compared to the reference plant.

Scenario	Baseline scenario			Description of the situation
	Power	Biomass	Heat (if relevant)	
20	P9	B4 and (B1 or B2 or B3)	H4 (and H6)	The project activity involves the installation of a new biomass residue fired cogeneration plant at a site where no power was generated prior to the implementation of the project activity. The project plant is a captive cogeneration plant that provides electricity and heat to captive users at the project site. In the absence of the project activity, a new fossil fuel fired captive power plant (in the following referred to as "reference plant") without cogeneration but with the same rated power capacity as the project plant would be installed instead of the project plant at the same site. The biomass residues would in the absence of the project activity (a) partly be used for heat generation in boilers at the project site and (b) partly be dumped or left to decay or burnt in an uncontrolled manner without utilizing them for energy purposes. This may apply, for example, where the quantity of biomass residues that was not needed for heat generation was dumped, left to decay or burnt in an uncontrolled manner prior to the project implementation or where one type of biomass residues would also be used in the absence of the project activity, whereas, another type of biomass residue would be dumped, left to decay or burnt in an uncontrolled manner. The heat generated by the project plant would in the absence of the project activity be generated in on-site boilers using (a) the same biomass residues as fired in the project plant, and, where applicable, (b) partly using fossil fuels. This may apply, for example, where prior to the implementation of the project activity heat has been generated in boilers using both fossil fuels and biomass residues.

NA = not applicable

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 includes fossil fuels co-fired in the project plant, fossil fuels used for on-site transportation or fossil fuels or electricity used for the preparation of the biomass residues, e.g., the operation of shredders or other equipment, as well as any other sources that are attributable to the project activity; and
- CO_2 emissions from off-site transportation of biomass residues that are combusted in the project plant; and
- where applicable, CH_4 emissions from anaerobic treatment of wastes originating from the treatment of the biomass residues prior to their combustion.

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

- CO_2 emissions from fossil fuel fired power plants at the project site and/or connected to the electricity system; and
- CO_2 emissions from fossil fuel based heat generation that is displaced through the project activity.

Where the most likely baseline scenario for the biomass residue use 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 in the project boundary. Project participants shall either include CH_4 emissions from 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 power plant at the project site;
- the means for transportation of biomass residues to the project site (e.g. vehicles);
- all power plants connected physically to the electricity system that the CDM project power plant is connected to. The spatial extent of the project electricity system, including issues related to the calculation of the build margin (BM) and operating margin (OM), is further defined in the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002).
- The site where the biomass residues would have been left for decay or dumped. This is applicable only to cases where the biomass residues would in the absence of the project activity be dumped or left to decay.

Table 3 illustrates which emissions sources are included and which are excluded from the project boundary for determination of both baseline and project emissions.

Table 3: Overview on emissions sources included in or excluded from the project boundary

	Source	Gas		Justification / Explanation
Baseline	Electricity generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Heat generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Uncontrolled burning or decay of surplus biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	To be decided by project participants	Project participants may decide to include this emission source, where case B1, B2 or B3 has been identified as the most likely baseline scenario.[a]
		N_2O	Excluded	Excluded for simplification. This is conservative. Note also that emissions from natural decay of biomass are not included in GHG inventories as anthropogenic sources.[a]
Project Activity	On-site fossil fuel and electricity consumption due to the project activity (stationary or mobile)	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.[b]
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.[b]
	Off-site transportation of biomass residues	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.[b]
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.[b]
	Combustion of biomass residues for electricity and / or heat generation	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included or excluded	This emission source must be included if CH_4 emissions from uncontrolled burning or decay of biomass residues in the baseline scenario are included.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small.
	Storage of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	Excluded for simplification. Since biomass residues are stored for not longer than one year, this emission source is assumed to be small.
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small.

	Waste water from the treatment of biomass residues	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Included	This emission source shall be included in cases where the waste water is treated (partly) under anaerobic conditions.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small.

Notes to the table:

a. Note that the emission factors for CH_4 and N_2O emissions from uncontrolled burning or decay of dumped biomass residues are highly uncertain and depend on many site-specific factors. Quantification is difficult and may increase transaction costs significantly. Note also that CH_4 and N_2O emissions from the natural decay or uncontrolled burning are in some cases (e.g. natural decay of forest residues) not anthropogenic sources of emissions included in Annex A of the Kyoto Protocol and should not be included in the calculation of baseline emissions pursuant to paragraph 44 of the modalities and procedures for the CDM.

b. CH_4 and N_2O emission factors depend significantly on the technology (e.g. vehicle type) and may be difficult to determine for project participants. Exclusion of this emission source is not a conservative assumption; however, it appears reasonable, since CH_4 and N_2O from on-site use of fossil fuels and transportation are expected to be very small compared to overall emission reductions, and since it simplifies the determination of emission reductions significantly.

Emission Reductions

The project activity mainly reduces CO_2 emissions through substitution of power and heat generation with fossil fuels by energy generation with biomass residues. The emission reduction ER_y by the project activity during a given year y is the difference between the emission reductions through substitution of electricity generation with fossil fuels ($ER_{electricity,y}$), the emission reductions through substitution of heat generation with fossil fuels ($ER_{heat,y}$), project emissions (PE_y), emissions due to leakage (L_y) and, where this emission source is included in the project boundary and relevant, baseline emissions due to the natural decay or burning of anthropogenic sources of biomass residues ($BE_{biomass,y}$), as follows:

$$ER_y = ER_{heat,y} + ER_{electricity,y} + BE_{biomass,y} - PE_y - L_y \quad \textbf{(1)}$$

Where:

ER_y	= Emissions reductions of the project activity during the year y (tCO_2/yr)
$ER_{electricity,y}$	= Emission reductions due to displacement of electricity during the year y (tCO_2/yr)
$ER_{heat,y}$	= Emission reductions due to displacement of heat during the year y (tCO_2/yr)
$BE_{biomass,y}$	= Baseline emissions due to natural decay or burning of anthropogenic sources of biomass residues during the year y (tCO_2e/yr)
PE_y	= Project emissions during the year y (tCO_2/yr)
L_y	= Leakage emissions during the year y (tCO_2/yr)

Lifetime aspects

In case of scenarios 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16 and 17 a power plant was already operated at the project site prior to the implementation of the project activity. In this case, the existing plant could be retired at the start of the project activity because it is replaced by the project plant (this could be applicable in scenarios 5, 6, 7, 8, 11, 14, 17) or may initially be operated in parallel to the project plant and be retired at a future point in time (at the end of its lifetime).

Similarly, in case of scenarios 1, 2, 3, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16 and 17, heat may already have been generated at the project site prior to the implementation of the project activity. The existing heat generation facility (e.g. boilers or a cogeneration plant) could be retired at the start of the project activity because it is replaced by the project plant or could initially be operated in parallel to the project plant and be retired at a future point in time (at the end of its lifetime).

Consistent with guidance by EB08 and EB22, in these cases, a baseline based on historical performance only applies until the existing power plant or heat generation facility would have been replaced or retrofitted in the absence of the project activity. From that point of time, a different baseline shall apply.

Project participants should determine the age and the average technical lifetime of any existing power plant and/or heat generation facilities, taking into account common practices in the sector and country. The average technical lifetime may be determined based on industry surveys, statistics, technical literature or the practices of the responsible company regarding replacement schedules, e.g. based on historical replacement records for similar equipment. The average technical lifetime should be chosen in conservative manner, i.e. the earliest point in time should be chosen in cases where only a time frame can be estimated, and should be documented and justified in the CDM-PDD.

Emission reductions may only be accounted until the existing power plant(s) or heat generation facilities would have reached its technical lifetime, i.e. until the age of the existing plant(s) or heat generation facilities would reach the average technical lifetime of such plant types or facilities in the sector and country, as determined above.[8]

Project emissions

Project emissions include

- CO_2 emissions from transportation of biomass residues to the project site (PET_y),
- CO_2 emissions from on-site consumption of fossil fuels due to the project activity ($PEFF_y$),
- CO_2 emissions from consumption of electricity ($PE_{EC,y}$),
- where this emission source is included in the project boundary and relevant: CH_4 emissions from the combustion of biomass residues ($PE_{Biomass,CH4,y}$), and
- where waste water from the treatment of biomass residues degrades under anaerobic conditions: CH_4 emissions from waste water.

Project emissions are calculated as follows:

$$\sout{PE_y = PET_y + PEFF_y + PE_{EC,y} + GWP_{CH4} \cdot PE_{Biomass,CH4,y}}$$

$$PE_y = PET_y + PEFF_y + PE_{EC,y} + GWP_{CH4} \cdot \left(PE_{Biomass,CH4,y} + PE_{WW,CH4,y}\right) \quad \textbf{(2)}$$

[8] The main rationale is that at the end of the lifetime of the existing plant, it is uncertain by what type of technology and fuel the existing plant would be replaced. In many cases, it is a reasonable assumption that the existing plant would at the end of its lifetime be replaced by a technology with the same or similar performance as the technology installed as part of the project activity. For example, where the existing plant uses a low-pressure boiler and the project uses a high pressure boiler, it is a reasonable assumption that at the end of the lifetime of the existing plant it would be replaced with a high-pressure boiler.

Where:

PET_y = CO_2 emissions during the year *y* due to transport of the biomass residues to the project plant (tCO_2/yr)

$PEFF_{,y}$ = CO_2 emissions during the year *y* due to fossil fuels co-fired by the generation facility or other fossil fuel consumption at the project site that is attributable to the project activity (tCO_2/yr)

$PE_{EC,y}$ = CO_2 emissions during the year *y* due to electricity consumption at the project site that is attributable to the project activity (tCO_2/yr)

GWP_{CH4} = Global Warming Potential for methane valid for the relevant commitment period

$PE_{Biomass,CH4,y}$ = CH_4 emissions from the combustion of biomass residues during the year *y* (tCH_4/yr)

$PE_{WW,CH4,y}$ = CH_4 emissions from waste water generated from the treatment of biomass residues in year *y* (tCH_4/yr)

a) Carbon dioxide emissions from combustion of fossil fuels for transportation of biomass residues to the project plant (PET_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).

