CLEAN DEVELOPMENT MECHANISM

ACM0006

Large-scale Consolidated Methodology

Electricity and heat generation from biomass

Version 14.0

Sectoral scope(s): 01

United Nations
Framework Convention on
Climate Change

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1. Introduction

1. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Generation of power and heat in thermal power plants, including cogeneration plants using biomass. Typical activities are new plant, capacity expansion, energy efficiency improvements or fuel switch projects
Type of GHG emissions mitigation action	• Renewable energy; • Energy efficiency; • Fuel switch; • GHG emission avoidance.

2. Scope, applicability, and entry into force

2.1. Scope

2. This methodology is applicable to project activities that operate biomass (co-)fired power-and-heat plants.[1] The CDM project activity may include the following activities or, where applicable, combinations of these activities:

(a) The installation of new plants at a site where currently no power or heat generation occurs (Greenfield projects);

(b) The installation of new plants at a site where currently power or heat generation occurs. The new plant replaces or is operated next to existing plants (capacity expansion projects);

(c) The improvement of energy efficiency of existing plants (energy efficiency improvement projects), which can also lead to a capacity expansion, e.g. by retrofitting the existing plant;

(d) The total or partial replacement of fossil fuels by biomass in existing plants or in new plants that would have been built in the absence of the project (fuel switch projects), e.g. by increasing the share of biomass use as compared to the baseline, by retrofitting an existing plant to use biomass.

1 The applicability of the methodology is restricted to power and heat projects. Power-only projects should refer to the consolidated methodology ACM0018 “Electricity generation from biomass in power-only plants”.

2.2. Applicability

3. The methodology is applicable under the following conditions:

   (a) Biomass used by the project facility is limited to biomass residues, biogas, RDF[2] and/or biomass from dedicated plantations;

   (b) Fossil fuels may be co-fired in the project plant. However, the amount of fossil fuels co-fired does not exceed 80% of the total fuel fired on energy basis;

   (c) For projects that use biomass residues from a production process (e.g. production of sugar or wood panel boards), the implementation of the project does 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;

   (d) The biomass used by the project facility is not stored for more than one year;

   (e) The biomass used by the project facility is not processed chemically or biologically (e.g. through esterification, fermentation, hydrolysis, pyrolysis, bio- or chemical-degradation, etc.) prior to combustion. Thermal degradation, drying and mechanical processing, such as shredding and pelletisation, are allowed.

4. In the case of fuel switch project activities, the use of biomass or the increase in the use of biomass as compared to the baseline scenario is technically not possible at the project site without a capital investment in:

   (a) The retrofit or replacement of existing heat generators/boilers; or

   (b) The installation of new heat generators/boilers; or

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

   (d) Equipment for preparation and feeding of biomass.

5. If biogas is used for power and/or heat generation, the biogas must be generated by anaerobic digestion of wastewater, and:

   (a) If the wastewater generation source is registered as a CDM project activity, the details of the wastewater project shall be included in the PDD, and emission reductions from biogas energy generation are claimed using this methodology;

   (b) If the wastewater source is not a CDM project, the amount of biogas does not exceed 50% of the total fuel fired on energy basis.

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

6. In the case biomass from dedicated plantations are used, the applicability conditions of the methodological tool “Project and leakage emissions from biomass” apply.

7. Finally, the methodology is only applicable if the baseline scenario, as identified per the “Selection of the baseline scenario and demonstration of additionality” section hereunder, is:

   (a) For power generation: scenarios P2 to P7, or a combination of any of those scenarios;

   (b) For heat generation: scenarios H2 to H7, or a combination of any of those scenarios;

   (c) If some of the heat generated by the CDM project activity is converted to mechanical power through steam turbines, for mechanical power generation: scenarios M2 to M5:

      (i) In the case of M2 and M3, if the steam turbine(s) are used for mechanical power in the project, the turbine(s) used in the baseline shall be at least as efficient as the steam turbine(s) used for mechanical power in the project;

      (ii) In the case of M4 and M5, steam turbine(s) for mechanical power are not allowed for the same purpose in the project;

2.3. Entry into force

8. The date of entry into force is the date of the publication of the EB 101 meeting report on 29 November 2018.

2.4. Applicability of sectoral scopes

9. For validation and verification of CDM projects and programme of activities by a designated operational entity (DOE) using this methodology application of sectoral scope 01 is mandatory.

3. Normative references

10. This consolidated baseline and methodology is based on elements from the following approved consolidated baseline and monitoring methodologies:

   (a) “ACM0014: Treatment of wastewater”;

   (b) “ACM0017: Production of biodiesel for use as fuel”;

   (c) “AMS-III.H: Methane recovery in wastewater treatment”.

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

   (a) “Combined tool to identify the baseline scenario and demonstrate additionality;

   (b) “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”;

   (c) “Emissions from solid waste disposal sites”;

(d) "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation";

(e) "Tool to calculate the emission factor for an electricity system";

(f) "Determining the baseline efficiency of thermal or electric energy generation systems";

(g) "Tool to determine the remaining lifetime of equipment";

(h) "Assessment of the validity of the original/current baseline and to update of the baseline at the renewal of the crediting period";

(i) "Project and leakage emissions from transportation of freight";

(j) "Project and leakage emissions from biomass".

12. For more information regarding the proposals and the tools as well as their consideration Executive Board (hereinafter referred to as the Board) of the clean development mechanism (CDM) please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

3.1. Selected approach from paragraph 48 of the CDM modalities and procedures

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

4. Definitions

14. The definitions contained in the Glossary of CDM terms shall apply.

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

(a) **Biomass**[3] non-fossilized and biodegradable organic material originating from plants, animals and microorganisms including:

(i) Biomass residue;

(ii) The non-fossilized and biodegradable organic fractions of industrial and municipal wastes; and

(iii) The gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material;

(b) **Biomass residues** - non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms which is a by-product, residue or waste stream from agriculture, forestry and related industries;

(c) **Cogeneration plant** - a power-and-heat plant in which at least one heat engine simultaneously generates both process heat and power;

(d) **Dedicated plantations** - plantations that are newly established as part of the CDM project activity for the purpose of supplying cultivated biomass to the project plant;

[3] The definitions of biomass and biomass residue are taken from the Glossary of CDM terms.

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

(f) **Heat generator** - a facility that generates heat by combustion of fuels. This includes, for example, a boiler that supplies steam or hot water, a heater that supplies hot oil or thermal fluid, or a furnace that supplies hot gas or combustion gases. When several heat generators are included in one project activity, each heat generator is referred to as “unit”;

(g) **Heat-to-power ratio** - the quantity of process heat recovered from a heat engine per unit of electricity generated in the same heat engine, measured in the same energy units. For example, a heat engine producing 1 MWh_{el} of electricity and 2 MWh_{th} of process heat has a heat-to-power ratio of 2;

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

(i) **Process heat** - the useful heat that is not used for electric power generation. It could include the heat used for mechanical power generation, where applicable;

(j) **Power** - electric power, unless explicitly mentioned otherwise;

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

(l) **Power-only plant** - a power plant to which the following conditions apply:

(i) All heat engines of the power plant produce only power and do not cogenerate heat; and

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

(m) **Power-and-heat plant** - a power plant which does not fulfil the conditions of a power-only plant. Power-and-heat plants encompass thus two broad categories of power plants: cogeneration plants (as defined above) and plants in which heat and power are produced at the same installation although not in cogeneration mode, e.g. a common heat header supplies heat for both process heat and power generation.

5. Baseline methodology

5.1. Project boundary

16. The spatial extent of the project boundary encompasses:

(a) All plants generating power and/or heat located at the project site, whether fired with biomass, fossil fuels or a combination of both;

(b) All power plants connected physically to the electricity system (grid) that the project plant is connected to;

(c) If applicable, all off-site heat sources that supply heat to the site where the CDM project activity is located (either directly or via a district heating system);

(d) The means of transportation of biomass to the project site;

(e) If the feedstock is biomass residues, the site where the biomass residues would have been left for decay or dumped;

(f) If the feedstock is biomass produced in dedicated plantations the geographic boundaries of the dedicated plantations;

(g) The wastewater treatment facilities used to treat the wastewater produced from the treatment of biomass;

(h) If biogas is included, the site of the anaerobic digester.

17. Note that the project boundary encompasses not only the plants generating power and/or heat that are directly affected by the CDM project activity (e.g. retrofitted or installed) but also all other plants generating power and/or heat located at the same site as the CDM project activity, whether fired with biomass, fossil fuels or a combination of both. Thus, power and heat generation, grid power and heat imports/exports should be considered for the whole site where the CDM project activity is located and all facilities are to be included in the power and heat balances.

Table 2. Emission sources included in or excluded from the project boundary

Source		Gas	Included	Justification/Explanation
Baseline	Electricity and heat generation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Uncontrolled burning or decay of surplus biomass residues	CO_2	No	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Yes or No	Project participants may decide to include this emission source, where case B1, B2 or B3 has been identified as the most likely baseline scenario
		N_2O	No	Excluded for simplification. This is conservative. Note also that emissions from natural decay of biomass are not included in GHG inventories as anthropogenic sources
Project activity	On-site fossil fuel consumption	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Off-site transportation of biomass	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Combustion of biomass for electricity and heat	CO_2	No	It is assumed that CO_2 emissions from surplus biomass do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Yes or No	This emission source must be included if CH_4 emissions from uncontrolled burning or decay of biomass residues in the baseline scenario are included

Source		Gas	Included	Justification/Explanation
		N_2O	No	Excluded for simplification. This emission source is assumed to be small
	Wastewater from the treatment of biomass	CO_2	No	It is assumed that CO_2 emissions from surplus biomass do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Yes	This emission source shall be included in cases where the waste water is treated (partly) under anaerobic conditions
		N_2O	No	Excluded for simplification. This emission source is assumed to be small
	Cultivation of land to produce biomass feedstock	CO_2	Yes	This emission source shall be included in cases biomass from dedicated plantation is used
		CH_4	Yes	This emission source shall be included in cases biomass from dedicated plantation is used
		N_2O	Yes	This emission source shall be included in cases biomass from dedicated plantation is used

5.2. Project documentation

18. The project participants shall document the specific situation of the CDM project activity in the CDM-PDD:

(a) For each plant generating power and/or heat that operated at the project site in the three years prior to the start of the CDM project activity: the type and capacity of the heat generators, the types and quantities of fuels used in the heat generators, the type and capacity of heat engines, and whether the equipment continues operation after the start of the CDM project activity;

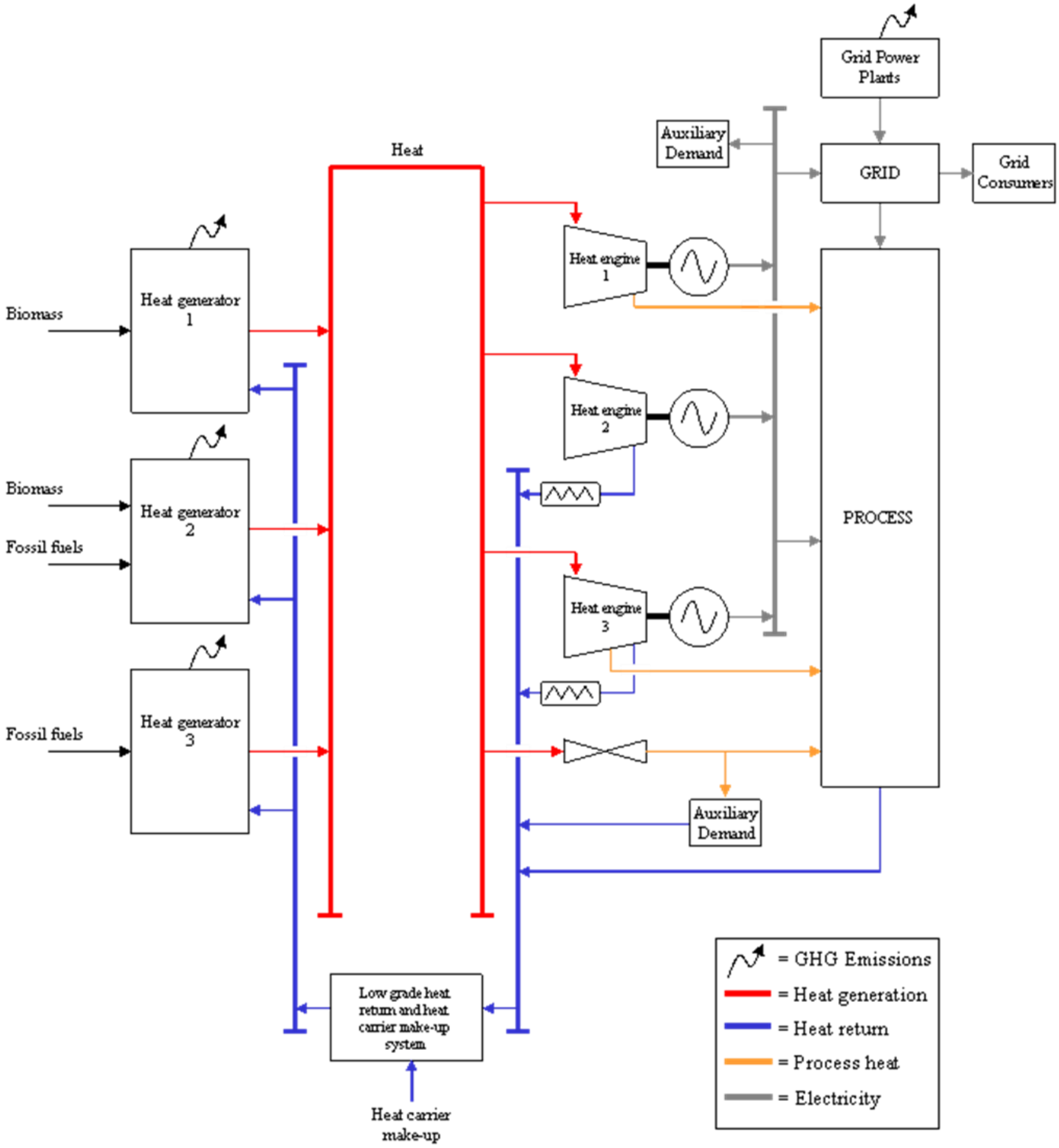
(b) For each plant generating power and/or heat installed under the CDM project activity: the type and capacity of the heat generators, the types and quantities of fuels used in the heat generators, the type and capacity of heat engines and direct heat extractions;

(c) For each plant generating power and/or heat that would be installed in the absence of the CDM project activity: the type and capacity of the plant, the type and capacity of the heat generators, heat engines and electric power generators and the types and quantities of fuels which would be used in each heat generator;

(d) The average amounts of electricity and heat that would be imported from off-site sources in the absence of the CDM project activity and the import forecast for the project scenario;

(e) A schematic diagram of the configuration of the CDM project activity and the baseline scenario, similar to the one presented in Figure 1. The diagram in Figure 1 is only an example. Project activities may differ from that configuration.