Option 1:

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

$$PET_y = N_y \cdot AVD_y \cdot EF_{km,CO2,y} \quad \textbf{(3)}$$

or

$$\sout{PET_y = \frac{\sum_k BF_{k,y}}{TL_y} \cdot AVD_y \cdot EF_{km,CO2,y}} \quad PET_y = \frac{\sum_k BF_{T,k,y}}{TL_y} \cdot AVD_y \cdot EF_{km,CO2,y} \quad \textbf{(4)}$$

Where:

PET_y = CO_2 emissions during the year *y* due to transport of the biomass residues to the project plant (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 residue 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)

$BF_{T,k,y}$ = Quantity of biomass residue type *k* that has been transported to the project site ~~combusted in the project plant~~ during the year *y* (tons of dry matter or liter)[9]

TL_y = Average truck load of the trucks used (tons or liter)during the year *y*.

k = Types of biomass residues used in the project plant and that have been transported to the project plant in year *y*

[9] Use tons of dry matter for solid biomass residues and liter for liquid biomass residues.

Option 2:

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

$$PET_y = \sum_i FC_{TR,i,y} \cdot NCV_i \cdot EF_{CO2,FC,i} \quad PET_y = \sum_i FC_{TR,i,y} \cdot NCV_i \cdot EF_{CO2,FF,i} \tag{5}$$

Where:

PET_y	=	CO_2 emissions during the year *y* due to transport of the biomass residues to the project plant (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 per year)[10]
NCV_i	=	Net calorific value of 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)
i	=	Fossil fuel types used for transportation of the biomass residues to the project plant in year *y*

b) Carbon dioxide emissions from on-site consumption of fossil fuels (*$PEFF_y$*)

The proper and efficient operation of the biomass residue fired power plant may require using some fossil fuels, e.g. for start-ups or during winter operation (when biomass humidity is too high) or for the preparation or on-site transportation of the biomass residues. Project participants may also co-fire fossil fuels to a limited extent in order to enhance the economic performance of the plant.[11] In addition, any other fuel consumption at the project site that is attributable to the project activity should be taken into account (e.g. for mechanical preparation of the biomass residues).

CO_2 emissions from on-site combustion of fossil fuels (*$PEFF_y$*) should be calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". –The type of fuel combustion that should be considered ~~calculation of these emissions~~ depends on the scenario from Table 2 that has been identified.

Scenarios 1 to 14 and 16 to ~~19~~20

In these scenarios, ~~CO_2 emissions from combustion of respective fuels are calculated~~ project emissions should be determined for the following two combustion processes *j*:

- Fossil fuels combusted in the project plant during the year *y* (*$FF_{project\ plant,i,y}$*);
- Fossil fuels combusted at the project site for other purposes that are attributable to the project activity during year *y* (*$FF_{project\ site,i,y}$*).

~~as follows:~~

$$PEFF_y = \sum_i \left(FF_{project\ plant,i,y} + FF_{project\ site,i,y}\right) \cdot NCV_i \cdot EF_{CO2,FF,i} \tag{6}$$

~~Where:~~

~~$FF_{project\ plant,i,y}$ = Quantity of fossil fuel type *i* combusted in the project plant during the year *y*~~

[10] Preferably use a mass unit for solid fuels and a volume unit for liquid and gaseous fuels.
[11] Note the applicability conditions of this methodology.

(mass or volume unit per year)[10]

$FF_{project site,i,y}$	=	Quantity of fossil fuel type *i* combusted at the project site for other purposes that are attributable to the project activity during the year *y* (mass or volume unit per year)[10]
NCV_i	=	Net calorific value of 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)

Scenario 15

Where scenario 15 applies, emission reductions are calculated based on the quantity of electricity that is generated by firing the biomass residues. Therefore, $PEFF_y$ should not include the quantity of fossil fuels co-fired in the project plant ($FF_{project\ plant,i,y}$) but only other quantities of fossil fuels used at the project site that are attributable to the project activity ($FF_{project\ site,i,y}$).

c) CO_2 emissions from electricity consumption ($PE_{EC,y}$)

CO_2 emissions from on-site electricity consumption ($PE_{EC,y}$) should be calculated using the latest approved version of the "Tool to calculate project emissions from electricity consumption". In applying the tool, the project plant as well as any other biomass-fired power plants at the project site should not be considered as captive power plants. This means that case B or C apply if (a) fossil fuel fired power plant(s) is/are operated next to the project plant and case A applies in all other cases. The on-site electricity consumption attributable to the project activity ($EC_{PJ,y}$) should include all electricity consumption that is consumed by the project activity (e.g. for mechanical treatment of the biomass), except for auxiliary electricity consumption by the project plant (e.g. for pumps, vans, etc).[12] by multiplying the electricity consumption by an appropriate grid emission factor, as follows:

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \quad (7)$$

Where:

$PE_{EC,y}$	=	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 grid electricity during the year *y* (tCO_2/MWh)

d) Methane emissions from combustion of biomass residues ($PE_{Biomass,CH4,y}$)

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

$$PE_{Biomass,CH4,y} = EF_{CH4,BF} \cdot \sum_k BF_{k,y} \cdot NCV_k \quad (8)$$

Where:

[12] The auxiliary electricity consumption by the project plant should be considered in the calculation of the net quantity of electricity generation in the project plant ($EG_{project\ plant,y}$).

$BF_{k,y}$ = Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)[9]
NCV_k = Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$EF_{CH4,BF}$ = CH_4 emission factor for the combustion of biomass residues in the project plant (tCH_4/GJ)

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. Project participants shall select the appropriate conservativeness factor from Table 5 below and shall multiply the estimate for the CH_4 emission factor with the conservativeness factor.

For example, where the default CH_4 emission factor of 30 kg/TJ from Table 4 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[13]

	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

e) Methane emissions from waste water treatment ($PE_{WW,CH4,y}$)

This emission source should be estimated in cases where waste water originating from the treatment of the biomass is (partly) treated under anaerobic conditions and where methane from the waste water is not captured and flared or combusted. Project emissions from waste water are estimated as follows:

$$PE_{WW,CH4,y} = V_{WW,y} \times COD_{WW,y} \times B_{o,WW} \times MCF_{WW} \quad (9)$$

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

Where:

$PE_{WW,CH4,y}$	=	CH_4 emissions from waste water generated from the treatment of biomass residues in year *y* (tCH_4/yr)
$V_{WW,y}$	=	Quantity of waste water generated in year *y* (m³/yr)
$COD_{WW,y}$	=	Average chemical oxygen demand of the waste water in year y (t COD/m³)
$B_{o,WW}$	=	Methane generation potential of the waste water (t CH_4/t COD)
MCF_{WW}	=	Methane correction factor for the waste water

Emission reductions due to displacement of electricity

Emission reductions due to the displacement of electricity are relevant for all scenarios from Table 2 above and are calculated by multiplying the net quantity of increased electricity generated with biomass residues as a result of the project activity (EG_y) with the CO_2 baseline emission factor for the electricity displaced due to the project ($EF_{electricity,y}$), as follows:

$$ER_{electricity,y} = EG_y \cdot EF_{electricity,y} \quad \textbf{(10)}$$

Where:

$ER_{electricity,y}$	=	Emission reductions due to displacement of electricity during the year *y* (tCO_2/yr)
EG_y	=	Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* (MWh)
$EF_{electricity,y}$	=	CO_2 emission factor for the electricity displaced due to the project activity during the year *y* (tCO_2/MWh)

Step 1: Determination of $EF_{electricity,y}$

The determination of the emission factor for displacement of electricity $EF_{electricity,y}$ depends on the type of project activity and the baseline scenario identified and should be determined as follows for the different scenarios identified in Table 2 above:

Scenarios 1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 16, 18 and 19

The project activity displaces electricity from other grid-connected sources (P4) or from less efficient plants fired with the same type of biomass residue (P5, P7). Apart from co-firing fossil fuels in the project plant, where relevant, electricity is not generated with fossil fuels at the project site. The emission factor for the displacement of electricity should correspond to the grid emission factor ($EF_{electricity,y} = EF_{grid,y}$) and $EF_{grid,y}$ shall be determined as follows:

- If the power generation capacity of the project plant is of more than 15 MW, $EF_{grid,y}$ should be calculated as a combined margin (CM), following the guidance in the section "Baselines" in the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002).

- If the power generation capacity of the project plant is less or equal to 15 MW, project participants may alternatively use the average CO_2 emission factor of the electricity system, as referred to in option (d) in step 1 of the baseline determination in ACM0002.

Scenarios 5, 6, 7, 8 and 17

The project activity displaces electricity in a captive power plant (P3) and may partly also displace electricity from the grid (P4). The emission factor for the displacement of electricity should reflect the emissions intensity of the captive power plant and the grid, taking into account an appropriate allocation between displacement of captive power and displacement of electricity from the grid. $EF_{electricity,y}$ shall be determined as follows[14]:

$$EF_{electricity,y} = \begin{cases} \alpha \cdot EF_{CP} + (1-\alpha) \cdot EF_{grid,y} & \text{where } 0 < \alpha < 1 \\ EF_{CP} & \text{where } \alpha \geq 1 \\ EF_{grid,y} & \text{where } \alpha \leq 0 \end{cases} \quad \textbf{(11)}$$

$$\text{with} \quad \alpha = \frac{\frac{EG_{CP,historic,3y}}{3} - EG_{CP,y}}{EG_{project\ plant,y}} \quad \textbf{(12)}$$

Where:

$EF_{electricity,y}$	=	CO_2 emission factor for the electricity displaced due to the project activity during the year *y* (tCO_2/MWh)
$EF_{grid,y}$	=	CO_2 emission factor for grid electricity during the year *y* (tCO_2/MWh)
EF_{CP}	=	CO_2 emission factor for electricity displaced in the fossil fuel fired captive power plant identified as baseline plant (P3) (tCO_2/MWh)
$EG_{CP,y}$	=	Net quantity of electricity generated in the fossil fuel fired captive power plant identified as baseline plant (P3) during the year *y* (MWh/yr)
$EG_{CP,historic,3y}$	=	Net quantity of electricity generated during the three most recent years in the fossil fuel fired captive power plant identified as baseline plant (P3) (MWh)
$EG_{project\ plant,y}$	=	Net quantity of electricity generated in the project plant during the year *y* (MWh)

The emission factor for captive power generation ($EF_{CP,y}$) is determined based on the historical performance of the plant in the most recent three years, by dividing CO_2 emissions from power generation with fossil fuels during the most recent three years by the overall electricity generation during the most recent three years, as follows:

$$EF_{CP} = \frac{\sum_i FF_{CP,historic,3y,i} \cdot NCV_i}{EG_{CP,historic,3y}} \cdot EF_{CP,CO2} \quad \textbf{(13)}$$

Where:

EF_{CP}	=	CO_2 emission factor for electricity displaced in the fossil fuel fired captive power plant identified as baseline plant (P3) (tCO_2/MWh)
$FF_{CP,historic,3y,i}$	=	Quantity of fossil fuel type *i* combusted during the most recent three years in the captive power plant (mass or volume unit)
NCV_i	=	Net calorific value of fossil fuel type *i* (GJ / mass or volume unit)

[14] This approach aims at identifying the quantities of electricity that replace captive power generation and grid electricity. For example, if electricity demand at the project site increases over time, the captive power plant may continue to produce the same quantity of electricity as prior to the project implementation in order to meet the increased demand. In this case, in the absence of the project activity additional electricity would have been purchased from the grid and consequently the biomass power generation replaces grid electricity.