Figure 1. Schematic diagram of the CDM project activity and the baseline scenario



5.3. Selection of the baseline scenario and demonstration of additionality

19. The selection of the baseline scenario and demonstration of additionality should be conducted by applying the "Combined tool to identify the baseline scenario and demonstrate additionality" using the following guidance.

5.3.1. Identification of alternative scenarios

20. The alternative scenarios should specify:

(a) How electric power would be generated in the absence of the CDM project activity (P scenarios);

(b) How heat would be generated in the absence of the CDM project activity (H scenarios);

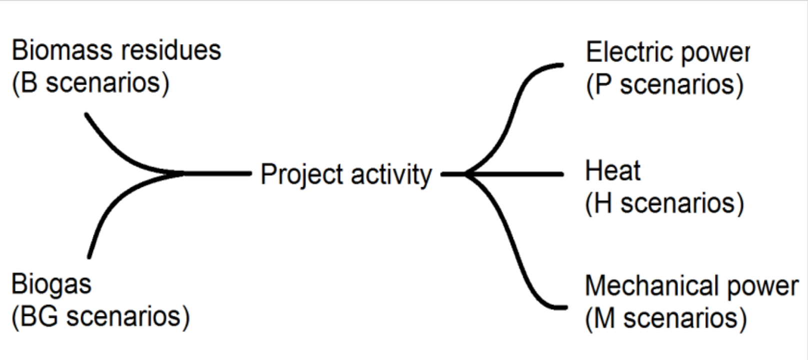
(c) If the CDM project activity generates mechanical power through steam turbine(s): how the mechanical power would be generated in the absence of the CDM project activity (M scenarios);

(d) If the CDM project activity uses biomass residues, what would happen to the biomass residues in the absence of the CDM project activity (B scenarios); and

(e) If the CDM project activity uses biogas from on-site wastewater, what would happen to the biogas in the absence of the CDM project activity (BG scenarios).

Box 1. Non-binding best practice example 1: Selection of the baseline scenario

Project participants should identify all alternative scenarios in terms of input and output in the absence of the project activity, including the project activity not being undertaken as a CDM project activity, the continuation of the baseline scenario and all plausible and relevant alternatives scenarios.



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

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

(b) P2: If applicable,[4] the continuation of power generation in existing power plants at the project site. The existing plants would operate at the same conditions (e.g. installed capacities, average load factors, or average energy efficiencies, fuel mixes, and equipment configuration) as those observed in the most recent three years prior to the starting date of the CDM project activity;

(c) P3: If applicable (see footnote 4), the continuation of power generation in existing power plants at the project site. The existing plants would operate with

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

different conditions from those observed in the most recent three years prior to the starting date of the project CDM activity;

(d) P4: If applicable,[5] the retrofitting of existing power plants at the project site. The retrofitting may or may not include a change in fuel mix;

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

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

(g) P7: The generation of power in the power grid.

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

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

(b) H2: If applicable (see footnote 5), the continuation of heat generation in existing plants at the project site. The existing plants would operate at the same conditions (e.g. installed capacities, average load factors, or average energy efficiencies, fuel mixes, and equipment configuration) as those observed in the most recent three years prior to the CDM project activity;

(c) H3: If applicable (see footnote 5), the continuation of heat generation in existing plants at the project site. The existing plants would operate with different conditions from those observed in the most recent three years prior to the CDM project activity;

(d) H4: If applicable (see footnote 5), the retrofitting of existing plants at the project site. The retrofitting may or may not include a change in fuel mix;

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

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

(g) H7: The use of heat from district heating.

23. The alternative scenarios for mechanical power should include, but not be limited to, inter alia:

(a) M1: The proposed project activity not undertaken as a CDM project activity;

(b) M2: If applicable (see footnote 5), the continuation of mechanical power generation from the same steam turbines in existing plants at the project site;

(c) M3: The installation of new steam turbines at the project site;

(d) M4: If applicable (see footnote 5), the continuation of mechanical power generation from electrical motors in existing plants at the project site;

(e) M5: The installation of new electrical motors at the project site.

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

24. When defining plausible and credible alternative scenarios for power and heat generation, the guidance below should be followed:

(a) For any of the alternative scenarios described above, all assumptions with respect to installed capacities, load factors, energy efficiencies, fuel mixes, and equipment configuration, should be clearly described and justified in the CDM-PDD. The justification for existing plants should be based on the conditions of the existing plants and the justification for new plants, or changes to existing plants, should be based on design parameters selected considering realistic and credible alternative design options;

(b) The whole electricity and heat generation under the project scenario must be considered in the selection of the baseline scenario. Therefore, the capacities of heat and electricity generation, including the grid if applicable, considered in the baseline scenario should be able to deliver the same level of process heat and power generation as that of the project scenario;

(c) If the CDM project activity involves an increase in installed capacity, an increase in generation, and/or a change in demand of electricity or heat as compared to the historical situation, the baseline scenario should be determined for the overall generation under the CDM project activity, possibly including a combination of the different scenarios described above. This is particularly relevant for cases in which existing plants have operated at the project site prior to the implementation of the CDM project activity;

(d) In cases where alternative scenarios include the installation of new power or heat generation capacity at the project site other than the proposed project activity, the economically most attractive technology and fuel mix should be identified among those which provide the same service (i.e. the same power and, if applicable, heat quantity), that are technologically available and that are in compliance with relevant regulations. The type of technology, the efficiency of the plants and the fuel type should be selected in a conservative manner, i.e. where several technologies and/or fuel types could be used and are similarly economically attractive, the least carbon intensive fuel type/the most efficient technology should be considered. Ensure that the selected technology represents at least the common practice for new plants in the respective industry sector, in the country or region, excluding CDM registered projects;[6]

(e) If existing plants operated at the project site prior to the implementation of the CDM project activity, they could be retired at the start of the project CDM activity because they are replaced by the project plant, or they may initially be operated in parallel to the project plant and be retired at a future point in time (at the end of their lifetime). In such cases, the remaining lifetime of the existing equipment has to be determined and a baseline based on historical performance only applies until the existing power plant would have been replaced or retrofitted in the absence of the CDM project activity. From that point of time, a different baseline shall apply. For the purpose of determining the remaining lifetime of equipment, use the latest version of the “Tool to determine the remaining lifetime of equipment”. The remaining lifetime should be selected in conservative manner, i.e. the earliest point

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

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.

25. When using biomass residues, the alternative scenarios of the biomass residues in absence of the project activity shall be determined following the guidance in the methodological tool “Project and leakage emissions from biomass”.

26. In addition to the alternative scenarios included in the methodological tool “Project and leakage emissions from biomass”, the alternative scenarios shall include:

(a) B5: The biomass residues are used for power or heat generation at the project site in new and/or existing plants;

27. In case the proposed project activity includes the use of biogas, the project shall consider the following baseline alternatives for the biogas:

(a) BG1: No biogas would be generated and wastewater would not be treated by anaerobic digestion;

(b) BG2: Biogas is captured and flared;

(c) BG3: Biogas is captured and used to produce electricity and/or thermal energy;

(d) BG4: Biogas is captured and used as feedstock or transportation fuel.

28. When defining plausible and credible alternative scenarios for the use of biogas, the guidance below should be followed:

(a) If scenario BG1 and BG2 are selected, no biogas shall be included in the baseline scenario of the proposed project activity;

(b) If scenario BG3 is selected, the same amount of biogas produced in the project shall be included in the baseline scenario. For the purpose of calculating the “Baseline Emissions” the biogas shall be considered a biomass residue;

(c) If scenario BG4 is selected, the methodology is not applicable;

(d) In case any emission reductions are claimed for the avoidance of methane in scenario BG1, the baseline scenario for and additionality of the biogas shall be determined in a separate biogas CDM project activity using methodology ACM0014 or AMS-III.H. In addition, all baseline, project and emissions not related to energy generation shall be accounted for in the biogas CDM project activity. Any incremental costs related to biogas energy generation in the project scenario shall be included in the biogas CDM PDD (e.g. costs of pipes, burner and control systems) and not in the proposed project activity under this methodology;

(e) In case of scenario BG2 and BG3 any incremental costs related to biogas energy generation in the project scenario shall be included in the PDD of the proposed project activity using this methodology. In case the biogas is supplied by an existing CDM project activity its reference shall be included in the PDD. Any required changes to the existing CDM project activity (e.g. change in project emissions due to flare emissions, reduction of certified emission reductions (CERs) due to energy supply to this methodology) shall be dealt with in the PDD of the existing CDM project activity.

29. For the purpose of identifying relevant alternative scenarios, provide an overview of *other* technologies or practices that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity and that have been implemented previously or are currently underway in the relevant geographical area. The relevant geographical area should in principle be the host country of the proposed CDM project activity. A region within the country could be the relevant geographical area if the framework conditions vary significantly within the country. However, the relevant geographical area should include preferably ten facilities (or projects) that provide outputs or services with comparable quality, properties and application areas as the proposed CDM project activity. If less than ten facilities (or projects) that provide outputs or services with comparable quality, properties and applications as the proposed CDM project activity are found in the region/host country, the geographical area may be expanded to an area that covers if possible, ten such facilities (or projects). In cases where the above described requirements for geographical area are not suitable, the project proponents should provide an alternative definition of geographical area. Other registered CDM project activities are not to be included in this analysis.

5.3.2. Investment analysis

30. The analysis should include all alternative scenarios which are not prevented by barriers, including scenarios where the project participants do not undertake an investment (e.g. a combination of B1 and P7).

5.4. Emission reductions

31. Emission reductions are calculated as follows:

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

Where:

ER_y	=	Emissions reductions in year *y* (t CO_2)
BE_y	=	Baseline emissions in year *y* (t CO_2)
PE_y	=	Project emissions in year *y* (t CO_2)
LE_y	=	Leakage emissions in year *y* (t CO_2)

32. A schematic diagram of the CDM project activity and the baseline scenario is presented in Figure 1.

5.5. Baseline emissions

33. Baseline emissions are calculated based on the baseline scenario identified in the section “Selection of the baseline scenario and demonstration of additionality”, above, taking into account how power and heat would be generated, and how the biomass would be used, in the absence of the CDM project activity.

34. Note that in the absence of the project activity, biomass residues could be (i) dumped, left to decay or burnt without being used (scenarios B1, B2 and B3) or (ii) used for other applications. Related baselines emissions are only calculated in the first case, according

to Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues.

35. In the baseline scenario power and heat could be generated in three different ways:

(a) **Use of biomass residues at the project site.** Power and heat could be generated with biomass residues at the project site. This applies, for example, (but not limited to) if:

(i) The CDM project activity is a replacement of an existing biomass residues fired plant;

(ii) The CDM project activity is a capacity expansion of an existing biomass residues fired plant;

(iii) The CDM project activity is a fuel switch project activity where some biomass residues have already been used prior to the implementation of the CDM project activity;

(iv) The CDM project activity is a retrofit of an existing biomass residues fired plant; and/or

(b) **Use of fossil fuels at the project site.** Power and heat could be generated with fossil fuels. This applies, for example, if:

(i) The CDM project activity is a fuel switch from fossil fuels to biomass residues;

(ii) In the baseline, a fossil fuel fired plant would continue to operate at the project site in parallel with a new biomass residues fired plant; and/or

(c) **Power generation in the electricity grid.** Power could be generated by power plants in the electricity grid. This applies, for example, if:

(i) The CDM project activity exports electricity to the grid and no electricity would be produced at the project site in the baseline;

(ii) The CDM project activity results in an increase of the quantity of power produced by plants included in the project boundary and this increased power is exported to the grid or would in the baseline be purchased from the grid;

(iii) No electricity would be produced at the project site in the baseline and power produced by plants included in the project boundary would in the baseline be purchased from the grid.

36. In many cases, power and heat would be generated in the baseline by a combination of these three ways and it may be difficult to clearly determine the precise mix of power generation in the grid and power or heat generation with biomass residues or fossil fuels that would have occurred in the absence of the CDM project activity. If power can be generated in an on-site fossil fuel power plant or can be purchased from the grid, it is particularly challenging to determine how electricity would be generated in the baseline. For example, to what extent an existing coal power plant is dispatched and to what extent electricity is purchased from the grid can depend on the prices for electricity and coal which change over time.

37. For this reason, this methodology adopts a conservative approach and assumes that biomass residues, if available, would be used in the baseline as a priority for the generation of power and heat. Furthermore, it is assumed that the heat provided by heat generators is used first in heat engines which operate in cogeneration mode, then in thermal applications to satisfy the heat demand, and after that in heat engines which operate for the generation of power only.

38. Based on these assumptions, baseline emissions are calculated as follows:

$$BE_y = EL_{BL,GR,y} \times EF_{EG,GR,y} + \sum_f FF_{BL,HG,y,f} \times EF_{FF,y,f} + EL_{BL,FF/GR,y} \times min\left(EF_{EG,GR,y}, EF_{EG,FF,y}\right) + BE_{BR,y}$$ Equation (2)

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2)
$EL_{BL,GR,y}$	=	Baseline minimum electricity generation in the grid in year *y* (MWh)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (t CO_2/MWh)
$FF_{BL,HG,y,f}$	=	Baseline fossil fuel demand for process heat in year *y* (GJ)
$EF_{FF,y,f}$	=	CO_2 emission factor for fossil fuel type *f* in year *y* (t CO_2/GJ)
$EL_{BL,FF/GR,y}$	=	Baseline uncertain electricity generation in the grid or on-site in year *y* (MWh)
$EF_{EG,GR,y}$	=	CO_2 emission factor for electricity generation with fossil fuels at the project site in the baseline in year *y* (t CO_2/MWh)
$BE_{BR,y}$	=	Baseline emissions due to disposal of biomass residues in year *y* (t CO2e)
y	=	Year of the crediting period
f	=	Fossil fuel type

39. The algorithm used to determine the data above can be summarized as follows:

(a) Step 1: Determine biomass availability, generation and capacity constraints, efficiencies and power emission factors;

(b) Step 2: Determine the minimum baseline electricity generation in the grid;

(c) Step 3: Determine the baseline biomass-based heat and power generation;

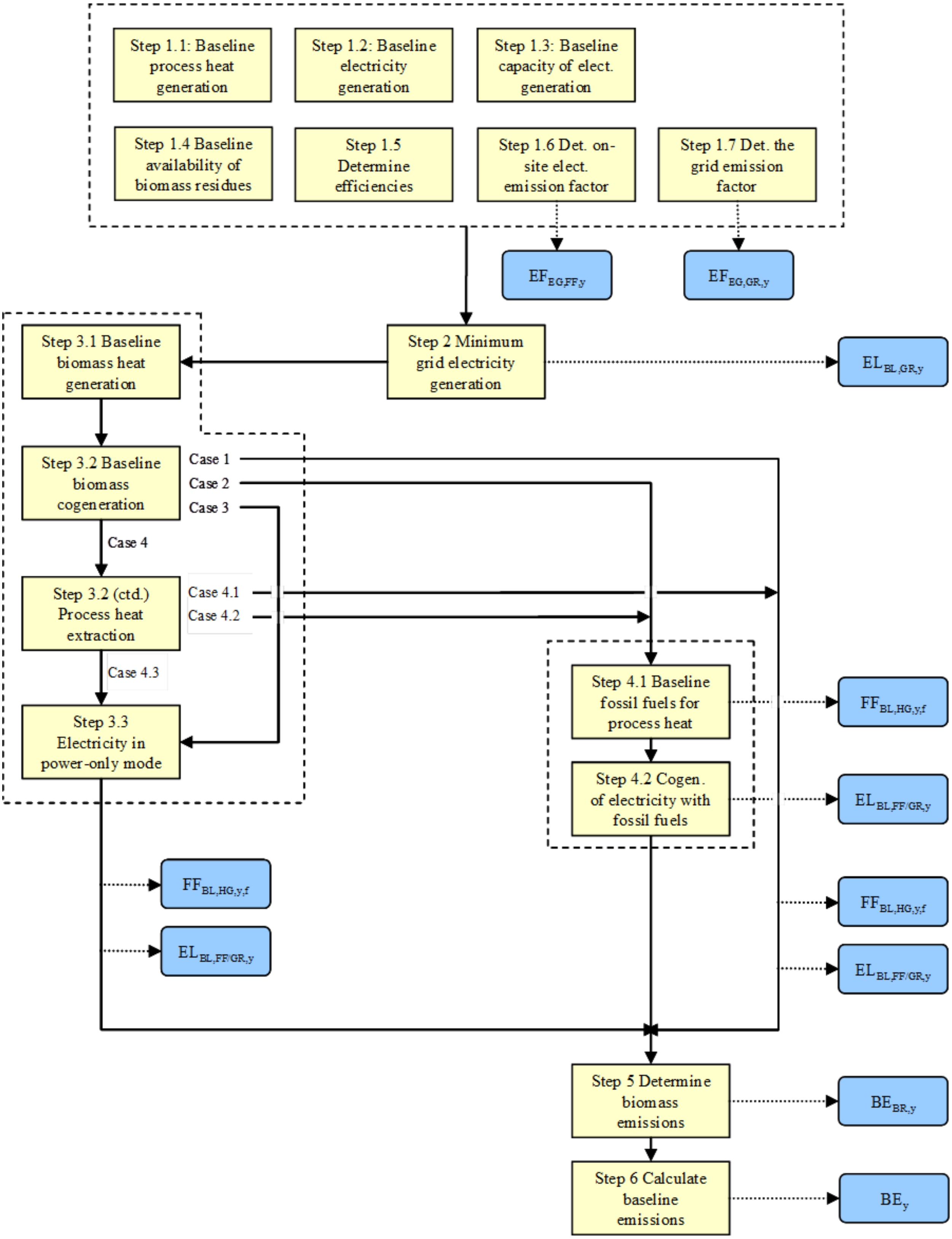
(d) Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation;

(e) Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues;

(f) Step 6: Calculate baseline emissions.

40. A flow chart is presented in Figure 2 for ease of reference.

Figure 2. Flow chart for the calculation of baseline emissions



5.5.1. Step 1: Determine biomass availability, generation and capacity constraints, efficiencies and power emission factors in the baseline

5.5.1.1. Step 1.1: Determine total baseline process heat generation

41. The amount of process heat that would be generated in the baseline in year *y* ($HC_{BL,y}$) is determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the CDM project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generators. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure.[7,8] The process heat should be calculated net of any parasitic heat used for drying of biomass.

42. This methodology assumes for the sake of simplicity that the proposed CDM project activity consumes steam from the same quality as in baseline process transported through one steam header. Project activities in which the baseline includes multiple steam headers with different enthalpies may apply this procedure as if their process included only one steam header as this leads to a conservative outcome of the baseline emission estimation.

43. However, there may be cases where the baseline situations involve steam headers with different steam enthalpies and applying the algorithm as if there is one steam header may be difficult or may result in a very different baseline emission situation. For example, a baseline scenario could consist of biomass boilers generating low enthalpy steam for direct use as process heat while fossil fuel boilers would generate steam with a higher enthalpy for use in a backpressure turbine. In such cases the project participant may consider the existence of multiple steam headers as a technical constraint in the application of the algorithm (as specified in Steps 3 and 4).

5.5.1.2. Step 1.2: Determine total baseline electricity generation

44. The amount of electricity that would be generated in the baseline in year *y* is calculated as follows:

$$EL_{BL,y} = EL_{PJ,grossy} + EL_{PJ,imp,y} - EL_{PJ,aux,y} \quad \text{Equation (3)}$$

Where:

$EL_{BL,y}$	=	Baseline electricity generation in year *y* (MWh)
$EL_{PJ,grossy}$	=	Gross quantity of electricity generated in all power plants which are located at the project site and included in the project boundary in year *y* (MWh)
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year *y* (MWh)

[7] Heat supplied during the CDM project activity to a district heating system shall count as process heat and be included in the process heat.

[8] Heat supplied during the CDM project activity to a mechanical steam turbine shall count as process heat and be included in the process heat.

$EL_{PJ,aux,y}$	=	Total auxiliary electricity consumption required for the operation of the power plants at the project site in year *y* (MWh)
y	=	Year of the crediting period

45. $EL_{PJ,aux,y}$ shall include all electricity required for the operation of equipment related to the preparation, storage and transport of biomass(e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.) and electricity required for the operation of all power or heat generating plants which are located at the project site and included in the project boundary (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.).

Box 2. Non-binding best practice example 2: Auxiliary electricity requirement

Project participants should account for the total auxiliary electricity consumption ($EL_{PJ,aux,y}$) required for the operation of the power plants at the project site. When appropriate, the total auxiliary electricity consumption may be estimated by considering the consumption capacity of all the installed equipment and assuming that they operated at maximum load during the monitoring period.

Example – A project activity involves the use of biomass residues to produce electricity and heat in an existing industrial facility. In order to operate the project activity, the project participants installed a biomass drier and a conveyor belt, and utilizes auxiliary electricity for the actual operation of the power plant.

As a conservative approach, the project participants calculate the total auxiliary electricity consumption during year *y* as the sum of the capacity of each equipment, times 8760 hours of operation per year (24 hours/day).

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

5.5.1.3. Step 1.3: Determine baseline capacity of electricity generation

47. The total capacity of electricity generation available in the baseline should be calculated using the equation below. The heat engines *i* and *j* should be obtained from the baseline scenario identified using the “Selection of the baseline scenario and demonstration of additionality” and the load factors should take into account seasonal operational constraints as well as other technical constraints in the system (e.g. availability of heat to drive heat engines).

$$CAP_{EG,total,y} = LOC_y \times \left[\sum_i \left(CAP_{EG,CG,i} \times LFC_{EG,CG,i} \right) + \sum_j \left(CAP_{EG,PO,j} \times LFC_{EG,PO,j} \right) \right] \quad \text{Equation (4)}$$

Where:

$CAP_{EG,total,y}$	=	Baseline electricity generation capacity in year *y* (MWh)

$CAP_{EG,CG,i}$	=	Baseline electricity generation capacity of heat engine *i* (MW)
$CAP_{EG,PO,j}$	=	Baseline electricity generation capacity of heat engine *j* (MW)
$LFC_{EG,CG,i}$	=	Baseline load factor of heat engine *i* (ratio)
$LFC_{EG,PO,j}$	=	Baseline load factor of heat engine *j* (ratio)
LOC_y	=	Length of the operational campaign in year *y* (hour)
i	=	Cogeneration-type heat engine in the baseline scenario
j	=	Power-only-type heat engine in the baseline scenario
y	=	Year of the crediting period

5.5.1.4. Step 1.4: Determine the baseline availability of biomass residues

48. Where the baseline scenario includes the use of biomass residues for the generation of power and/or heat at the project site in new and/or existing plants, the amount of biomass residues of category *n* that would be available in the baseline in year *y* ($BR_{B5,n,y}$) has to be determined.

49. The determination of this parameter shall be based on the monitored amounts of biomass residues used for power and/or heat generation in the project boundary for which B5 or BG3 has been identified as the baseline scenario in the CDM-PDD. The biomass residues quantities used should be monitored separately for (a) each type of biomass residue (e.g. sugarcane bagasse, rice husks, empty fruit bunches, etc.) and each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.).

50. Where the whole amount of biomass residues of one particular type and from one particular source would be used in the baseline in clearly identifiable baseline heat generators, the monitored quantities of biomass residues used in the project can be directly allocated to those heat generators in the baseline scenario. However, the following situations require particular attention:

    (a) One biomass residue type from one particular source could be used in the baseline in two or more heat generators. In this case, the use of this biomass residue type from this source has to be allocated to the different heat generators should they have different efficiencies;

    (b) One biomass residue type from one particular source could have two different fates in the baseline scenario. For example: rice husks are obtained from one source but would in the baseline partly be dumped (B1) and partly be used for power generation at the project site (B5). This can apply, for example, if parts of one biomass residue type were already collected prior to the implementation of the CDM project activity while another part was not needed and thus dumped, left to decay or burnt. In this case, it is necessary to allocate the biomass residue quantity used under the project to the following fates in the baseline scenario:

        (i) Power or heat generation at the project site in new and/or existing plants (B5); or

        (ii) Dumping, leaving to decay anaerobically or burning (B1, B2 and/or B3); or

(iii) Other fates (B4).