$EG_{CP,historic,3y}$	=	Net quantity of electricity generated during the three most recent years in the fossil fuel fired captive power plant identified as baseline plant (P3) (MWh)
$EF_{CP,CO2}$	=	CO_2 emission factor for the fossil fuel used in the captive power plant (tCO_2/GJ)

Scenario 15

The project activity displaces fossil fuel based electricity generation in the project plant. The emission factor for the displacement of electricity should be based on the historical performance of the plant and be calculated ex-ante with equation (11) above ($EF_{electricity,y} = EF_{CP}$), assuming that the efficiency of electricity generation does not change significantly as a result of substitution of fossil fuels with biomass residues and assuming that the composition of fossil fuels fired during the most recent three years would be similar during the crediting period.

Scenario 20

The project activity displaced electricity generation in a fossil fuel fired power plant that would in the absence of the project activity be installed at the project site ("reference plant"). The emission factor for the displacement of electricity is calculated based on the efficiency of the reference plant and the fuel type that would be used in the reference plant, as follows:

$$EF_{electricity,y} = \frac{EF_{CO2,FF,ref}}{\varepsilon_{el,reference\ plant}} \times 3.6 \qquad \textbf{(14)}$$

Where:

$EF_{electricity,y}$	=	CO_2 emission factor for the electricity displaced due to the project activity during the year *y* (tCO_2/MWh)
$EF_{CO2,FF,ref}$	=	CO_2 emission factor for the fossil fuel type that would in the absence of the project activity be used in the reference plant (tCO_2/GJ)
$\varepsilon_{el,reference\ plant}$		Average net energy efficiency of electricity generation in the reference plant that would be constructed in the absence of the project activity (dimensionless)
3.6		conversion factor for joule to electricity unit, GJ/MWh

Step 2: Determination of EG_y

The determination of EG_y depends on the type of project activity and the baseline scenario identified and should be determined as follows for the different scenarios identified in Table 2 above:

Scenario 2, 3, 5, 17 and 20

Where scenarios 2, 3, 5, 7, 17 or 20 apply, EG_y corresponds to the net quantity of electricity generation in the project plant ($EG_y = EG_{project\ plant,y}$).

Scenario 10, 12 and 16

Where scenarios 10, 12 or 16 apply, EG_y corresponds to the lower value between (a) the net quantity of electricity generated in the new power plant that is installed as part of the project activity ($EG_{project\ plant,y}$) and (b) the difference between the total net electricity generation from firing the same type(s) of biomass residues at the project site ($EG_{total,y}$) and the historical generation of the existing power plant(s) ($EG_{historic,3yr}$), based on the three most recent years, as follows[15]:

$$EG_y = MIN\left\{\begin{matrix} EG_{project\ plant,y} \\ EG_{total,y} - \frac{EG_{historic,3yr}}{3} \end{matrix}\right\} \quad (15)$$

Where:

EG_y	= Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year y (MWh/yr)
$EG_{project\ plant,y}$	= Net quantity of electricity generated in the project plant during the year y (MWh/yr)
$EG_{total,y}$	= Net quantity of electricity generated in all power plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant[16], including the new power plant installed as part of the project activity and any previously existing plants, during the year y (MWh/yr)
$EG_{historic,3yr}$	= Net quantity of electricity generated during the most recent three years in all power plants at the project site, generated from firing the same type(s) of biomass residues as used in the project plant[16] (MWh)

Scenarios 1, 4, 6, 8, 9, 11 and 13

For the scenarios 1, 4, 6 and 8, EG_y is determined as the difference between the electricity generation in the project plant and the quantity of electricity that would be generated by other power plant(s) using the same quantity of biomass residues that is fired in the project plant, as follows:

$$EG_y = EG_{project\ plant,y} - \varepsilon_{el,other\ plant(s)} \cdot \frac{1}{3.6} \cdot \sum_k BF_{k,y} \cdot NCV_k \quad (16)$$

Where:

EG_y	= Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year y (MWh)
$EG_{project\ plant,y}$	= Net quantity of electricity generated in the project plant during the year y (MWh)
$\varepsilon_{el,other\ plant(s)}$	= Average net energy efficiency of electricity generation in (the) other power plant(s) that would use the biomass residues fired in the project plant in the absence of the project activity ($MWh_{el}/MWh_{biomass}$)
$BF_{k,y}$	= Quantity of biomass residue type k combusted in the project plant during the year y (tons of dry matter or liter)[9]
NCV_k	= Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter)

For the scenarios 9, 11 and 13 from Table 2, EG_y is determined as the difference between

[15] This provision aims at accounting for any diversion of biomass from the existing power plants to the new power generation unit.
[16] The fraction of electricity generated from firing biomass residues should be determined by dividing the relevant quantity of biomass residues by the total quantity of all fuels fired, both expressed in energy quantities. The relevant quantity of biomass refers to those biomass residue types that are fired in the project plant.

- the lower value between (a) the net quantity of electricity generated in the new power plant that is installed as part of the project activity and (b) the difference between the total net electricity generation by the new power plant and the existing power plant(s) and the historical generation of the existing power plant(s), based on the three most recent years, and
- the quantity of electricity that could be generated by other power plant(s) using the same quantity of biomass residues that are fired in the project plant,

as follows[15]:

$$EG_y = MIN \begin{Bmatrix} EG_{project\ plant,y} - \varepsilon_{el,other\ plant(s)} \cdot \frac{1}{3.6} \cdot \sum_k BF_{k,y} \cdot NCV_k \\ EG_{total,y} - \frac{EG_{historic,3yr}}{3} \end{Bmatrix} \quad \textbf{(17)}$$

Where:

EG_y	=	Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* (MWh)
$EG_{project\ plant,y}$	=	Net quantity of electricity generated in the project plant during the year *y* (MWh)
$\varepsilon_{el,other\ plant(s)}$	=	Average net energy efficiency of electricity generation in (the) other power plant(s) that would use the biomass residues fired in the project plant in the absence of the project activity ($MWh_{el}/MWh_{biomass}$)
$EG_{total,y}$	=	Net quantity of electricity generated in all power plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant[16], including the new power plant installed as part of the project activity and any previously existing plants, during the year *y* (MWh/yr)
$EG_{historic,3yr}$	=	Net quantity of electricity generated during the most recent three years in all power plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant[16] (MWh)
$BF_{k,y}$	=	Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)[9]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)

Where scenarios 4 or 13 apply, $\varepsilon_{el,other\ plant(s)}$ corresponds to the average net efficiency of electricity generation in the "reference plant" ($\varepsilon_{el,reference\ plant}$) that would be installed in the absence of the CDM project activity.

Where scenarios 1, 6, 8 or 9 apply and where the project activity is power generation with (without) cogeneration, $\varepsilon_{el,other\ plant(s)}$ should reflect the average net efficiency of electricity generation in power plants in the grid with (without) cogeneration that fire the same type of biomass residues ($\varepsilon_{el,grid\ plant(s)}$).

Where scenario 11 applies, $\varepsilon_{el,other\ plant(s)}$ corresponds to the average net efficiency of electricity generation in the existing power plant(s) fired with the same type of biomass residue at the project site ($\varepsilon_{el,existing\ plant(s)}$).

Scenarios 14, 18 and 19

Where scenarios 14, 18 or 19 apply, EG_y is determined based on the average efficiency of electricity generation

- in the project plant prior to project implementation ($\varepsilon_{el,baseline\ plant} = \varepsilon_{el,pre\ project}$) in case of scenario 14, or
- in the reference plant that would be installed in the absence of the project activity and that would have a lower efficiency of electric generation than the project plant ($\varepsilon_{el,baseline\ plant} = \varepsilon_{el,reference\ plant}$) in case of scenario 18,
- in the reference plant (after retrofit) with a lower efficiency of electricity generation than with the retrofit in the project activity ($\varepsilon_{el,baseline\ plant} = \varepsilon_{el,reference\ retrofit\ plant}$) in case of scenario 19,

and the average net efficiency of electricity generation in the project plant after project implementation $\varepsilon_{el,project\ plant,y}$, as follows:

$$EG_y = EG_{project\ plant,y} \cdot \left(1 - \frac{\varepsilon_{el,baseline\ plant}}{\varepsilon_{el,project\ plant,y}}\right) \quad \textbf{(18)}$$

Where:

EG_y	=	Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year y (MWh)
$EG_{project\ plant,y}$	=	Net quantity of electricity generated in the project plant during the year y (MWh)
$\varepsilon_{el,baseline\ plant}$	=	Average efficiency of electricity generation in the baseline plant ($MWh_{el}/MWh_{biomass}$)
$\varepsilon_{el,project\ plant,y}$	=	Average efficiency of electricity generation in the project plant ($MWh_{el}/MWh_{biomass}$)

The average net efficiency of electricity generation in the project plant ($\varepsilon_{el,project\ plant,y}$) should be calculated by dividing the electricity generation during the year *y* by the sum of all fuels (biomass residue types *k* and fossil fuel types *i*), expressed in energy units, as follows:

$$\varepsilon_{el,project\ plant,y} = \frac{EG_{project\ plant,y}}{\sum_k NCV_k \cdot BF_{k,y} + \sum_i NCV_i \cdot FF_{project\ plant,i,y}} \quad \textbf{(19)}$$

Where:

$\varepsilon_{el,project\ plant,y}$	=	Average net energy efficiency of electricity generation in the project plant
$EG_{project\ plant,y}$	=	Net quantity of electricity generated in the project plant during the year y (MWh)
$BF_{k,y}$	=	Quantity of biomass residue type k combusted in the project plant during the year y (tons of dry matter or liter)[9]
NCV_k	=	Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter)
NCV_i	=	Net calorific value of fossil fuel type i (GJ / mass or volume unit)
$FF_{project\ plant,i,y}$	=	Quantity of fossil fuel type i combusted in the project plant during the year y (mass or volume unit per year)[10]

<u>*Scenario 15*</u>

Where scenario 15 applies, EG_y is determined based on the fraction of biomass residues that have been used in the project plant, taking into account all biomass residues types *k* and fossil fuel types *i* fired in the project plant during a year, as follows:

$$EG_y = EG_{project\ plant,y} \cdot \frac{\sum_k BF_{k,y} \cdot NCV_k}{\sum_k BF_{k,y} \cdot NCV_k + \sum_i FF_{project\ plant,i,y} \cdot NCV_i} \quad \textbf{(20)}$$

Where:

EG_y	=	Net quantity of increased electricity generation as a result of the project activity (incremental to baseline generation) during the year *y* (MWh)
$EG_{project\ plant,y}$	=	Net quantity of electricity generated in the project plant during the year *y* (MWh)
$BF_{k,y}$	=	Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)[9]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
NCV_i	=	Net calorific value of fossil fuel type *i* (GJ / mass or volume unit)
$FF_{project\ plant,i,y}$	=	Quantity of fossil fuel type *i* combusted in the project plant during the year *y* (mass or volume unit per year)[10]

General guidance for all scenarios

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

Where steam generation occurs (partly) separately from electricity generation (e.g. where steam is diverted from the boiler of one plant to the turbine of another plant), the fuel consumption should be allocated to the plants where electricity generation occurs, i.e. the fuel consumption associated with steam that is generated in a separate boiler and diverted to the turbine of another plant should be considered as fuel used for that turbine. In cases where any steam quantities are diverted to the project plant, they should be measured as part of monitoring. The fuel combustion associated with such steam quantities should be included in $FF_{project\ plant,i,y}$ and/or $BF_{k,y}$ respectively and should be calculated by dividing the quantity of diverted steam by the efficiency of steam generation. Where several fuels are fired at the same time to generate steam, the more carbon intensive fuel should be considered, as a conservative approach, for parameters monitored during the crediting period.

Emission reductions or increases due to displacement of heat

In case of cogeneration plants, project participants shall determine the emission reductions or increases due to displacement of heat ($ER_{heat,y}$). The determination of $ER_{heat,y}$ depends on the type of project activity and the most likely baseline scenario and should be determined as follows for the different scenarios identified in Table 2 above:

Scenario 1, 3, 7, 8 and 15

Where scenario 1, 3, 7, 8 or 15 apply, $ER_{heat,y} = 0$.[17]

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[17] In case of scenario 1, the heat would in the absence of the project activity be generated in boilers using fossil fuels (or by other means involving fossil fuels) at the project site and the biomass would be combusted in power plants, including cogeneration plants, at other sites. This involves two different substitution effects:
(a) Fossil fuels are saved at the project site due to the displacement of heat generated from fossil fuels.
(b) The project activity diverts biomass from other (cogeneration) power plants to the project activity. This may indirectly increase the use of fossil fuels for heat generation elsewhere.
These two substitution effects may be of different size, depending on a number of factors, including the performance of the project plant, the fossil-fuel fired boiler as well as the other power plants, and the carbon intensity of the fuels used. As a simplification, it is assumed that the two effects are of similar magnitude and that $ER_{heat} = 0$.
In case of scenarios 7, 8 and 15, the quantity of heat generated by the project plant displaces heat generation in the existing fossil fuel fired cogeneration plant. However, the associated emission reductions are already accounted in the calculation of emission reductions from electricity generation.

<u>*Scenario 2, 10, 16 and 17*</u>

If the identified baseline scenario is the use of heat from external sources (H7) or other heat generation technologies (H8) emissions due to the displacement of heat are assumed as zero ($ER_{heat,y} = 0$) as a conservative approach.[18]

If the identified baseline scenario is the generation of heat in boilers using fossil fuels (H6), baseline emissions are calculated by multiplying the savings of fossil fuels with the appropriate CO_2 emission factor.

Emission reductions from savings of fossil fuels are determined by dividing the quantity of generated heat that displaces heat generation in fossil fuel fired boilers (Q_y) by the efficiency of the boiler that would be used in the absence of the project activity (ε_{boiler}), and by multiplying with the CO_2 emission factor of the fuel type that would be used in the absence of the project activity for heat generation ($EF_{CO2,BL,heat}$), as follows:

$$\sout{ER_{heat,y} = \frac{Q_y \cdot EF_{CO2,BL,heat,i}}{\varepsilon_{boiler}}} \quad ER_{heat,y} = \frac{Q_y \cdot EF_{CO2,BL,heat}}{\varepsilon_{boiler}} \tag{21}$$

The determination of the quantity of generated heat that displaces heat generation in fossil fuel fired boilers (Q_y) depends on the scenario, as follows:

- In case of scenario 2 or 17, the baseline scenario is that all heat generated by the cogeneration project plant would in the absence of the project activity be generated in fossil fuel fired boilers. Thus:

$$Q_y = Q_{project\ plant,y} \tag{22}$$

- In case of scenario 10, the baseline scenario is as well that heat generated by the cogeneration project plant would in the absence of the project activity be generated in fossil fuel fired boilers. However, since another biomass residue fired cogeneration plant may already be operating next to the project plant, heat and power generation may be diverted from the existing cogeneration plant to the new cogeneration plant installed as part of the project activity. In order to account for any diversion of heat generation from the existing to the new cogeneration plant, the lower value between the (a) actual generation in the project plant and (b) the difference between the all heat generation in cogeneration plants and the historical level of heat generation in cogeneration plants is used to determine Q_y, as follows:

$$Q_y = MIN\left\{\begin{matrix} Q_{project\ plant,y} \\ Q_{total,y} - \dfrac{Q_{historic,3yr}}{3} \end{matrix}\right\} \tag{23}$$

- In case of scenario 16, the baseline scenario is that heat generated by the cogeneration project plant would in the absence of the project activity be generated in both fossil fuel fired boilers and heat-

[18] Project participants are encouraged to submit proposals for further amendment of this methodology in order to reflect respective emission reductions from the displacement of heat.

only boilers fired with biomass residue type(s) that are also used in the project plant. As in scenario 10, heat generation may be diverted from an existing cogeneration plant to the project plant. In addition, the quantity of heat that has historically been generated in heat-only boilers, using the same type(s) of biomass residues, is subtracted, as follows:

$$Q_y = MIN\left\{\begin{matrix} Q_{project\ plant,y} \\ Q_{total,y} - \dfrac{Q_{historic,3yr}}{3} \end{matrix}\right\} - \frac{Q_{biomass,historic,3yr}}{3} \qquad \textbf{(24)}$$

Where $Q_{biomass,historic,3yr}$ has not been measured or can not directly be measured because other fuels are co-fired, it may be determined based on historical fuel consumption data and the efficiency of the boiler(s), as follows:

$$Q_{biomass,historic,3yr} = \varepsilon_{boiler,biomass} \cdot \sum_k BF_{k,boiler,historic,3yr} \cdot NCV_k \qquad \textbf{(25)}$$

Where:

$ER_{heat,y}$	= Emission reductions due to displacement of heat during the year y (tCO_2/yr)
Q_y	= Quantity of increased heat generation in the project plant (incremental to heat generation in any existing cogeneration plants) that displaces heat generation in fossil fuel fired boilers during the year y (GJ/yr)
$Q_{,project\ plant,y}$	= Net quantity of heat generated in the cogeneration project plant from firing biomass residues[19] during the year y (GJ)
$Q_{total,y}$	= Net quantity of heat generated in all cogeneration plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant, including the cogeneration plant installed as part of the project activity and any previously existing plants, during the year y (GJ)
$Q_{historic,3yr}$	= Net quantity of heat generated during the most recent three years in all cogeneration plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant (GJ)
$Q_{biomass,historic,3yr}$	= Net quantity of heat generated during the most recent three years in all boilers at the project site, generated from firing the same type(s) of biomass residues as in the project plant (GJ)
ε_{boiler}	= Energy efficiency of the boiler that would be used in the absence of the project activity
$\varepsilon_{boiler\ biomass}$	= Energy efficiency of the biomass residue fired boiler that would be used in the absence of the project activity
$BF_{k,boiler,historic,3yr}$	= Quantity of biomass residue type k that has been fired in boilers for heat generation during the most recent three years at the project site (tons of dry matter or liter)[9]
NCV_k	= Net calorific value of the biomass residue type k (GJ/ton of dry matter or GJ/liter)
$EF_{CO2,BL,heat,i}$	= CO_2 emission factor of the fossil fuel type i used for heat generation in the absence the project activity (tCO_2/GJ)

[19] The fraction of heat generated from firing biomass residues should be determined by dividing the quantity of biomass residues by the total quantity of all fuels fired, both expressed in energy units.

Scenarios 4, 11, 12, 13, 14, 18 and 19

In case of scenarios 4, 11, 13, 14, 18 and 19, heat and electricity would in the absence of the project activity be generated in a similar cogeneration plant but with a different configuration, i.e. the efficiency of electricity generation is lower than in the project plant. The efficiency of heat generation, i.e. the heat generated per quantity of biomass residue fired, may differ between the project plant and the plant in the baseline scenario (the "reference plant" in case of scenarios 4, 13, 18 and 19, the existing or captive plant(s) in case of scenarios 11, the project plant prior to the implementation of the project activity in case of scenario 14). Where the efficiency of heat generation is smaller in the project plant than in the baseline scenario, i.e. where

$\varepsilon_{th,project\ plant} < \varepsilon_{th,reference\ plant}$ (in case of scenario 4, 13 or 18), or
$\varepsilon_{th,project\ plant} < \varepsilon_{th,existing\ plant(s)}$ (in case of scenario 11), or
$\varepsilon_{th,project\ plant} < \varepsilon_{th,pre\ project}$ (in case of scenario 14), or
$\varepsilon_{th,project\ plant} < \varepsilon_{th,reference\ retrofit\ plant}$ (in case of scenario 19), or

the quantity of heat generated in the project plant is smaller than the quantity of heat that would be generated in the absence of the project activity. This implies that the project implementation involves additional heat generation from other sources or a longer operation of the project plant. This may result in an increase in GHG emissions.