51. Where one of these situations arises, the project participants should specify and justify in the CDM-PDD in a transparent manner how the relevant allocations should be made. The approaches used should be consistent with the identified baseline scenario and reflect the particular situation of the underlying project activity. In doing so, the following allocation rules should be adhered to:

(a) The sum of biomass residues used in the baseline for power or heat generation in all heat generators shall be equal to the total amount of biomass residues which are used under the CDM project activity and for which the baseline scenario is B5;

(b) The allocation of biomass residues should be undertaken in a conservative manner. This means that in case of uncertainty an allocation rule should be applied that tends to result in lower emission reductions;

(c) In the case a biomass residues type from one particular source has been used prior to the implementation of the CDM project activity partly in heat generators operated at the project site (scenario B5) and partly has been dumped, left to decay anaerobically or burnt (scenarios B1, B2, B3) and if this situation would continue in the baseline scenario, then use, as a conservative approach to address the uncertainty associated with such an allocation, the maximum value among the following two approaches for the quantity of biomass residue of category *n* allocated to scenario B5;

(i) The quantity of biomass residue of category *n* is the highest annual historical use of that biomass residue type from that source for power and/or heat generation at the project site observed in the most recent three calendar years prior the date of submission of the PDD for validation of the CDM project activity for which data is already available; and

(ii) In the case of projects that use biomass residues from an on-site production process (e.g. production of sugar cane or rice), the quantity of biomass residues of category *n* is calculated as follows:

$$BR_{B5,n,y} = P_y \times MAX\left\{\frac{BR_{HIST,n,x}}{P_x};\frac{BR_{HIST,n,x-1}}{P_{x-1}};\frac{BR_{HIST,n,x-2}}{P_{x-2}}\right\}$$ Equation (5)

Where:

$BR_{B5,n,y}$	=	Quantity of biomass residues of category *n* used in the CDM project activity in year *y* for which the baseline scenario is B5 (tonne on dry-basis)
$BR_{HIST,n,x}$	=	Quantity of biomass residues of category *n* used for power or heat generation at the project site in year *x* prior the date of submission of the PDD for validation of the CDM project activity (tonnes on dry-basis) prior the date of submission of the PDD for validation of the CDM project activity
P_y	=	Quantity of the main product of the production process (e.g. sugar cane, rice) produced in year *y* from plants operated at the project site
P_x	=	Quantity of the main product of the production process (e.g. sugar cane, rice) produced in year *x* from plants operated at the project site

y	=	Year of the crediting period
x	=	Last calendar year prior to the start of the crediting period for which data is already available at the date of submission of the PDD for validation
n	=	Biomass residue category

5.5.1.5. Step 1.5: Determine the efficiencies of heat generators, and efficiencies and heat-to-power ratio of heat engines

52. The efficiencies of heat generators and heat engines should be calculated using one of the following options:

(a) **Option 1: Default values.** Use Option *f* in the latest approved version of the "Tool to determine the baseline efficiency of thermal or electric energy generation systems".[9]

The default value for the losses linked to the electricity generator group (i.e. turbine/engine, couplings and electricity generator), $GGL_{default}$, is 5%;

(b) **Option 2: Manufacturer's data.** This option is only applicable to heat engines and heat generators that were operated at the project site prior to the implementation of the CDM project activity (and not new equipment that would be constructed and operated at the project site in the baseline scenario). The efficiency of the heat generator or heat engine is determined based on manufacturer's data of the efficiency under optimal operating conditions and take into account the actual conditions of the fuel used (including moisture content of biomass residues);

(c) **Option 3:** This option is only applicable to heat generators and heat engines that were operated at the project site for at least three calendar years prior the date of submission of the PDD for validation of the CDM project activity. The efficiencies of heat generators and heat engines are determined based on the historical records, as follows:

5.5.1.5.1. Efficiency for heat generators

53. The efficiency for heat generators should be calculated using the following equation:

Equation (6)

$$\eta_{BL,HG,BR,h} = MAX\left\{\frac{HG_{BR,h,x}}{\sum_{n} BR_{n,h,x} \times NCV_{BR,n,x}};\frac{HG_{BR,h,x-1}}{\sum_{n} BR_{n,h,x} \times NCV_{BR,n,x-1}};\frac{HG_{BR,h,x-2}}{\sum_{n} BR_{n,h,x-2} \times NCV_{BR,n,x-2}}\right\}$$

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

Equation (7)

$$\eta_{BL,HG,FF,h} = MAX\left\{\frac{HG_{FF,h,x}}{\sum_{n} FF_{f,h,x} \times NCV_{FF,f,x}};\frac{HG_{FF,h,x-1}}{\sum_{n} FF_{f,h,x-1} \times NCV_{FF,f,x-1}};\frac{HG_{FF,h,x-2}}{\sum_{n} FF_{f,h,x-2} \times NCV_{FF,f,x-2}}\right\}$$

Where:

$\eta_{BL,HG,BR,h}$	=	Baseline biomass-based heat generation efficiency of heat generator *h* (ratio)
$\eta_{BL,HG,FF,h}$	=	Baseline fossil-based heat generation efficiency of heat generator *h* (ratio)
$HG_{BR,h,x}$	=	Net quantity of heat generated from using biomass residues in heat generator *h* in year *x* (GJ/yr)
$HG_{FF,h,x}$	=	Net quantity of heat generated from using fossil fuels in heat generator *h* in year *x* (GJ/yr)
$BR_{n,h,x}$	=	Quantity of biomass residues of category *n* used in heat generator *h* in year *x* (tonnes on dry-basis)
$FF_{f,h,x}$	=	Quantity of fossil fuel type *f* fired in heat generator *h* in year *x* (mass or volume unit/yr)
$NCV_{BR,n,x}$	=	Net calorific value of biomass residues of category *n* in year *x* (GJ/tonnes on dry-basis)
$NCV_{FF,f,x}$	=	Net calorific value of fossil fuel type *f* in year *x* (GJ/mass or volume unit)
x	=	Last calendar year prior to the start of the crediting period
n	=	Biomass residue category
f	=	Fossil fuel type
h	=	Heat generator in the baseline scenario

54. If fossil fuels and biomass residues were used for heat generation in the heat generator *h* prior to the implementation of the CDM project activity, then $HG_{BR,h,x}$, $HG_{BR,h,x-1}$ and $HG_{BR,h,x-2}$, as well as $HG_{FF,h,x}$, $HG_{FF,h,x-1}$ and $HG_{FF,h,x-2}$, are determined as follows:

Equation (8)

$$HG_{BR,h,x} = HG_{h,x} \times \frac{\sum_{n} BR_{n,h,x} \times NCV_{BR,n,x}}{\sum_{n} BR_{n,h,x} \times NCV_{BR,n,x} + \sum_{f} FF_{f,h,x} \times NCV_{FF,f,x}}$$

Equation (9)

$$HG_{FF,h,x} = HG_{h,x} \times \frac{\sum_{n} FF_{f,h,x} \times NCV_{FF,f,x}}{\sum_{n} BR_{n,h,x} \times NCV_{BR,n,x} + \sum_{f} FF_{f,h,x} \times NCV_{FF,f,x}}$$

Where:

$HG_{BR,h,x}$	=	Net quantity of heat generated from using biomass residues in heat generator *h* in year *x* (GJ/yr)
$HG_{FF,h,x}$	=	Net quantity of heat generated from using fossil fuels in heat generator *h* in year *x* (GJ/yr)
$HG_{h,x}$	=	Net quantity of heat generated in heat generator *h* in year *x* (GJ/yr)
$BR_{n,h,x}$	=	Quantity of biomass residues of category *n* used in heat generator *h* in year *x* (tonnes on dry-basis)
$FF_{f,h,x}$	=	Quantity of fossil fuel type *f* fired in heat generator *h* in year *x* (mass or volume unit/yr)
$NCV_{BR,n,x}$	=	Net calorific value of biomass residues of category *n* in year *x* (GJ/tonnes on dry-basis)
$NCV_{FF,f,x}$	=	Net calorific value of fossil fuel type *f* in year *x* (GJ/mass or volume unit)

5.5.1.5.2. Efficiency for heat engines

The efficiency for heat engines should be calculated using the following equation:

$$\eta_{BL,EG,PO,i/j} = MAX\left\{\frac{EL_{BR,PO,x,i/j}}{HG_{BR,PO,x,i/j}};\frac{EL_{BR,PO,x-1,i/j}}{HG_{BR,PO,x-1,i/j}};\frac{EL_{BR,PO,x-2,i/j}}{HG_{BR,PO,x-2,i/j}}\right\}$$ Equation (10)

Where:

$\eta_{BL,EG,CG,i/j}$	=	Baseline electricity generation efficiency of heat engine *i* (MWh/GJ)
$\eta_{BL,EG,PO,i/j}$	=	Average electric power generation efficiency of heat engine *j* (MWh/GJ)
$EL_{BR,PO,x,i/j}$	=	Quantity of electricity generated in heat engine *i/j* in year *x* (MWh)
$HG_{BR,PO,x,i/j}$	=	Quantity of heat used in heat engine *i/j* in year *x* (GJ)
x	=	Last calendar year prior to the start of the crediting period
i	=	Cogeneration-type heat engine in the baseline scenario
j	=	Power-only-type heat engine in the baseline scenario

55. The heat-to-power ratio of cogeneration-type heat engines (e.g. backpressure and heat-extraction steam turbines) should be calculated as follows.

(a) **Case 1:** For existing heat engines with a minimum three-year operational history prior to the CDM project activity:

$$HPR_{BL,EG,CG,/PO,i/j} = \frac{1}{3.6}\times MAX\left\{\frac{HC_{BR,CG/PO,x,i/j}}{EL_{BR,CG/PO,x,i/j}};\frac{HC_{BR,CG/PO,x-1,i/j}}{EL_{BR,CG/PO,x-1,i/j}};\frac{HC_{BR,CG/PO,x-2,i/j}}{EL_{BR,CG/PO,x-2,i/j}}\right\}$$ Equation (11)

Where:

$HPR_{BL,i}$	=	Baseline heat-to-power ratio of the heat engine *i* (ratio)

$HC_{BR,CG/PO,x,i/j}$	=	Quantity of process heat extracted from the heat engine *i/j* in year *x* (GJ)
$EL_{BR,CG/PO,x,i/j}$	=	Quantity of electricity generated in heat engine *i/j* in year *x* (MWh)
x	=	Last calendar year prior to the start of the crediting period
i	=	Cogeneration-type heat engine in the baseline scenario
j	=	Power-only-type heat engine in the baseline scenario

(b) **Case 2:** For heat engines without a minimum three-year operational history prior to the CDM project activity the heat-to-power ratio should be determined as per the design conditions of the plant, for the configuration identified as baseline scenario".

5.5.1.6. Step 1.6: Determine the emission factor of on-site electricity generation with fossil fuels

56. If no fossil fuel based power generation was identified as part of the baseline scenario, or if fossil fuel based power generation was identified as part of the baseline scenario, but all capacity of power generation based on fossil fuels is used in the cogeneration mode (i.e. up to step 4.2), then make $EF_{EG,FF,y} = EF_{EG,GR,y}$.

57. Otherwise, i.e. fossil fuel based power generation was identified as part of the baseline scenario and after conducting the steps up to 4.2 some power generation capacity based on fossil fuels is left, $EF_{EG,FF,y}$ should be determined using Option A or Option B below. If fossil fuel power plants were operated at the project site prior to the implementation of the CDM project activity, either Option A or Option B can be used. For new power plants that would be constructed at the project site in the baseline scenario, Option B should be used.

(a) **Option A:** Determine $EF_{EG,FF,y}$ as per the procedure described under "Scenario B: Electricity consumption from an off-grid captive power plant" in the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", using data from the three calendar years prior the date of submission of the PDD for validation of the CDM project activity.

(b) **Option B:** Determine a default emission factor for $EF_{EG,FF}$ based on a default efficiency of the power plant that would be operated at the project site in the baseline and a default CO_2 emission factor for the fossil fuel types that would be used, as follows:

$$EF_{EG,FF} = 3.6 \times \frac{EF_{BL,CO2,FF}}{\eta_{BL,FF}} \quad \text{Equation (12)}$$

Where:

$EF_{EG,FF}$	=	CO_2 emission factor for electricity generation with fossil fuels at the project site in the baseline in year *y* (tCO_2/MWh)
$EF_{BL,CO2,FF}$	=	CO_2 emission factor of the fossil fuel type that would be used for power generation at the project site in the baseline (tCO_2/GJ)
$\eta_{BL,FF}$	=	Efficiency of the fossil fuel power plant(s) at the project site in the baseline (ratio)

5.5.1.7. Step 1.7: Determine the emission factor of grid electricity generation

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

5.5.2. Step 2: Determine the minimum baseline electricity generation in the grid

59. The calculation of the minimum amount of electricity that would be generated in the grid in the baseline is based on the assumption that the amount of electricity generated on-site in the baseline cannot be higher than the installed capacity of power generation available in the baseline scenario. Therefore, the following equation should be used:

$$EL_{BL,GR,y} = max\left(0, EL_{BL,y} - CAP_{EG,total,y}\right)$$ Equation (13)

Where:

$EL_{BL,GR,y}$	=	Baseline minimum electricity generation in the grid in year *y* (MWh)
$EL_{BL,y}$	=	Baseline electricity generation in year *y* (MWh)
$CAP_{EG,total,y}$	=	Baseline electricity generation capacity in year *y* (MWh)
y	=	Year of the crediting period

60. For baseline alternatives not connected to the grid or otherwise technically or legally impossible to export power to the grid $EL_{BL,GR,y}$ = 0.

5.5.3. Step 3: Determine the baseline biomass-based heat and power generation

5.5.3.1. Step 3.1: Determine the baseline biomass-based heat generation

61. It is assumed that the use of biomass residues for which scenario B5 has been identified as the baseline scenario ($BR_{B5,n,y}$) would be prioritized over the use of any fossil fuels in the baseline. From that assumption, the equivalent amount of heat that would be generated with biomass residues ($HG_{BL,BR,y}$) should be determined.

62. Considering that the several heat generators and different categories of biomass residues might be identified as part of the baseline scenario, the prioritization of heat generators use and the allocation of biomass residues to different heat generators may be challenging and much dependent on specific site conditions. For that reason, the methodology proposes general principles that should be adhered to in order to determine the prioritization and allocation, which still leave room for technical constraints to be reflected given specific site conditions.[10]

[10] An example of a technical constraint is the case where the baseline includes multiple steam headers. In such cases the project participant may: (a) Identify and rank process steam demand from process according to different enthalpies from highest to lowest; (b) Rank steam headers according to different enthalpies from highest to lowest; (c) Apply the guidance in this and the following step for each steam header starting with the steam demand with the highest enthalpy.