Similar considerations apply to scenario 12, where the heat would be generated in biomass residue fired boilers in the absence of the project activity. Although the cogeneration process as a whole is more efficient than separate generation of electricity and heat, a cogeneration plant usually produces less heat per biomass fired than a boiler ($\varepsilon_{th,project\ plant} < \varepsilon_{boiler}$). As a consequence, the project plant will in most cases produce less heat than would be produced in the boilers in the absence of the project activity if the same amount of biomass residues is used in both cases. This implies, as for scenarios 4, 11, 13, 14, 18 and 19, that the project implementation involves additional heat generation from other sources or increased operation of the project plant.

To address this substitution effect for all scenarios (4, 11, 12, 13, 14, 18 and 19), project participants may either

- demonstrate that the thermal efficiency in the project plant is larger or similar compared with the thermal efficiency of the plant considered in baseline scenario and then assume $ER_{heat,y} = 0$, or, if this is not the case,
- account for any increases in CO_2 emissions, as described in the following.

This increased level of heat generation as a result of the project activity may be generated by different means, such as

(a) additional biomass residues being fired in the project plant, i.e. leading to a higher load factor than in the absence of the project activity;
(b) increasing or initiating heat generation in boilers fired with the same type of biomass residue;
(c) co-firing fossil fuels in the project plant, e.g. in cases where the supply of biomass residues is limited;
(d) increasing or initiating heat generation in boilers fired with fossil fuels.

Project participants shall identify how additional heat is generated in the context of the project activity, as follows:

- In the absence of any boilers and of any fossil fuel consumption for power or heat generation at the project site, option (a) shall apply.
- Where biomass boilers fired with the same type of biomass residue are operated and no fossil fuels are used for power or heat generation at the project site, option (b) shall apply.
- Where fossil-fuels are co-fired in the project plant but not in any boilers, option (c) shall apply.
- Where fossil fuels are fired in boilers, option (d) shall apply.

In the case of (a), the additional heat generation can be assumed not to involve additional emissions and $ER_{heat,y} = 0$. In case of (b), emission reductions due to displacement of heat can be estimated as well as zero as a simplified assumption ($ER_{heat,y} = 0$). In case of (c), increases in CO_2 emissions are considered as project emissions ~~and accounted with equation (6)~~ above. In case of (d), project participants shall account for CO_2 emissions from increased combustion of fossil fuels in the boiler(s) due to the project activity, as follows for the different scenarios:

Scenarios 4, 13, and 18:

$$ER_{heat,y} = \frac{Q_{project\ plant,y} \cdot EF_{CO2,BL,heat}}{\varepsilon_{boiler}} \cdot \left(1 - \frac{\varepsilon_{th,reference\ plant}}{\varepsilon_{th,project\ plant}}\right) \quad \textbf{(26)}$$

Scenario 11:

$$ER_{heat,y} = \frac{Q_{project\ plant,y} \cdot EF_{CO2,BL,heat}}{\varepsilon_{boiler}} \cdot \left(1 - \frac{\varepsilon_{th,existing\ plant(s)}}{\varepsilon_{th,project\ plant}}\right) \quad \textbf{(27)}$$

Scenario 12:

$$ER_{heat,y} = \frac{Q_{project\ plant,y} \cdot EF_{CO2,BL,heat}}{\varepsilon_{boiler}} \cdot \left(1 - \frac{\varepsilon_{boiler}}{\varepsilon_{th,project\ plant}}\right) \quad \textbf{(28)}$$

Scenario 14:

$$ER_{heat,y} = \frac{Q_{project\ plant,y} \cdot EF_{CO2,BL,heat}}{\varepsilon_{boiler}} \cdot \left(1 - \frac{\varepsilon_{th,pre\ project}}{\varepsilon_{th,project\ plant}}\right) \quad \textbf{(29)}$$

Scenario 19:

$$ER_{heat,y} = \frac{Q_{projectplant,y} \cdot EF_{CO2,BL,heat}}{\varepsilon_{boiler}} \cdot \left(1 - \frac{\varepsilon_{th,referenceretrofitplant}}{\varepsilon_{th,projectplant}}\right) \quad \textbf{(30)}$$

Where:

$ER_{heat,y}$	=	Baseline emissions due to displacement of heat during the year *y* (tCO_2/yr)
$Q_{project\ plant,y}$	=	Net quantity of heat generated in the cogeneration project plant from firing biomass residues[19] during the year y (GJ)
ε_{boiler}	=	Energy efficiency of the boiler that is used during the project activity to generate heat next to the cogeneration power plant
$\varepsilon_{th,reference\ plant}$	=	Average net energy efficiency of heat generation in the reference plant that would use the biomass residues fired in the project plant in the absence of the project activity ($MWh_{heat}/MWh_{biomass}$)
$\varepsilon_{th,reference\ retrofit\ plant}$	=	Average net energy efficiency of heat generation in the reference retrofit plant that would use the biomass residues fired in the project plant in the absence of the project activity ($MWh_{heat}/MWh_{biomass}$)
$\varepsilon_{th,pre\ project}$	=	Average net efficiency of heat generation in the project plant prior to project implementation ($MWh_{el}/MWh_{biomass}$)
$\varepsilon_{th,existing\ plant(s)}$	=	Average net energy efficiency of heat generation in the existing or captive cogeneration

plant(s) ($MWh_{heat}/MWh_{biomass}$)

$\varepsilon_{th,project\ plant}$ = Average net energy efficiency of heat generation in the project cogeneration plant ($MWh_{heat}/MWh_{biomass}$)

$EF_{CO2,BL,heat,i}$ = CO_2 emission factor of the fossil fuel type ~~i~~ used for heat generation in the absence the project activity (tCO_2/GJ)

Note that the emission reductions calculated here are negative.

$\varepsilon_{th,reference\ plant}$ should represent the efficiency of heat generation in commonly installed new biomass residue fired cogeneration power plants in the respective industry sector in the country or region.

To determine $\varepsilon_{th,pre\ project}$, project participants shall measure the net efficiency of heat generation prior to project implementation.

To determine $\varepsilon_{th,existing\ plant(s)}$, project participants shall measure the net efficiency of heat generation prior to project implementation in all existing cogeneration plant(s).

$\varepsilon_{th,reference\ retrofit\ plant}$ should represent the efficiency of heat generation in commonly installed biomass residue fired cogeneration power plants that have been recently retrofitted according to the industrial standards in the respective industry sector in the country or region.The average net energy efficiency of heat generation in the project plant ($\varepsilon_{th,project\ plant,y}$) should be calculated by dividing the heat generation during the year *y* by the sum of all fuels (biomass residue types *k* and fossil fuel types *i*), expressed in energy units, as follows:

$$\varepsilon_{th,project\ plant,y} = \frac{Q_{project\ plant,y}}{\sum_k NCV_k \cdot BF_{k,y} + \sum_i NCV_i \cdot FF_{project\ plant,i,y}} \quad \textbf{(31)}$$

Where:

$\varepsilon_{th,project\ plant,y}$	=	Average net energy efficiency of heat generation in the project plant
$Q_{project\ plant,y}$	=	Quantity of heat generated in the cogeneration project plant from firing biomass residues[19] during the year *y* (GJ)
$EG_{project\ plant,y}$	=	Net quantity of electricity generated in the project plant during the year *y* (MWh)
$BF_{k,y}$	=	Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)[9]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
NCV_i	=	Net calorific value of fossil fuel type *i* (GJ / mass or volume unit)
$FF_{project\ plant,i,y}$	=	Quantity of fossil fuel type *i* combusted in the project plant during the year *y* (mass or volume unit per year)[10]

Scenario 20

In case of scenario 20, heat would in the absence of the project activity be generated in a boiler that may also be co-fired with fossil fuels. The cogeneration of heat in the project activity therefore displaces heat generation in a boiler using biomass residues and, where applicable, fossil fuels. In case where no fossil fuels would be co-fired in the boiler in the absence of the project activity, $ER_{heat,y} = 0$. In case where fossil fuels would be co-fired in the boiler, the emission reductions from displacement of these fossil fuels are calculated based on the total quantity of heat generation in the project plant ($Q_{total,y}$), the efficiency of the boiler that would be used in the absence of the project activity (ε_{boiler}), the quantity of biomass residues that are used in the project plant and would in the absence of the project be used in that boiler ($BF_{k,boiler,y}$) and the CO_2 emission factor of the fossil fuel type that would be used in the boiler ($EF_{CO2,BL,heat}$), as follows:

$$ER_{heat,y} = \left[\frac{Q_{project\ plant,y}}{\varepsilon_{BL,boiler}} - \sum_{k} BF_{k,y} \times NCV_k\right] \times EF_{CO2,BL,heat} \quad (32)$$

Where:

$ER_{heat,y}$	=	Baseline emissions due to displacement of heat during the year *y* (tCO_2/yr)
$Q_{project\ plant,y}$	=	Quantity of heat generated in the cogeneration project plant from firing biomass residues[19] during the year *y* (GJ)
$\varepsilon_{BL,boiler}$	=	Energy efficiency of the boiler that would be used in the absence of the project activity to generate heat
$BF_{k,y}$	=	Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)[9]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$EF_{CO2,BL,heat}$	=	CO_2 emission factor of the fossil fuel type used for heat generation in the absence the project activity (tCO_2/GJ)
k	=	Biomass residue types *k* which are used in the project plant and which would in the absence of the project activity be used in a boiler for heat generation (B4)

Baseline emissions due to natural decay or uncontrolled burning of anthropogenic sources of biomass residues (applicable to scenarios 2, 3, 5, 7, 10, 15, 16, 17 and 20)

For scenarios 1, 4, 6, 8, 9, 11, 12, 13 and 14, baseline emissions due to uncontrolled burning or decay of the biomass residues are zero ($BE_{Biomass,y} = 0$), since in this case the biomass residues would not decay or be burnt in the absence of the project activity. For all other scenarios (2, 3, 5, 7, 10, 15, 16, 17 and 20), baseline emissions due to uncontrolled burning or decay of the biomass residues ($BE_{Biomass,y}$) should be determined consistent with the most plausible baseline scenario for the use of the biomass residues, if this source is included in the project boundary.

$BE_{Biomass,y}$ is determined in two steps:

Step 1: Determination of the quantity of biomass residues used as a result of the project activity.
Step 2: Estimation of methane emissions, consistent with the baseline scenario for the use of biomass residues (B1, B2 or B3)

Step 1. Determination of the quantity of biomass residues used as a result of the project activity ($BF_{PJ,k,y}$)

In case of scenarios 2, 5, 7, 15 and 17, the total quantity of biomass residues used in the project plant ($\Sigma\ BF_{k,y}$) is attributable to the project activity and hence $BF_{PJ,k,y} = BF_{k,y}$.

In case of scenarios 3, 10 and 16, biomass residues are already used at the project site prior to the implementation of the project activity and would in the absence of the CDM continued to be used. In case of scenario 20, the biomass residues may partly be dumped, left to decay or burnt in an uncontrolled manner. In these cases, the incremental use of biomass residues as a result of the project activity (i.e. $BF_{PJ,k,y}$) should be determined, consistent with the relevant scenario, as follows:

Scenario 3

The biomass residues would in the absence of the project activity (a) be used for heat generation in boilers at the project site and (b) be dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes. The incremental use of biomass residues as a result of the project activity is calculated as the difference between the total quantity used in the project plant and the quantity that would have been used to generate the heat in boilers.

- In case that only one type of biomass residue *k* is used, determine $BF_{PJ,k,y}$ as follows:

$$BF_{PJ,k,y} = BF_{k,y} - \frac{Q_{project\ plant,y}}{\varepsilon_{boiler} \cdot NCV_k} \qquad \textbf{(33)}$$

- In case that more than one type of biomass residue *k* is used in the project plant, determine $BF_{PJ,k,y}$ based on the specific circumstances of the project activity, thereby ensuring that the total incremental quantity of all biomass residues types *k* used as a result of the project activity corresponds to the difference between the total quantity of biomass residues used in the project plant and the total quantity that would be required to generate heat in boilers in the absence of the project activity, as follows:

$$\sum_k \mathrm{BF}_{\mathrm{PJ,k,y}} \cdot \mathrm{NCV}_\mathrm{k} \overset{!}{=} \sum_\mathrm{k} \mathrm{BF}_{\mathrm{k,y}} \cdot \mathrm{NCV}_\mathrm{k} - \frac{\mathrm{Q}_{\mathrm{project\ plant,y}}}{\varepsilon_{\mathrm{boiler}}} \qquad \textbf{(34)}$$

Where:

$BF_{PJ,k,y}$	=	Incremental quantity of biomass residue type *k* used as a result of the project activity in the project plant during the year *y* (tons of dry matter or liter)[9]
$BF_{k,y}$	=	Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)[9]
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$Q_{project\ plant,y}$	=	Quantity of heat generated in the cogeneration project plant from firing biomass residues[19] during the year y (GJ),
ε_{boiler}	=	Energy efficiency of the boiler that would be used in the absence of the project activity

<u>*Scenario 10*</u>

Consistent with equation (21) above, $BF_{PJ,k,y}$ corresponds to the incremental use of biomass residues above the historical level of the most recent three years prior to the implementation of the project activity.

- In case that only one type of biomass residue *i* is used, determine $BF_{PJ,k,y}$ as follows:

$$BF_{PJ,k,y} = MIN\begin{Bmatrix} BF_{k,y} \\ \\ BF_{all\ plants,k,y} - \dfrac{BF_{historic,k,3yr}}{3} \end{Bmatrix} \qquad \textbf{(35)}$$

- In case that more than one type of biomass residue *k* is used in the project plant, determine $BF_{PJ,k,y}$ based on the specific circumstances of the project activity, thereby ensuring that the total incremental quantity of all biomass residues types *k* used as a result of the project activity corresponds to the smaller value between (a) the quantity of biomass residues used in the project plant and (b) the difference between the total quantity of biomass residues used in all plants at the project site and the average historic quantity of biomass residues used in the most recent three years prior to the implementation of the project activity (all expressed in energy units), as follows:

$$\sum_i BF_{PJ,k,y} \cdot NCV_k \overset{!}{=} MIN \left\{ \begin{array}{c} \sum_k BF_{k,y} \cdot NCV_k \\ \sum_i BF_{all\ plants,k,y} \cdot NCV_k - \frac{\sum_k BF_{historic,k,3yr} \cdot NCV_k}{3} \end{array} \right\} \quad (36)$$

Where:

$BF_{PJ,k,y}$	= Incremental quantity of biomass residue type *k* used as a result of the project activity in the project plant during the year *y* (tons of dry matter or liter)[9]
$BF_{k,y}$	= Quantity of biomass residue type *k* combusted in the project plant during the year *y* (tons of dry matter or liter)[9]
NCV_k	= Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)
$BF_{all\ plants,k,y}$	= Quantity of biomass residue type *k* combusted in all power plants at the project site during the year *y* (tons of dry matter or liter)[9]
$BF_{historic,k,3y}$	= Quantity of biomass residue type *k* used as fuel in all installations (power plants, boilers, etc) at the project site during the most recent three years prior to the implementation of the project activity (tons of dry matter or liter)[9]

Scenario 16

$BF_{PJ,k,y}$ should be determined taking into account the project specific circumstances, consistent with the types and quantities of biomass residues that would be dumped, left to decay or burnt in an uncontrolled manner as identified in the procedure to select the most plausible baseline scenario. Ensure that only the incremental increase in the use of biomass residues due to the project activity is taken into account.

Scenario 20

$BF_{PJ,k,y}$ should be determined taking into account the project specific circumstances, consistent with the types and quantities of biomass residues that would be dumped, left to decay or burnt in an uncontrolled manner as identified in the procedure to select the most plausible baseline scenario. Ensure that no quantities of biomass that would be used for heat generation in the absence of the project activity are included.

Step 2. Estimation of methane emissions, consistent with the baseline scenario for the use of biomass residues (B1, B2 or B3)

Follow the procedures for the respective baseline scenario (B1, B2 or B3), 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. Where for a certain biomass type *k* leakage can not be ruled out, using one of the approaches outlined in the leakage section, no baseline methane emissions can be claimed from decay, dumping or uncontrolled burning of that biomass.

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:

$$BE_{biomass,y} = GWP_{CH4} \cdot \sum_{k} BF_{PJ,k,y} \cdot NCV_{k} \cdot EF_{burning,CH4,k,y} \qquad (37)$$

where:

$BE_{biomass,y}$	=	Baseline emissions due to natural decay or burning of anthropogenic sources of biomass residues during the year *y* (tCO_2e/yr)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)
$BF_{PJ,k,y}$	=	Incremental quantity of biomass residue type *k* used as a result of the project activity in the project plant during the year *y* (tons of dry matter or liter)[9]
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 and for which leakage effects could be ruled out with one of the approaches L_1, L_2 or L_3 described in the leakage section

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 $EF_{burning,CH4,k,y}$.[20]

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 6 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 6: 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

[20] 2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.

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 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 $BE_{biomass,y}$ 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 and for which leakage could be ruled out using one of the approaches L_1, L_2 or L_3 described in the leakage section.

~~Use from 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.~~

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.

Where the most likely baseline scenario is the use of the biomass residues for energy generation (scenarios 1, 4, 6, 8, 9, 11, 12, 13 and 14), the diversion of biomass residues to the project activity is already considered in the calculation of baseline reductions. In this case, leakage effects do not need to be addressed.

Where the most likely baseline scenario is that the biomass residues are dumped or left to decay or burnt in an uncontrolled manner without utilizing it for energy purposes (scenarios 2, 3, 5, 7, 10, 15, 16, 17 and 20), project participants shall demonstrate that the use of the biomass residues does not result in increased fossil fuel consumption elsewhere. For this purpose, project participants shall assess as part of the monitoring the supply situation for the types of biomass residues used in the project plant. The following options may be used to demonstrate that the biomass residues used in the plant did not increase fossil fuel consumption elsewhere:

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).

This approach is applicable to situations where project participants use only biomass residues from specific sites and do not purchase biomass residues from or sell biomass residues to a market.

L_2 Demonstrate that there is an abundant surplus of the biomass residue in the region of the project activity which is not utilized. For this purpose, demonstrate that the quantity of available biomass residue 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 is not utilized.

Where project participants wish to use approaches L_2 or L_3 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 can not demonstrate with one of the approaches above that the use of the biomass 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 residue is substituted by the most carbon intensive fuel in the country.

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

$$L_y = EF_{CO2,LE} \cdot \sum_k BF_{PJ,k,y} \cdot NCV_k \qquad \textbf{(38)}$$

Where:

L_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)
$BF_{PJ,k,y}$	=	Incremental quantity of biomass residue type *k* used as a result of the project activity in the project plant during the year *y* (tons of dry matter or liter)[9]
k	=	Types of biomass residues for which leakage effects could not be ruled out with one of the approaches L_1, L_2 or L_3 above
NCV_k	=	Net calorific value of the biomass residue type *k* (GJ/ton of dry matter or GJ/liter)

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.)