63. In order to do that, follow the procedure below:

(a) Prepare a list of all heat generators that would use biomass residues in the baseline scenario. The list should include both biomass-based and co-fired heat generators;

(b) Allocate the biomass types and quantities for which B5 has been identified as the alternative scenario ($BR_{B5,n,y}$) to the different heat generators ($BR_{B5,n,h,y}$). In doing so, the following principles should be adhered to:

(i) Where a biomass residue type can technically be used in more than one heat generator, it should be assumed that it is allocated from the most efficient to the less efficient heat generators to the maximum extent possible, taking into account any technical and operational constraints;

(ii) Where a biomass residue type can technically be used in both heat generators which do not require co-firing fossil fuels and heat generators which require co-firing fossil fuels, it should be assumed that it is to the maximum extent possible used in the heat generator which does not require co-firing fossil fuels, taking into account any technical and operational constraints. Any remaining biomass residue quantities are then allocated to the subsequent heat generators which require co-firing fossil fuels;

(iii) In both cases, if different types of biomass residues result in different levels of heat generation efficiency, the allocation of biomass residues should be guided by the principle that the biomass residues would be allocated so as to maximize the heat generation efficiency of the set of heat generators;

(iv) In the case of a district heating system or off site heat supply where the individual heat sources can be identified, the biomass boilers in the district heating system shall be included in this list. In case of a district heating system where no individual heat sources can be identified, see step 4 for further guidance how to deal with this case;

(v) One particular case of technical constraint is that of heat generators that require that a minimum amount of fossil fuels be (co-)fired for heat generation. In that case the project participant may wish to: (i) clearly identify the fossil fuel type and quantity required due to this technical constraint; (ii) add the identified quantity to the parameter $FF_{BL,HG,y,f}$; (iii) determine the heat generation from this quantity of fossil fuel based on the efficiency of the heat generator; and (iv) add the calculated heat generation to the parameter $HG_{BL,BR,y}$;

(c) Document and justify in the CDM-PDD in a transparent manner how the allocation of biomass residue types and quantities to heat generators will be performed during monitoring;

(d) Calculate the amount of heat generated with biomass residues based on the allocation rules established in the CDM-PDD using the following equations:

$$HG_{BL,BR,y} = \sum_{h}\sum_{n}\left(BR_{B5,n,h,y} \times NCV_{BR,n,y} \times \eta_{BL,HG,BR,h}\right)$$ Equation (14)

Subject to

$$\sum_{h}\sum_{n} BR_{B5,n,h,y} = \sum_{n} BR_{B4,n,y}$$ Equation (15)

i.e. the biomass residues used in each heat generator should not exceed the total amount of biomass residues available.

$$\sum_{n}\left(BR_{B5,n,h,y} \times NCV_{BR,n,y} \times \eta_{BL,HG,BR,h}\right) \leq LOC_{y} \times CAP_{HG,h} \times LFC_{HG,h}$$ Equation (16)

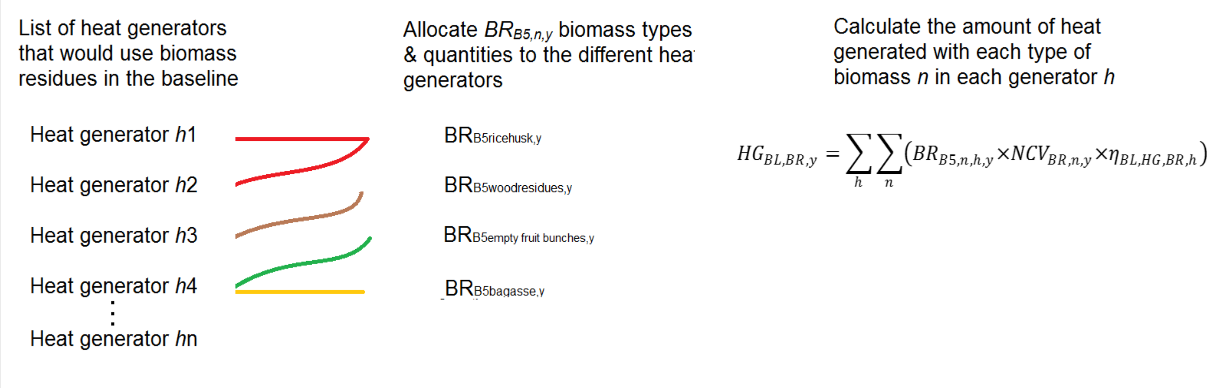
i.e. the heat generation in each heat generator should not exceed the total capacity of the heat generator.

Where:

$HG_{BL,BR,y}$	=	Baseline biomass-based heat generation in year *y* (GJ)
$BR_{B5,n,h,y}$	=	Quantity of biomass residues of category *n* used in heat generator *h* in year *y* with baseline scenario B5 (tonne on dry-basis)
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category *n* in year *y* (GJ/tonne on dry-basis)
$\eta_{BL,HG,BR,h}$	=	Baseline biomass-based heat generation efficiency of heat generator *h* (ratio)
$BR_{B4,n,y}$	=	Quantity of biomass residues of category *n* used in the CDM project activity in year *y* for which the baseline scenario is B4 (tonne on dry-basis)
LOC_{y}	=	Length of the operational campaign in year *y* (hour)
$CAP_{HG,h}$	=	Baseline capacity of heat generator *h* (GJ/h)
$LFC_{HG,h}$	=	Baseline load factor of heat generator *h* (ratio)
y	=	Year of the crediting period
h	=	Heat generator in the baseline scenario

Box 3. Non-binding best practice example 3: Baseline biomass-based heat generation (as per step 3.1)

This methodology assumes that the use of biomass residues ($BR_{B5,n,y}$) would be prioritized over the use of any fossil fuels in the baseline. The equivalent amount of heat that would be generated with biomass residues ($HG_{BL,BR,y}$) should be determined based on the allocation of the quantities of each type of biomass to the different generators.



5.5.3.2. Step 3.2: Determine the baseline biomass-based cogeneration of process heat and electricity and heat extraction

64. It is assumed that cogeneration of process heat and power using biomass-based heat ($HG_{BL,BR,y}$) would be prioritized over the use of fossil fuels for the generation of process heat and power on-site. From that assumption the equivalent amount of electricity ($EL_{BL,BR,CG,y}$) and process heat ($HC_{BL,BR,CG,y}$) that would be generated are determined.

65. Considering that the several heat engines of different types might be identified as part of the baseline scenario, the prioritization of heat engines use may be challenging and much dependent on specific site conditions. For that reason, the methodology proposes general principles that should be adhered to in order to determine the prioritization of use, which still leave room for technical constraints to be reflected given specific site conditions.

66. In order to do that follow the procedure below:

    (a) Prepare a list containing the heat engines identified in the baseline scenario for which heat and power can be cogenerated. The list should contain, in case of steam cycles, only back-pressure and heat-extraction steam turbines. Condensing steam turbines should not be considered at this stage;

    (b) Allocate the total biomass-based heat ($HG_{BL,BR,y}$) to the different heat engines ($HG_{BL,BR,CG,y,i}$). In doing so, the following principles should be adhered to:

        (i) Where heat can technically be used in more than one heat engine type, it should be assumed that it is allocated so as to maximize the cogeneration of process heat. For instance, in case of steam cycles, if both back-pressure and heat-extraction steam turbines are identified in the baseline, heat should be first allocated to back-pressure turbines and then to heat-extraction turbines to the maximum extent possible, taking into account any technical and operational constraints;

(ii) Subject to the allocation rule above, it should be assumed that heat is allocated from the most efficient to the less efficient heat engines to the maximum extent possible, taking into account any technical and operational constraints;

(c) Document and justify in the CDM-PDD in a transparent manner how the allocation of biomass-based heat to heat engines will be performed during monitoring;

(d) Calculate the amount of electricity and process heat generation based on the allocation above using the following equations:

$$EL_{BL,BR,CG,y} = \frac{1}{3.6} \times \sum_i \left(\frac{1}{(HPR_{BL,i} + 1 + GGL_{default})} \times HG_{BL,BR,CG,y,i} \right)$$ Equation (17)

$$HC_{BL,BR,CG,y} = \sum_i \left(\frac{HPR_{BL,i}}{(HPR_{BL,i} + 1 + GGL_{default})} \times HG_{BL,BR,CG,y,i} \right)$$ Equation (18)

Subject to:

$$\sum_i HG_{BL,BR,CG,y,i} \leq HG_{BL,BR,y}$$ Equation (19)

i.e. the biomass-based heat used in cogeneration mode should not exceed the total biomass-based heat generated.

$$HG_{BL,BR,CG,y,i} \leq HG_{BL,y}$$ Equation (20)

i.e. the process heat cogenerated should not exceed the total process heat demand.

$$(\eta_{BL,EG,CG,i} \times HG_{BL,BR,CG,y,i}) \leq LOC_y \times CAP_{EG,CG,i} \times LFC_{EG,CG,i}$$ Equation (21)

i.e. the electricity generation in each heat engine should not exceed the total capacity of the heat engine.

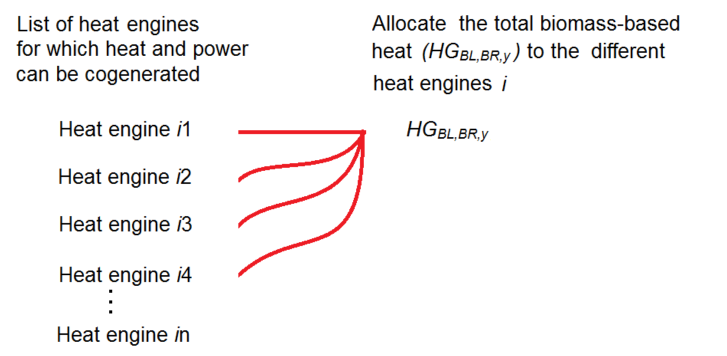
Where:

$EL_{BL,BR,CG,y}$	=	Baseline biomass-based cogenerated electricity in year *y* (MWh)
$\eta_{BL,EG,CG,i}$	=	Baseline electricity generation efficiency of heat engine *i* (MWh/GJ)
$HG_{BL,BR,CG,y,i}$	=	Baseline biomass-based heat used in heat engine *i* in year *y* (GJ)
$HC_{BL,BR,CG,y}$	=	Baseline biomass-based process heat cogenerated in year *y* (GJ)
$HPR_{BL,i}$	=	Baseline heat-to-power ratio of the heat engine *i* (ratio)
$GGL_{default}$	=	The default value for the losses linked to the electricity generator group (turbine, couplings and electricity generator. Set at 0.05) (ratio)
$HG_{BL,BR,y}$	=	Baseline biomass-based heat generation in year *y* (GJ)

$HG_{BL,y}$	=	Baseline process heat generation in year *y* (GJ)
LOC_y	=	Length of the operational campaign in year *y* (hour)
$CAP_{EG,CG,i}$	=	Baseline electricity generation capacity of heat engine *i* (MW)
$LFC_{EG,CG,i}$	=	Baseline load factor of heat engine *i* (ratio)
i	=	Cogeneration-type heat engine in the baseline scenario
y	=	Year of the crediting period

Box 4. Non-binding best practice example 4: Baseline biomass-based cogeneration as per step 3.2

This methodology assumes that cogeneration of process heat and power using biomass-based heat ($HG_{BL,BR,y}$) would be prioritized over the use of fossil fuels. The equivalent amount of electricity ($EL_{BL,BR,CG,y}$) and process heat ($HC_{BL,BR,CG,y}$) that would be generated are determined based on the allocation of biomass based heat to the different engines *i*.



$$EL_{BL,BR,CG,y} = \frac{1}{3.6} \times \sum_i \left(\frac{1}{(HPR_{BL,i} + 1 + GGL_{default})} \times HG_{BL,BR,CG,y,i} \right)$$

$$HC_{BL,BR,CG,y} = \sum_i \left(\frac{HPR_{BL,i}}{(HPR_{BL,i} + 1 + GGL_{default})} \times HG_{BL,BR,CG,y,i} \right)$$

67. The next step to be followed depends on the outcomes of the calculations above. Four cases are possible.

5.5.3.2.1. Step 3.2.1:

68. If $HG_{BL,BR,y} = \sum_i HG_{BL,BR,CG,y,i}$ and $HC_{BL,y} = HC_{BL,BR,CG,y}$, then all the heat that would be generated using biomass residues in the baseline would be used in cogeneration-type heat engines and would suffice to serve all process heat demand. It is assumed then that the use of fossil fuels on-site in the baseline scenario would be uncertain (except for the amount required due to technical constraints) because it would depend on a number of factors that are not taken into account in this methodology, particularly on the relative prices of on-site electricity generation using fossil fuels and the electricity price in the grid. In order to estimate the baseline parameters that result project participants should:

(a) Define $EL_{BL,FF/GR,y} = EL_{BL,y} - EL_{BL,GR,y} - EL_{BL,BR,CG,y}$, $EL_{PJ,offset,y} = 0$, $EL_{BL,HG,y,f} = 0$; and

(b) Proceed to Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues.

5.5.3.2.2. Step 3.2.2

69. If $HG_{BL,BR,y} = \sum_{i} HG_{BL,BR,CG,y,i}$ and $HC_{BL,y} > HC_{BL,BR,CG,y}$, then all the heat that would be generated using biomass residues in the baseline would be used in cogeneration-type heat engines but still some process heat demand would remain to be met. It is assumed then that the process heat balance that remains to be met would be met by using fossil fuels. In order to estimate the baseline parameters that result, project participants should:

(a) Define $HC_{balance,FF,y} = HC_{BL,y} - HC_{BL,BR,CG,y}$,

$EL_{balance,FF,y} = EL_{BL,y} - EL_{BL,GR,y} - EL_{BL,BR,CG,y}$, and

(b) Proceed to Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation.

5.5.3.2.3. Step 3.2.3

70. If $HG_{BL,BR,y} > \sum_{i} HG_{BL,BR,CG,y,i}$ and $HC_{BL,y} = HC_{BL,BR,CG,y}$, then all process heat demand would be met with biomass-based heat in the baseline and still there would be some biomass-based heat to be used. It is assumed then that this heat would be used for generation of power in power-only mode, i.e. without cogeneration of process heat. In order to estimate the baseline parameters that result project participants should:

(a) Define $HG_{balance,BR,PO,y} = HG_{BL,BR,y} - \sum_{i} HG_{BL,BR,CG,y,i}$,

$EL_{balance,PO,y} = EL_{BL,y} - EL_{BL,GR,y} - EL_{BL,BR,CG,y}$; and

(b) Proceed to Step 3.3: Determine the baseline biomass-based electricity generated in power-only mode.