Data and parameters not monitored

Data / parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential for CH_4
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:	

Parameter:	**$EG_{CP,historic,3y}$**
Data unit:	MWh
Description:	Net quantity of electricity generated during the three most recent years in the fossil fuel fired captive power plant identified as baseline plant (P3)
Source of data:	On-site measurements
Measurement procedures (if any):	
Any comment:	Applicable to scenarios 5, 6, 7, 8 and 17

Parameter:	**$EG_{historic,3yr}$**
Data unit:	MWh
Description:	Net quantity of electricity generated during the most recent three years in all power plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant[16]
Source of data:	On-site measurements
Measurement procedures (if any):	
Any comment:	Applicable to scenarios 10, 12 and 16

Parameter:	**$FF_{CP,historic,3y,i}$**
Data unit:	Mass or volume unit
Description:	Quantity of fossil fuel type *i* combusted during the most recent three years in the captive power plant
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 electricity generated and any fuel purchase receipts (if available).
Any comment:	Applicable to scenarios 5, 6, 7, 8 and 17

Parameter:	$\varepsilon_{th,pre\ project}$
Data unit:	MWh_{th} / $MWh_{biomass}$
Description:	Average net efficiency of heat generation in the project plant prior to project implementation
Source of data:	On-site measurements
Measurement procedures (if any):	Measure the quantity of fuels fired and the heat generation during a representative time period and divide the quantity of heat generated by the energy quantity of the fuels fired. In case of turbines with heat extractions, the efficiency should be determined over a time period that reasonably represents the different operation modes. The three most recent historical years should preferably be used to determine the average efficiency, where such data is available and where this time period is reasonably representative.
Any comment:	Applicable to scenario 14

Parameter:	$\varepsilon_{el,pre\ project}$
Data unit:	MWh_{el} / $MWh_{biomass}$
Description:	Average net efficiency of electricity generation in the project plant prior to project implementation
Source of data:	On-site measurements, to be conducted prior to the implementation of the project activity.
Measurement procedures (if any):	Measure the quantity of fuels fired and the electricity generation during a representative time period and divide the quantity of electricity generated by the energy quantity of the fuels fired. In case of turbines with heat extractions, the efficiency should be determined over a time period that reasonably represents the different operation modes. The three most recent historical years should preferably be used to determine the average efficiency, where such data is available and where this time period is reasonably representative.
Any comment:	Applicable to scenario 14

Parameter:	$\varepsilon_{el,grid\ plant(s)}$
Data unit:	MWh_{el} / $MWh_{biomass}$
Description:	Average net efficiency of electricity generation in biomass residue fired power plants in the grid that fire the same type of biomass residues as the project plant.
Source of data:	Statistics, surveys, relevant studies, measurements and/or expert judgements. Choose $\varepsilon_{el,grid\ plant(s)}$ in a conservative manner, document the sources of information and justify the choice.
Measurement procedures (if any):	
Any comment:	Applicable to scenarios 1, 6, 8 and 9

Parameter:	$\varepsilon_{el,reference\ plant}$ or $\varepsilon_{th,reference\ plant}$
Data unit:	-
Description:	Average net energy efficiency of power or heat generation in the reference power plant that would use the biomass residues fired in the project plant in the absence of the project activity
Source of data:	Use the efficiency of electricity or heat generation, as identified as part of the baseline scenario selection procedure. Consider commonly installed new biomass residue fired power plants that are common practice for new plants in the respective industry sector in the country or region. Choose the efficiency in a conservative manner, i.e. choose a higher efficiency within a plausible range of efficiencies that are reached by new plants in the relevant sector, document relevant sources of information (relevant studies, measurements and/or expert judgments) in the CDM-PDD and justify the choice.
Measurement procedures (if any):	
Any comment:	Applicable to scenarios 4, 13, 18 and 20

Parameter:	$\varepsilon_{el,reference\ retrofit\ plant}$ or $\varepsilon_{th,reference\ retrofit\ plant}$
Data unit:	-
Description:	Average net energy efficiency of electricity or heat generation in the reference power plant after the retrofit that would take place in the absence of the project activity
Source of data:	Use the efficiency of electricity or heat generation in commonly installed biomass residue fired power plants that have been retrofitted according to the common practice in the respective industry sector in the country or region. Choose the efficiency in a conservative manner, i.e. choose a higher efficiency within a plausible range of efficiencies that are reached with retrofits in the respective sector. Document relevant sources of information (relevant studies, measurements and/or expert judgments) in the CDM-PDD and justify the choice.
Measurement procedures (if any):	
Any comment:	Applicable to scenario 19

Parameter:	$\varepsilon_{el,existing\ plant(s)}$ / $\varepsilon_{th,existing\ plant(s)}$
Data unit:	-
Description:	Average net efficiency of electricity / heat generation in the existing power / cogeneration plant(s) fired with the same type of biomass residue at the project site
Source of data:	On-site measurements
Measurement procedures (if any):	Measure the quantity of fuels fired and the electricity generation during a representative time period and divide the quantity of electricity generated by the energy quantity of the fuels fired. In case of turbines with heat extractions, the efficiency should be determined over a time period that reasonably represents the different operation modes. The three most recent historical years should preferably be used to determine the average efficiency, where such data is available and where this time period is reasonably representative.
Any comment:	Applicable to scenario 11

Parameter:	$\varepsilon_{BL,boiler}$
Data unit:	-
Description:	Energy efficiency of the boiler that would be used in the absence of the project activity to generate heat
Source of data:	Assume, as a conservative simplification, an efficiency of 100% or use the efficiency, as identified as part of the baseline scenario selection procedure. Consider commonly installed new biomass residue fired boilers that are common practice for new boilers in the respective industry sector in the country or region. Choose the efficiency in a conservative manner, i.e. choose a higher efficiency within a plausible range of efficiencies that are reached by new boilers in the relevant sector, document relevant sources of information (relevant studies, measurements and/or expert judgments) in the CDM-PDD and justify the choice.
Measurement procedures (if any):	-
Any comment:	Applicable to scenario 20

Parameter:	$Q_{historic,3yr}$
Data unit:	GJ
Description:	Net quantity of heat generated during the most recent three years in all cogeneration plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant
Source of data:	On-site measurements
Measurement procedures (if any):	Heat generation is determined as the difference of the enthalpy of the steam generated by the cogeneration plants minus the enthalpy of the feed-water 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. The fraction of heat generated from firing biomass residues should be determined by dividing the quantity of biomass residues fired by the total quantity of all fuels fired, both expressed in energy quantities.
Any comment:	Applicable to scenarios 10 and 16

Parameter:	**$Q_{biomass,historic,3yr}$**
Data unit:	GJ
Description:	Net quantity of heat generated during the most recent three years in all boilers at the project site, generated from firing the same type(s) of biomass residues as in the project plant
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. The fraction of heat generated from firing biomass residues should be determined by dividing the quantity of biomass residues fired by the total quantity of all fuels fired, both expressed in energy quantities.
Any comment:	Applicable to scenario 16. Where $Q_{biomass,historic,3yr}$ can not directly be measured, project participants may alternative measure $BF_{k,boiler,historic,3yr}$ and $\varepsilon_{boiler\ biomass}$.

Parameter:	**$BF_{k,boiler,historic,3yr}$**
Data unit:	tons of dry matter or liter[9]
Description:	Quantity of biomass residue type *k* that has been fired in boilers for heat generation during the most recent three years at the project site
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:	Applicable to scenario 16 in cases where $Q_{biomass,historic,3yr}$ has not been measured or can not directly be measured because other fuels are co-fired

Parameter:	**$\varepsilon_{boiler\ biomass}$**
Data unit:	-
Description:	Energy efficiency of the biomass residue fired boiler that would be used in the absence of the project activity
Source of data:	On-site measurements
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:	Applicable to scenario 16 in cases where $Q_{biomass,historic,3yr}$ has not been measured or can not directly be measured because other fuels are co-fired

Parameter:	**$BF_{historic,k,3y}$**
Data unit:	tons of dry matter or liter[9]
Description:	Quantity of biomass residue type *k* used as fuel in all installations (power plants, boilers, etc) 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):	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:	Applicable to scenario 10

Parameter:	**Moisture content of biomass residues used historically**
Data unit:	% Water content
Description:	Moisture content of each biomass residue type *k* or *i*
Source of data:	On-site measurements
Measurement procedures (if any):	
Any comment:	Applicable to scenario 10 and to scenario 16 in case where $Q_{biomass,historic,3yr}$ is not determined directly. In case of dry biomass, determination of this parameter is not necessary.

Parameter:	**NCV_i**
Data unit:	GJ / mass or volume unit
Description:	Net calorific values 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.
Any comment:	Applicable to scenarios 5, 6, 7, 8 and 17

Parameter:	**$EF_{CO2,FF,ref}$**
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor for the fossil fuel type that would in the absence of the project activity be used in the reference plant
Source of data:	Use the IPCC default value of the fuel type identified as part of the baseline scenario selection procedure at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement procedures (if any):	-
Any comment:	Applicable to scenario 20

Parameter:	**$EF_{CO2,BL,heat}$**
Data unit:	tCO_2/GJ

Description:	CO_2 emission factor of the fossil fuel type used for heat generation in the absence the project activity
Source of data:	Use the IPCC default value of the fuel type identified as part of the baseline scenario selection procedure at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Measurement procedures (if any):	-
Any comment:	Applicable to scenario 20

Parameter:	**$B_{o,WW}$**
Data unit:	t CH_4 / t COD
Description:	Methane generation potential of the waste water
Source of data:	2006 IPCC Guidelines
Value to be applied:	0.25
Any comment:	Applicable if waste water originating from the treatment of the biomass is (partly) treated under anaerobic conditions and where methane from the waste water is not captured and flared or combusted

Parameter:	**MCF_{WW}**
Data unit:	-
Description:	Methane correction factor for the waste water
Source of data:	2006 IPCC Guidelines
Value to be applied:	Use 1.0 as a conservative default
Any comment:	Applicable if waste water originating from the treatment of the biomass is (partly) treated under anaerobic conditions and where methane from the waste water is not captured and flared or combusted

Document and justify all selected values in the CDM-PDD.

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.

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated differently in the comments in the tables below.

Project participants should establish a system to monitor the amount of all types of biomass combusted. If the amount of biomass combusted is estimated from the amount of biomass delivered to the project site, a procedure should be established to undertake an energy balance for the verification period, considering the stocks of biomass at the beginning and end of each verification period. On-site fossil fuel consumption for the operation of the biomass power plant should be metered through mass or volume (flow) meters, or with an energy balance over the verification period, considering stocks at the beginning and at the end of each verification period. Where possible, project participants should cross-check these estimates with fuel purchase receipts.