5.5.3.2.4. Step 3.2.4

71. If $HG_{BL,BR,y} > \sum_{i} HG_{BL,BR,CG,y,i}$ and $HC_{BL,y} > HC_{BL,BR,CG,y}$, then there would be biomass-based heat in the baseline that could still be used and process heat demand to be met. It is assumed then that this balance of biomass-based heat would be extracted from the heat header and used to meet the process heat demand without cogeneration of power. Three cases should thus be considered (refer to the monitoring tables for a definitions of $h_{LOW,y}$ and $h_{HIGH,y}$ used in the equations below):

(a) Case 3.2.4.1:

(i) If $HC_{BL,y} - HC_{BL,BR,CG,y} = \frac{h_{LOW,y}}{h_{HIGH,y}} \times \left(HG_{BL,BR,y} - \sum_{i} HG_{BL,BR,CG,y,i} \right)$, i.e. the balance of biomass-based heat (right-hand side of the equation) equals the

remaining demand for process heat (left-hand side of the equation). Then there is no more biomass-based heat available and the demand for process heat has been met. It is assumed then that the use of fossil fuels on-site would be uncertain in the baseline scenario (except for the amount required due to technical constraints) because it would depend on a number of factors that are not taken into account in this methodology, particularly on the relative prices of on-site electricity generation using fossil fuels and the electricity price in the grid. In order to estimate the baseline parameters that result project participants should:

a. Define $EL_{BL,FF/GR,y} = EL_{BL,y} - EL_{BL,GR,y} - EL_{BL,BR,CG,y}$, $EL_{PJ,offset,y} = 0$ $FF_{BL,HG,y,f} = 0$; and

b. Proceed to Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues.

(b) Case 3.2.4.2:

(i) If $HC_{BL,y} - HC_{BL,BR,CG,y} > \frac{h_{LOW,y}}{h_{HIGH,y}} \times \left(HG_{BL,BR,y} - \sum_i HG_{BL,BR,CG,y,i} \right)$, i.e. the balance of biomass-based heat (right-hand side of the equation) is less than the remaining demand for process heat (left-hand side of the equation). Then all biomass-based heat was used and there still remains process heat demand to be met. It is assumed then that this process heat demand would be met by using fossil fuels in the baseline. In order to estimate the baseline parameters that result project participants should:

a. Define $HC_{balance,FF,y} = \left(HC_{BL,y} - HC_{BL,BR,CG,y}\right) - \frac{h_{LOW}}{h_{HIGH}} \times \sum_i \mathrm{HG}_{\mathrm{BL,BR,CG,y,i}} \left(HG_{BL,BR,y} - \sum_i \mathrm{HG}_{\mathrm{BL,BR,CG,y,i}} \sum_i \mathrm{HG}_{\mathrm{BL,BR,CG,y,i}} \right)$, $EL_{balance,FF,y} = EL_{BL,y} - EL_{BL,GR,y} - EL_{BL,BR,CG,y}$; and

b. Proceed to Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation.

(c) Case 3.2.4.3:

(i) If $HC_{BL,y} - HC_{BL,BR,CG,y} < \frac{h_{LOW}}{h_{HIGH}} \times \sum_i HG_{BL,BR,CG,y,i} \left(HG_{BL,BR,y} - \sum_i HG_{BL,BR,CG,y,i} \sum_i HG_{BL,BR,CG,y,i} \right)$, i.e. the balance of biomass-based heat (right-hand side of the equation) is greater than the remaining demand for process heat (left-hand side of the equation). Then the balance of heat produced with biomass residues is greater than the balance of process heat demand, meaning that there remains some biomass-based heat to be used after the demand for process heat was met. It is assumed then that this heat

would be used to generate electricity in power-only mode, i.e. without cogeneration of process heat. In order to estimate the baseline parameters that result project participants should:

a. Define $HG_{balance,BR,PO,y} = \sum_i HG_{BL,BR,CG,y,i} \left(HG_{BL,BL,y} - \sum_i HG_{BL,BR,CG,y,i} \sum_i HG_{BL,BR,CG,y,i} \right) - \frac{h_{HIGH}}{h_{LOW}} \times \left(HC_{BL,y} - HC_{BL,BR,CG,y} \right)$, $EL_{balance,PO,y} = EL_{BL,y} - EL_{BL,GR,y} - EL_{BL,BR,CG,y}$ and,

b. Proceed to Step 3.3: Determine the baseline biomass-based electricity generated in power-only mode.

5.5.3.3. Step 3.3: Determine the baseline biomass-based electricity generated in power-only mode

72. If power-only-type heat engines, i.e. heat engines that produce only electricity without cogeneration of process heat, have been identified in the baseline scenario, it is assumed that the balance of heat produced using biomass residues, if any, would be used in power-only mode.

73. Considering that the several heat engines of different types might be identified as part of the baseline scenario, the prioritization of heat engines use may be challenging and much dependant on specific site conditions. For that reason, the methodology proposes general principles that should be adhered to in order to determine the prioritization of use, which still leave room for technical constraints to be reflected given specific site conditions.[11]

74. In order to do that follow the procedure below:

(a) Prepare a list containing the power-only-type heat engines (i.e. heat engines that do not cogenerate any process heat) identified in the baseline scenario. The list should contain, in case of steam cycles, only condensing steam turbines. Back-pressure and heat-extraction steam turbines should not be considered here;

(b) Allocate the balance of biomass-based heat ($HG_{balance,BR,PO,y}$) to the different heat engines ($HG_{BL,BR,PO,y,j}$). In doing so, the following principles should be adhered to:

(i) Where heat can technically be used in more than one heat engine, it should be assumed that heat is allocated from the most efficient to the less efficient heat engines to the maximum extent possible, taking into account any technical and operational constraints;

(ii) Document and justify in the CDM-PDD in a transparent manner how the allocation of heat to heat engines will be performed during monitoring;

[11] An example of a technical constraint could be that the enthalpy of the biomass generated steam would not meet the minimum enthalpy required for a power-only type heat engine. In that case it shall be assumed that there would be no power generated by biomass fired power-only heat engines in the baseline.

(c) Calculate the amount of electricity generated based on the allocation above using the following equations:

$$EL_{BL,BR,PO,y} = \sum_{i}\left(HG_{BL,BR,PO,y,j} \times \eta_{BL,EG,PO,j}\right)$$ Equation (22)

Subject to

$$\sum_{i} HG_{BL,BR,PO,y,j} \leq HG_{balance,BR,PO,y}$$

i.e. the biomass-based heat used in the heat engines should not exceed the biomass-based heat balance,

$$\left(HG_{BL,BR,PO,y,j} \times \eta_{BL,EG,PO,j}\right) \leq LOC_{y} \times CAP_{EG,PO,j} \times LFC_{EG,PO,j}$$

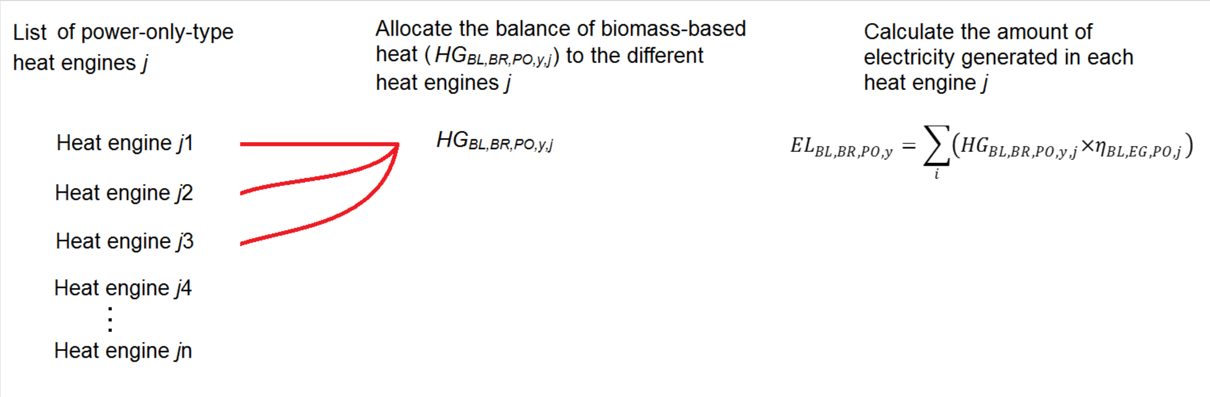
i.e. the electricity generation in each heat engine should not exceed the total capacity of the heat engine.

Where:

$EL_{BL,BR,PO,y}$	=	Baseline biomass-based electricity (power-only) in year *y* (MWh)
$HG_{BL,BR,PO,y,j}$	=	Baseline biomass-based heat used in heat engine *j* in year *y* (GJ)
$\eta_{BL,EG,PO,j}$	=	Average electric power generation efficiency of heat engine *j* (MWh/GJ)
$HG_{balance,BR,PO,y}$	=	Baseline biomass-based heat balance after cogeneration in year *y* (GJ)
LOC_{y}	=	Length of the operational campaign in year *y* (hour)
$CAP_{EG,PO,j}$	=	Baseline electricity generation capacity of heat engine *j* (MW)
$LFC_{EG,PO,j}$	=	Baseline load factor of heat engine *j* (ratio)

Box 5. Non-binding best practice example 5: Baseline biomass-based power-only as per step 3.3

This methodology assumes that if power-only-type heat engines have been identified in the baseline scenario, the balance of heat produced using biomass residues, if any, would be used in power-only mode. The baseline biomass-based electricity in power-only ($EL_{BL,BR,PO,y,j}$) is determined based on the allocation of the balance of biomass based heat to the different engines *i*.



75. The following cases are possible depending on the results of the calculations above:

(a) **Step 3.3.1**: If $EL_{balance,PO,y} \geq EL_{BL,BR,PO,y}$, the amount of electricity generated on-site in the baseline is either equal to or less than the amount of electricity generated in the project scenario. In that case:

(i) Define $EL_{BL,FF/GR,y} = EL_{balance,PO,y} - EL_{BL,BR,PO,y}$, $EL_{PJ,offset,y} = 0$, $FF_{BL,HG,y,f} = 0$, and,

(ii) Proceed to Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues;

(b) **Step 3.3.2**: If $EL_{balance,PO,y} < EL_{BL,BR,PO,y}$, the amount of electricity generated on-site in the baseline exceeds the amount of electricity generated in the project scenario. If grid-export was available in the baseline, this result indicates that the CDM project activity results in a decrease of power output which is likely to be supplied by the grid. As a consequence, project emissions in the form of generation of electricity in the grid should be accounted for via the parameter $EL_{PJ,offset,y}$. In order to continue project participants should:

(i) Define $EL_{BL,FF/GR,y} = 0$, $EL_{PJ,offset,y} = EL_{BL,BR,PO,y} - EL_{balance,PO,y}$, $FF_{BL,HG,y,f} = 0$ and,

(ii) Proceed to Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues.

5.5.4. Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation

5.5.4.1. Step 4.1: Determine the baseline fossil fuel based cogeneration of process heat and electricity and the remaining process heat demand

76. In many cases the amount of biomass residues available is not enough to generate the heat required to meet the process heat demand. In such cases, and if fossil-fuel-based heat generators have been identified in the baseline scenario, it is assumed that the balance of process heat is met using fossil fuels, resulting in related fossil fuel baseline emissions. Where cogeneration capacity is still available it is assumed that the remaining process heat demand will first be supplied by cogeneration and then by direct use of heat supplied by heat generators.

77. Considering that several cogeneration heat engines of different types might be identified as part of the baseline scenario, the prioritization of cogeneration heat engines use may be challenging and much dependent on specific site conditions. For that reason, the methodology proposes general principles that should be adhered to in order to determine the prioritization and allocation, which still leave room for technical constraints to be reflected given specific site conditions.

78. In order to determine the amount of heat and electricity that would be cogenerated using fossil fuels, the procedure below should be followed:

    (a) Prepare a list containing the cogeneration heat engines identified in the baseline scenario for which heat and power can be cogenerated. The list should contain, in case of steam cycles, only backpressure and heat-extraction steam turbines. Condensing steam turbines should not be considered;

    (b) Allocate the process heat balance ($HC_{balance,FF,y}$) to the different cogeneration heat engines that still have capacity to cogenerate heat and power, up to the level required for meeting the balance of process heat demand. In doing so, the following principles should be adhered to:

        (i) Where heat can technically be used in more than one cogeneration heat engine type, it should be assumed that it is allocated so as to maximize the cogeneration of process heat. For instance, in case of steam cycles, if both back-pressure and heat-extraction steam turbines are identified in the baseline, the process heat balance should be first allocated to back-pressure turbines and then to heat-extraction turbines to the maximum extent possible, taking into account any technical and operational constraints, including partial use of the heat engine in previous steps;

        (ii) Subject to the allocation rule above, it should be assumed that the process heat is allocated from the most efficient to the less efficient heat engines to the maximum extent possible, taking into account any technical and operational constraints;

    (c) Document and justify in the CDM-PDD in a transparent manner how the allocation of heat to heat engines will be performed during monitoring.

79. Calculate for each cogeneration heat engine *i* the amount of cogenerated electricity and the amount of heat that would need to be generated by fossil fuels in heat generators in order to supply the cogeneration heat engine, as follows:

$$HG_{BL,FF,CG,y,i} = \frac{\left(HPR_{BL,i} + 1 + GGL_{default}\right)}{HPR_{BL,i}} \times HC_{BL,FF,CG,y,i}$$ Equation (23)

i.e. the amount of fossil fuel based heat required to supply the cogeneration heat engine *i*

$$EL_{BL,FF,y} = \sum_i \frac{HC_{BL,FF,CG,y,i}}{HPR_{BL,i}}$$ Equation (24)

i.e the amount of fossil fuel based electricity cogenerated by cogeneration heat engine *i*

$$HG_{BL,FF,CG,y} = \sum_i HC_{BL,FF,CG,y,i}$$ Equation (25)

Subject to

$$\sum_i HC_{BL,FF,CG,y,i} \leq HC_{balance,FF,y}$$

i.e. the fossil fuel based cogenerated process heat should not exceed the balance of process heat demand.

$$\frac{1}{3.6} \times \left(\left(HG_{BL,FF,CG,y,i} + HG_{BL,BR,CG,y,i}\right) \times \frac{1}{\left(HPR_{BL,i} + 1 + GGL_{default}\right)} \right) \leq LOC_y \times CAP_{EG,CG,i} \times LFC_{EG,CG,i}$$

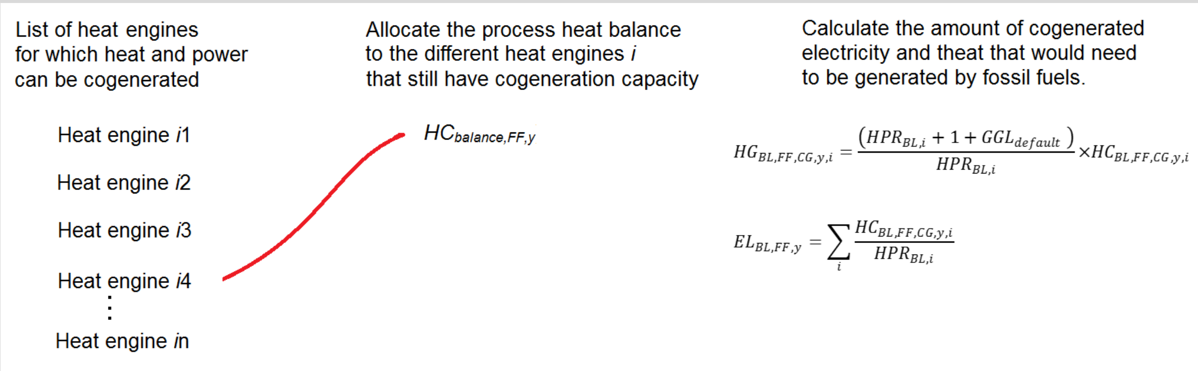
Where:

$HG_{BL,FF,y,i}$	=	Baseline fossil-based heat used in heat engine *i* in year *y* (GJ)
$HC_{BL,BR,CG,y}$	=	Baseline biomass-based process heat cogenerated in year *y* (GJ)
$GGL_{default}$	=	The default value for the losses linked to the electricity generator group (turbine, couplings and electricity generator. Set at 0.05) (ratio)
$HPR_{BL,i}$	=	Baseline Heat Power Ratio of heat engine *i* (ratio)
$EL_{BL,FF,y}$	=	Baseline fossil-based electricity generation in year *y* (MWh)
$HG_{BL,FF,y,h}$	=	Baseline fossil-based heat generation in heat generator *h* in year *y* (GJ)
$HC_{balance,FF,y}$	=	Balance of process heat demand after cogeneration in year *y* (GJ)
$HG_{BL,FF,CG,y,i}$	=	Baseline fossil-fuel-based heat used in heat engine *i* in year *y* (GJ)
$HG_{BL,BR,CG,y,i}$	=	Baseline biomass-based heat used in heat engine *i* in year *y* (GJ)

LOC_y	=	Length of the operational campaign in year *y* (hour)
$CAP_{EG,CG,i}$	=	Baseline electricity generation capacity of heat engine *i* (MW)
$LFC_{EG,CG,i}$	=	Baseline load factor of heat engine *i* (ratio)
f	=	Fossil fuel type
y	=	Year of the crediting period
i	=	Cogeneration-type heat engine in the baseline scenario

Box 6. Non-binding best practice example 6: Baseline fossil fuel based cogeneration as per step 4.1

This methodology assumes that in many cases, the amount of biomass residues available is not enough to generate the heat required to meet the process heat demand. In such cases, and if fossil-fuel-based heat generators have been identified in the baseline scenario, it is assumed that the balance of process heat is met using fossil fuels. The amount of cogenerated electricity and heat that would need to be generated by fossil fuels are determined based on the allocation of the heat balance to the different engines *i*.



80. In case after step 4.1 $HC_{balance,FF,y} > HC_{BL,FF,CG,y}$, then there would still be process heat demand to be met. It is assumed then that this balance of process heat would be generated with fossil fuels and extracted from the heat header and used to meet the process heat demand without cogeneration of power until all baseline process heat is met.

$$HG_{BL,FF,DHE,y} = \left(HC_{balance,FF,y} - HC_{BL,FF,CG,y}\right) \times \frac{h_{HIGH,y}}{h_{LOW,y}} \quad \text{Equation (26)}$$

$$HG_{BL,FF,y} = HG_{BL,FF,CG,y} + HG_{BL,FF,DHE,y} \quad \text{Equation (27)}$$

Where:

$HC_{balance,FF,y}$	=	Balance of process heat demand after cogeneration in year *y* (GJ)
$HC_{BL,FF,CG,y}$	=	Baseline fossil-fuel-based process heat cogenerated in year *y* (GJ)
$h_{LOW,y}$	=	Specific enthalpy of the heat carrier at the process heat demand side (GJ/tonnes)

$h_{HIGH,y}$	=	Specific enthalpy of the heat carrier at the heat generator side (GJ/tonnes)
$HG_{BL,FF,y}$	=	Baseline fossil-based heat generation in year *y* (GJ)
$HG_{BL,FF,DHE,y}$	=	Baseline fossil-based heat used to meet baseline process heat demand via direct heat extraction in year *y* (GJ)
$HG_{BL,FF,CG,y}$	=	Baseline fossil-based heat cogeneration in year *y* (GJ)

81. The following cases are possible depending on the results of the calculations above:

(a) **Step 4.1.1**: If $EL_{balance,FF,y} \geq EL_{BL,FF,y}$, the amount of electricity generated on-site in the baseline is either equal to or less than the amount of electricity generated in the project scenario. In order to determine the resulting baseline emissions project participants should:

(i) Define $EL_{BL,FF/GR,y} = EL_{balance,FF,y} - EL_{BL,FF,y}$, $EL_{PJ,offset,y} = 0$, and,

(ii) Proceed to Step 4.2.

(b) **Step 4.1.2**: If $EL_{balance,FF,y} < EL_{BL,FF,y}$, the amount of electricity generated on-site in the baseline exceeds the amount of electricity generated in the project scenario. If grid-export was available in the baseline, this result indicates that the CDM project activity results in a decrease of power output which is likely to be supplied by the grid. As a consequence, project emissions in the form of generation of electricity in the grid should be accounted for via the parameter $EL_{PJ,offset,y}$. In order to determine the resulting baseline emissions project participants should:

(i) Define $EL_{BL,FF/GR,y} = 0$, $EL_{PJ,offset,y} = EL_{BL,FF,y} - EL_{balance,FF,y}$; and,

(ii) Proceed to Step 4.2.

5.5.4.2. Step 4.2: Determine the baseline heat generation to meet the fossil-based cogeneration of heat and power and the heat to meet the balance of process heat

82. Considering that several heat generators might be identified as part of the baseline scenario, the prioritization of heat generators use may be challenging and much dependent on specific site conditions. For that reason, the methodology proposes general principles that should be adhered to in order to determine the prioritization and allocation, which still leave room for technical constraints to be reflected given specific site conditions.

83. In order to determine the amount of fossil fuels that would be required, the procedure below should be followed:

(a) Prepare a list of all heat generators that would use fossil fuels in the baseline scenario. In the case where the reference baseline plant would have been connected to a district heating system list all heat sources that supply heat to the district heating system. In case the heat sources to the district heating cannot be individually identified or no data is available the district heating system itself shall be identified as a heat source;

(b) Allocate the total heat generation required from fossil fuels ($HG_{BL,FF,y}$) to the different heat generators ($HG_{BL,FF,y,h}$), subject to the difference in heat content in the different heat carriers, up to the level required for meeting the balance of process heat demand. In doing so, the following principles should be adhered to:

(i) Where heat can technically be generated in more than one heat generator, it should be assumed that it is generated starting from the most efficient to the less efficient heat generators to the maximum extent possible, taking into account any technical and operational constraints, including co-firing and the partial use of the heat generator in the previous steps;

(ii) If different types of fossil fuels can technically be used in the heat generators, the type of fossil fuel used should be guided by the principle that fossil fuels would be used so as to maximize the heat generation efficiency of the set of heat generators;

(iii) In case of connection to a district heating system or off site heat supply where the heat is generated in a cogeneration system rather than in a heat-only boiler, the emission factor for this fuel source shall be conservatively set at 0;

(iv) In case of connection to a district heating system or off site heat supply from which the individual sources cannot be identified, the district heating system shall be considered the most efficient heat source. The capacity of the district heating system shall be considered unlimited unless it can be justified (based on historical consumption data or heat purchase contracts) that the amount of heat to be consumed from/ or delivered to the district heat system was limited. The emission factor of the district heating system shall be considered 0;

(c) Document and justify in the CDM-PDD in a transparent manner how the allocation of fossil fuel types and quantities to different heat generators will be performed during monitoring.

84. Estimate the total amount of fossil fuels required to generate the heat required for the cogeneration in Step 4.1 and the balance of process heat based on the allocation principles above using the following equations:

$$\sum_h HG_{BL,FF,y,h} = HG_{BL,FF,DHE,y} + HG_{BL,FF,CG,y}$$ Equation (28)

$$FF_{BL,HG,y,f} = \sum_h \left(\frac{HG_{BL,FF,y,h}}{\eta_{BL,HG,FF,h}}\right)$$ Equation (29)

Subject to

$$HG_{BL,FF,y,h} \leq LOC_y \times CAP_{HG,h} \times LFC_{HG,h}$$ Equation (30)

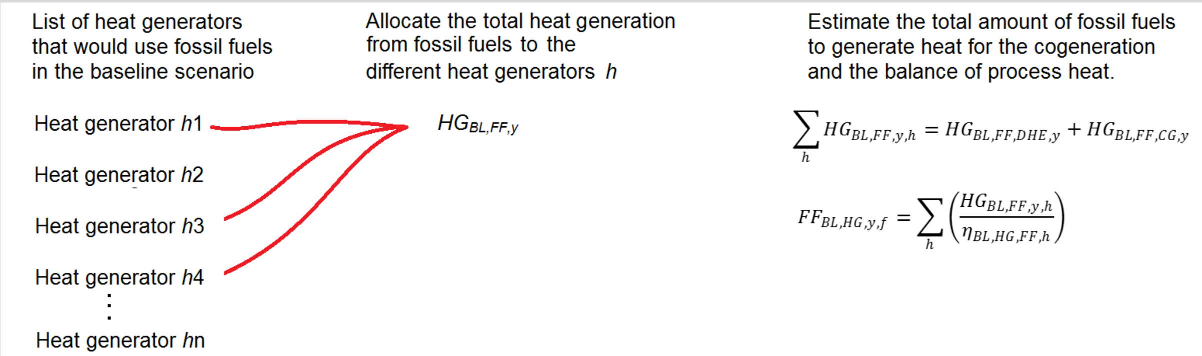
i.e. the heat generation in each heat generator should not exceed the total capacity of the heat generator.

Where:

$FF_{BL,HG,y,f}$	=	Baseline fossil fuel demand for process heat in year *y* (GJ)
$HG_{BL,FF,y,h}$	=	Baseline fossil-based heat generation in heat generator *h* in year *y* (GJ)
$\eta_{BL,HG,FF,h}$	=	Baseline fossil-based heat generation efficiency of heat generator *h* (ratio)
LOC_y	=	Length of the operational campaign in year *y* (hour)
$CAP_{HG,h}$	=	Baseline capacity of heat generator *h* (GJ/h)
$LFC_{HG,h}$	=	Baseline load factor of heat generator *h* (ratio)
$HG_{BL,FF,DHE,y}$	=	Baseline fossil-based heat used to meet baseline process heat demand via direct heat extraction in year *y* (GJ)
$HG_{BL,FF,CG,y}$	=	Baseline fossil-based heat cogeneration in year *y* (GJ)

Box 7. Non-binding best practice example 7: Baseline heat generation to meet the fossil-based cogeneration as per step 4.2

This methodology considers that several heat generators might be identified as part of the baseline scenario. In such cases, the total heat generation required from fossil fuels is allocated to the different heat generators *h* in order to determine the total amount of fossil fuels required to generate the heat required for the cogeneration and the balance of process heat.



85. Proceed to Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues

5.5.5. Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues

86. The calculation of baseline emissions due to uncontrolled burning or decay of biomass residues is optional and project participants can decide whether to include these emission sources or not. If project participants wish to include these emission sources, the procedure below should be followed, and emissions from combustion of biomass residues under the CDM project activity should be also be determined. Otherwise, this section does not need to be applied and project emissions do not need to include emissions from the combustion of biomass residues under the CDM project activity.

87. Baseline emissions due to uncontrolled burning or decay of biomass residues are only determined for those categories of biomass residues for which B1, B2 or B3 has been identified as the baseline scenario.

88. The emissions are determined separately for biomass residues categories for which scenarios B1 and B3 (aerobic decay or uncontrolled burning) apply, and for biomass residues categories for which scenario B2 (anaerobic decay) apply:

$$BE_{BR,y} = BE_{BR,B1/B3,y} + BE_{BR,B2,y} \quad \text{Equation (31)}$$

Where:

$BE_{BR,y}$	=	Baseline emissions due to disposal of biomass residues in year y (t CO2e)
$BE_{BR,B1/B3,y}$	=	Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues in year y (t CO_2)
$BE_{BR,B2,y}$	=	Baseline emissions due to anearobic decay of biomass residues in year y (t CO_2)

5.5.5.1. Step 5.1: Determine $BE_{BR,B1/B3,y}$

89. For the biomass residues categories for which the most likely baseline scenario 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 (aerobic decay and uncontrolled burning), that the biomass residues would be burnt in an uncontrolled manner.