Data and parameters monitored

Data / Parameter:	$BF_{k,y}$
Data unit:	tons of dry matter or liter[9]
Description:	Quantity of biomass residue type *k* combusted in the project plant 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 electricity (and heat) generated and any fuel purchase receipts (if available).
Monitoring frequency:	Continuously, prepare annually an energy balance.
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	

Data / Parameter:	$BF_{T,k,y}$
Data unit:	tons of dry matter or liter[9]
Description:	Quantity of biomass residue type *k* that has been transported to the project site during the year *y* where *k* are the types of biomass residues used in the project plant in 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 electricity (and heat) generated and any fuel purchase receipts (if

	available).
Monitoring frequency:	Continuously, prepare annually an energy balance.
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	

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:	$\mathbf{EF_{CH4,BF}}$
Data unit:	tCH_4/GJ
Description:	CH_4 emission factor for the combustion of biomass residues in the project plant
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:	$\mathbf{AVD_y}$
Data unit:	km
Description:	Average round trip distance (from and to) between biomass fuel supply sites and the project site
Source of data:	Records by project participants on the origin of the biomass
Measurement procedures (if any):	
Monitoring frequency:	Continuously
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:	Applicable if option 1 is chosen to estimate CO_2 emissions from transportation. If biomass is supplied from different sites, this parameter should correspond to the mean value of km traveled by trucks that supply the biomass plant

Data / Parameter:	N_y
Data unit:	-
Description:	Number of truck trips for the transportation of biomass.
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, e.g. by the relation with previous years.
Any comment:	Applicable if option 1 is chosen to estimate CO_2 emissions from transportation. 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 for transportation of biomass.
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:	Applicable if option 1 is chosen to estimate CO_2 emissions from transportation. Project participants have to monitor either the number of truck trips N_y or this parameter.

Data / Parameter:	$EF_{km,CO2,y}$
Data unit:	tCO_2/km
Description:	Average CO_2 emission factor 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:	Applicable if option 1 is chosen to estimate CO_2 emissions from transportation.

Data / parameter:	**$FC_{TR,i,y}$**
Data unit:	Mass or volume unit[10]
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:	Applicable if option 2 is chosen to estimate CO_2 emissions from transportation.

Data / Parameter:	**$EF_{CO2,FF,i}$**
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):	Measurements shall be carried out at reputed laboratories and according to relevant international standards.
Monitoring frequency:	In case of measurements: At least every six months, taking at least three samples for each measurement. In case of other data sources: Review the appropriateness of the data annually.
QA/QC procedures:	Check consistency of measurements and local / national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements.
Any comment:	

~~**Data / Parameter:**~~	~~**$EF_{CO2,BL,heat,i}$**~~
~~Data unit:~~	~~tCO_2/GJ~~
~~Description:~~	~~CO_2 emission factor of the fossil fuel type *i* used for heat generation in the absence the project activity~~
~~Source of data:~~	~~Either conduct measurements or use accurate and reliable local or national data where available. Where such data is not available, use IPCC default emission factors (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the value in a conservative manner and justify the choice.~~
~~Measurement procedures (if any):~~	~~Measurements shall be carried out at reputed laboratories and according to relevant international standards.~~
~~Monitoring frequency:~~	~~In case of measurements: At least every six months, taking at least three samples for each measurement.~~ ~~In case of other data sources: Review the appropriateness of the data annually.~~
~~QA/QC procedures:~~	~~Check consistency of measurements and local / national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements.~~

~~Any comment:~~	~~For the purpose of determining $EF_{FF,CO2,y}$, the least or most carbon intensive fuel type – whatever is more conservative – 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 at the project site in the year *y*.[21]~~

Data / Parameter:	**$FF_{project\ plant,i,y}$**
Data unit:	mass or volume unit per year[10]
Description:	Quantity of fossil fuel type *i* combusted in the project plant during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight or volume meters.
Monitoring frequency:	Continuously
QA/QC procedures:	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes.
Any comment:	This should include fossil fuels co-fired in the project plant but not any other fuel consumption at the project site that is attributable to the project activity (e.g. for mechanical preparation of the biomass residues)

Data / Parameter:	**$FF_{project\ site,i,y}$**
Data unit:	mass or volume unit per year[10]
Description:	Quantity of fossil fuel type *i* combusted at the project site for other purposes that are attributable to the project activity during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Use weight or volume meters
Monitoring frequency:	Continuously
QA/QC procedures:	Cross-check the measurements with an annual energy balance that is based on purchased quantities and stock changes.
Any comment:	This should not include fossil fuels co-fired in the project plant but any other fuel consumption at the project site that is attributable to the project activity (e.g. for mechanical preparation of the biomass residues)

Data / Parameter:	**-**
Data unit:	GJ
Description:	Quantity of steam diverted from other boilers to the project plant.
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net heat generation should be cross-checked with receipts from sales (if available) and the quantity of biomass fired (e.g. check whether the net heat generation divided by the quantity of biomass fired results in

[21] This provisions aims to avoid potential gaming through the use of more or less carbon intensive fuels. Note that if $ER_{heat,y} > 0$ the use of the least carbon intensive fuel is conservative, whereas in cases where $ER_{heat,y} < 0$ the use of the most carbon intensive fuel is conservative.

	a reasonable thermal efficiency that is comparable to previous years).
Any comment:	This parameter only needs to be monitored if steam used in the project plant is partly produced in separate boilers.

Data / Parameter:	**-**
Data unit:	-
Description:	Average net efficiency of steam generation in the plant(s) from where steam is diverted to the project plant
Source of data:	
Measurement procedures (if any):	The efficiency should be calculated by dividing the steam generation by the sum of the fuels used, both expressed in energy units.
Monitoring frequency:	Annually
QA/QC procedures:	Check consistency with manufacturers information or the efficiency of comparable plants. See guidance on efficiency at the beginning of the Monitoring methodology section.
Any comment:	This parameter only needs to be monitored if steam used in the project plant is partly produced in separate boilers

Data / Parameter:	$EG_{project\ plant,y}$
Data unit:	MWh/yr
Description:	Net quantity of electricity generated in the project plant during the year y
Source of data:	On-site measurements
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net electricity generation should be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Any comment:	

Data / Parameter:	$EG_{CP,y}$
Data unit:	MWh/yr
Description:	Net quantity of electricity generated in the fossil fuel fired captive power plant during the year y
Source of data:	On-site measurements
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net electricity generation should be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Any comment:	Applicable to scenarios 5, 6, 7, 8 and 17

Data / Parameter:	**$EG_{total,y}$**
Data unit:	MWh/yr
Description:	Net quantity of electricity generated in all power plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant, including the new power plant installed as part of the project activity and any previously existing plants, during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net electricity generation should be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Any comment:	The fraction of electricity generated from firing biomass residues should be determined by dividing the relevant quantity of biomass residues by the total quantity of all fuels fired, both expressed in energy quantities. The relevant quantity of biomass refers to those biomass residue types that are fired in the project plant.

Data / Parameter:	**$Q_{project\ plant,y}$**
Data unit:	GJ
Description:	Net quantity of heat generated from firing biomass in the project plant
Source of data:	On-site measurements
Measurement procedures (if any):	Net heat generation is determined as the difference of the enthalpy of the steam generated by the project cogeneration plant minus the enthalpy of the feed-water 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. The fraction of heat generated from firing biomass residues should be determined by dividing the quantity of biomass residues fired by the total quantity of all fuels fired, both expressed in energy quantities.
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net heat generation should be cross-checked with receipts from sales (if available) and the quantity of fuels fired (e.g. check whether the net heat generation divided by the quantity of fuels fired results in a reasonable thermal efficiency that is comparable to previous years).
Any comment:	Only applicable to cogeneration project activities.

Data / Parameter:	**$Q_{total,y}$**
Data unit:	GJ
Description:	Net quantity of heat generated in all cogeneration plants at the project site, generated from firing the same type(s) of biomass residues as in the project plant, including the cogeneration plant installed as part of the project activity and any previously existing plants, during the year *y*
Source of data:	On-site measurements
Measurement procedures (if any):	Net heat generation is determined as the difference of the enthalpy of the steam generated by the cogeneration plants minus the enthalpy of the feed-water 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. The fraction of heat generated from firing biomass residues should be determined by dividing the quantity of biomass residues fired by the total quantity of all fuels fired, both expressed in energy quantities.
Monitoring frequency:	Continuously
QA/QC procedures:	The consistency of metered net heat generation should be cross-checked with receipts from sales (if available) and the quantity of biomass fired (e.g. check whether the net heat generation divided by the quantity of biomass fired results in a reasonable thermal efficiency that is comparable to previous years).
Any comment:	Only applicable to cogeneration project activities.

Data / Parameter:	**NCV_i**
Data unit:	GJ / mass or volume unit
Description:	Net calorific value of the 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, possibly collect additional information or conduct 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:	**$EF_{burning,CH4,k,y}$**
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:	ε_{boiler}
Data unit:	-
Description:	Average net energy efficiency of heat generation in the boiler that would generate heat in the absence of the project activity
Source of data:	Either use the higher value among (a) the measured efficiency 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.
Monitoring frequency:	Quarterly, if the boiler continues to operate during the crediting period Once at the project start, if the boiler is retired at the start of the project activity
QA/QC procedures:	Check consistency with manufacturers information or the efficiency of comparable plants.
Any comment:	Note that this parameter is used for various different boiler(s) that would generate heat in the baseline, depending on the relevant scenario.

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* 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

Data / parameter:	-
Data unit:	Tons
Description:	Quantity of available biomass residues of type *k* 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

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

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 grid electricity during the year *y*
Source of data:	Use the latest approved version of ACM0002 to calculate the grid emission factor. If the power generation capacity of the project plant is less or equal to 15 MW, project participants may use the average CO_2 emission factor of the electricity system, as referred to in option (d) in step 1 of the baseline determination in ACM0002.
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:	**$BF_{all\ plants,k,y}$**
Data unit:	tons of dry matter or liter[9]
Description:	Quantity of biomass residue type *k* combusted in all power plants 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 cross-checked 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:	Applicable to scenario 10

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:	**$EF_{CP,CO2}$**
Data unit:	t CO_2 per GJ or MWh
Description:	CO_2 emission factor for the fossil fuel used in the captive power plant
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 $EF_{CP,CO2}$, 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 at the project site due the year *y*.