90. Baseline emissions are calculated by multiplying the quantity of biomass residues with the net calorific value and an appropriate emission factor, as follows:

$$BE_{BR,B1/B3,y} = GWP_{CH4} \times \sum_{n} BR_{B1/B3,n,y} \times NCV_{BR,n,y} \times EF_{BR,n,y} \quad \text{Equation (32)}$$

Where:

$BE_{BR,B1/B3,y}$	=	Baseline emissions due to aerobic decay or uncontrolled burning of biomass residues in year y (t CO_2)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (t CO_2/t CH_4)
$BR_{B1/B3,n,y}$	=	Quantity of biomass residues of category n used in the CDM project activity in year y for which the baseline scenario is B1 or B3 (tonnes on dry-basis)
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category n in year y (GJ/tonne on dry-basis)
$EF_{BR,n,y}$	=	CH_4 emission factor for uncontrolled burning of the biomass residues category n during the year y (tCH_4/GJ)
n	=	Biomass residue category

91. To determine the CH_4 emission factor ($EF_{BR,n,y}$), project participants may undertake measurements or use referenced default values. In the absence of more accurate information, it is recommended to use for biomass residues 0.0027 t CH_4 per ton of biomass as default value for the product of $NCV_{BR,n,y}$ and $EF_{BR,n,y}$.[12]

92. The uncertainty of the CH_4 emission factor ($EF_{BR,n,y}$) 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. The appropriate conservativeness factor from Table 3 below shall be chosen and multiplied with the estimate for the CH_4 emission factor. For example, if the default CH_4 emission factor of 0.0027 t CH_4/t biomass is used, the uncertainty can be deemed to be greater than 100%, resulting in a conservativeness factor of 0.73. Thus, in this case an emission factor of 0.001971 t CH_4/t biomass should be used.

Table 3. Conservativeness factors

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

Box 8. Non-binding best practice example 8: Baseline emissions due to uncontrolled burning as per step 5.1

Project participants may opt to consider baseline emissions due to uncontrolled burning for those categories of biomass residues which baseline has been identified as B1 (biomass residues are dumped or left to decay mainly under aerobic conditions) or B3 (the biomass residues are burnt in an uncontrolled manner).

Example – A project activity involves the utilization of wood residues that are burnt in an uncontrolled manner in the baseline, and empty fruit bunches that are left to decay aerobically. The project participants choose to determine baseline emissions due to uncontrolled burning of biomass based on the monitored quantities of each type of biomass and the default emission factor of 0.001971 t CH_4/t biomass.

$$BE_{BR,B1/B3,y} = GWP_{CH4} \times \left(BR_{woodresidues,y} + BR_{emptyfruitbunches,y}\right) \times 0.001971 \text{ (tCH4/t)}$$

5.5.6. Step 5.2: Determine $BE_{BR,B2,y}$

93. For the biomass residues categories, as described in the biomass residues categories table, for which the most likely alternative scenario is that the biomass residues would decay under clearly anaerobic conditions (case B2), project participants shall calculate baseline emissions using the latest approved version of the tool “Emissions from solid

[12] 2006 IPCC Guidelines, Volume 4, Table 2.5, default value for agricultural residues.

waste disposal sites”. The variable $BE_{CH4,SWDS,y}$ calculated by the tool corresponds to $BE_{BR,B2,y}$ in this methodology. The project participants shall use as waste quantities prevented from disposal ($W_{j,x}$) in the tool, those quantities of biomass residues ($BR_{n,B2,y}$) for which B2 has been identified as the baseline scenario.

94. The determination of $BR_{n,B2,y}$ shall be based on the monitored amounts of biomass residues used in power plants included in the project boundary. Where all biomass residues with the alternative scenario B2 come from one particular source, the monitored quantities of biomass residues used from that source in the project plant can be directly used. Where only parts of the biomass residues from one source would be dumped under clearly anaerobic conditions (B2), an allocation should be made consistently with the information provided for the CDM project activity in the CDM-PDD. The allocation should be made in a conservative manner and consistent with the guidance provided before for $BR_{B4,n,y}$. The project participants should specify and justify in the CDM-PDD in a transparent manner how the relevant allocations should be made and how $BR_{n,B2,y}$ should be determined for the relevant biomass residue category *n* based on the monitored quantities. The approaches used should be consistent with the identified baseline scenario and reflect the particular situation of the underlying project activity.

5.5.7. Step 6: Calculate baseline emissions

95. Calculate baseline emissions using equation 2 above.

5.6. Project emissions

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

(a) Emissions from fossil fuel consumption at the project site for the generation of electric power and heat and for auxiliary loads related to the generation of electric power and heat;

(b) CO_2 emissions from grid-connected fossil fuel power plants in the electricity system for any electricity that is imported from the grid to the project site;

(c) If either $EL_{balance,PO,y} < EL_{BL,BR,PO,y}$ (Step 3.3.2) or $EL_{balance,FF,y} < EL_{BL,FF,y}$ (Step 4.2.2), CO_2 emissions from grid-connected fossil fuel power plants in the electricity system due to reduction in electricity generation at the project site as compared to the baseline scenario;

(d) CO_2 emissions from off-site transportation of biomass that are combusted in the project plant;

(e) If applicable, CH_4 emissions from combustion of biomass for electric power and heat generation at the project site;

(f) If applicable, emissions from anaerobic treatment of wastewater originating from the treatment of the biomass prior to their combustion;

(g) If heat and/or power is produced from biomass cultivated in dedicated plantations: project emissions from cultivation of plantation (this source shall not be included if the total area of dedicated plantation is registered as one or several A/R CDM project activities).

97. Project emissions are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{GR1,y} + PE_{GR2,y} + PE_{TR,y} + PE_{BR,y} + PE_{WW,y} + PE_{BG2,y} + PE_{BC,y}$$ Equation (33)

Where:

PE_y	=	Project emissions in year *y* (t CO_2)
$PE_{FF,y}$	=	Emissions during the year *y* due to fossil fuel consumption at the project site (t CO_2)
$PE_{GR1,y}$	=	Emissions during the year *y* due to grid electricity imports to the project site (t CO_2)
$PE_{GR2,y}$	=	Emissions due to a reduction in electricity generation at the project site as compared to the baseline scenario in year *y* (t CO_2)
$PE_{TR,y}$	=	Emissions during the year *y* due to transport of biomass to the project plant (t CO_2)
$PE_{BR,y}$	=	Emissions from the combustion of biomass during the year *y* (t CO2e)
$PE_{WW,y}$	=	Emissions from wastewater generated from the treatment of biomass in year *y* (t CO2e)
$PE_{BG2,y}$	=	Emissions from the production of biogas in year *y* (t CO2e)
$PE_{BC,y}$	=	Project emissions associated with the cultivation of land to produce biomass in year *y* (t CO_2)

5.6.1. Determination of PE_{FFy}

98. The following emission sources should be included in determining $PE_{FF,y}$:

(a) Emissions from on-site fossil fuel consumption for the generation of electric power and heat. This includes all fossil fuels used at the project site in heat generators (e.g. boilers) for the generation of electric power and heat; and

(b) Emissions from on-site fossil fuel consumption of auxiliary equipment and systems related to the generation of electric power and heat. This includes fossil fuels required for the operation of auxiliary equipment related to the power and heat plants (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.) which are not accounted in the first bullet, and fossil fuels required for the operation of equipment related to the preparation, storage and transportation of fuels (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.).

99. The latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" should be used to calculate $PE_{FF,y}$. All combustion processes *j* as described in the two bullets above should be included.

Box 9. Non-binding best practice example 9: Emissions due to fossil fuel consumption

Project participants should determine the project emissions due to fossil fuel consumption taking into account the on-site fossil fuel consumption for the generation of electric power and heat, and on-site fossil fuel consumption of auxiliary equipment and systems related to the generation of electric power and heat. Example - A project activity that utilizes fossil fuels purchased from the market as auxiliary fuel for the generation of electric power and heat, and for the operation of auxiliary equipment related to the preparation, storage and transportation of biomass. The quantities of fossil fuel purchased are monitored continuously using mass or volume meters and cross-checked with invoices that can be identified specifically for the proposed CDM project activity.

5.6.2. Determination of $PE_{GR1,y}$

100. If electricity is imported from the grid to the project site during year *y*, corresponding emissions should be accounted for as project emissions, as follows:

$$PE_{GR1,y} = EF_{EG,GR,y} \times EL_{PJ,imp,y}$$ Equation (34)

Where:

$PE_{GR1,y}$	=	Emissions during the year *y* due to grid electricity imports to the project site (t CO_2)
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year *y* (MWh)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (t CO_2/MWh)

5.6.3. Determination of $PE_{GR2,y}$

101. If $EL_{balance,PO,y} < EL_{BL,BR,PO,y}$ (Step 3.3.2) or $EL_{balance,FF,y} < EL_{BL,FF,y}$ (Step 4.2.2), the amount of electricity generated on-site in the baseline exceeds the amount of electricity generated in the project scenario. In such cases, it is assumed that an equivalent amount of electricity is generated during year *y* in order to offset this reduction in electricity generation at the project site. Corresponding emissions should be accounted as project emissions as follows:

$$PE_{GR2,y} = EF_{EG,GR,y} \times EL_{PJ,offset,y}$$ Equation (35)

Where:

$PE_{GR2,y}$	=	Emissions due to a reduction in electricity generation at the project site as compared to the baseline scenario in year *y* (tCO_2)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (tCO_2/MWh)
$EL_{PJ,offset,y}$	=	Electricity that would be generated in the baseline that exceeds the generation of electricity during year *y* (MWh)

5.6.4. Determination of $PE_{TR,y}$

102. In cases where the biomass residues are not generated directly at the project site, and always in the case of biomass from plantations, project participants shall determine CO_2 emissions resulting from transportation of the biomass to the project plant using the latest version of the tool "Project and leakage emissions from transportation of freight". $PE_{TR,m}$ in the tool corresponds to the parameter $PE_{TR,y}$ in this methodology and the monitoring period *m* is one year.

Box 10. Non-binding best practice example 10: Emissions from transportation of the biomass

Project participants should determine the project emissions resulting from the transportation of the biomass from the source (e.g. dedicated plantation or off-site industrial facility) to the project plant.

Example - A project activity involves the use of biomass from a dedicated plantation and bagasse from a nearby industry, which are located 25 km and 10 km away from the project plant, respectively.

The project participants opted to use the conservative default values provided by the TOOL12: "Project and leakage emissions from transportation of freight" and, therefore monitor:

- the quantity of each type of biomass transported;
- the return distance from the dedicated plantation (50 km) and nearby industry (20 km); and
- the type of vehicle used, in order to select the appropriate emission factor (i.e. 245 g CO_2/t.km for light vehicles of up to 3.5-3.9 tons or 129 g CO_2/t.km for heavy vehicles of 3.5-3.9 tons or more).

5.6.5. Determination of $PE_{BR,y}$

103. If project proponents chose to include emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$) in the calculation of baseline emissions, then emissions from the combustion of biomass residues have also to be included in the project scenario. Otherwise, this emission source may be excluded. Corresponding emissions are calculated as follows:

$$PE_{BR,y} = GWP_{CH4} \times EF_{CH4,BR} \times \sum_{n} BR_{PJ,n,y} \times NCV_{BR,n,y} \quad \text{Equation (36)}$$

Where:

$PE_{BR,y}$	=	Emissions from the combustion of biomass residues during the year *y* (tCO_2e)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2/tCH4)
$EF_{CH4,BR}$	=	CH_4 emission factor for the combustion of biomass residues in the project plant (tCH_4/GJ)
$BR_{PJ,n,y}$	=	Quantity of biomass residues of category *n* used in the CDM project activity in year *y* (tonnes on dry-basis)
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category *n* in year *y* (GJ/tonne on dry-basis)

104. To determine the CH_4 emission factor ($EF_{CH4,BR}$), 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.

105. 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 CH4 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

5.6.6. Determination of $PE_{WW,y}$

106. 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:

$$PE_{WW,y} = GWP_{CH4} \times V_{WW,y} \times COD_{WW,y} \times B_{o,WW} \times MCF_{WW} \quad \text{Equation (37)}$$

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

Where:

$PE_{WW,y}$	=	Emissions from wastewater generated from the treatment of biomass in year *y* (t CO2e)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (t CO_2/t CH_4)
$V_{WW,y}$	=	Quantity of waste water generated in year *y* (m^3)
$COD_{WW,y}$	=	Average chemical oxygen demand of the waste water in year *y* (tCOD/m^3)
$B_{o,WW}$	=	Methane generation potential of the waste water (t CH_4/tCOD)
MCF_{WW}	=	Methane correction factor for the waste water (ratio)

5.6.7. Determination of $PE_{BG2,y}$

107. In case the project includes biogas, the consideration of project emissions associated with the production of biogas depends on the selected baseline scenario for biogas and whether the biogas is sourced from a registered CDM project activity according to the following provisions:

(a) In case the biogas is provided by a registered CDM project activity, the project emissions will be covered in the PDD of the registered CDM project activity;

(b) In case the biogas is not provided by a registered CDM project activity:

(i) If baseline scenario BG1 is selected, the project emissions should be included in this proposed CDM project activity. The emission source shall include project emissions from physical leakage of methane from the anaerobic digester, from treatment of wastewater effluent from the anaerobic digester (where applicable), and from land application of sludge (where applicable). The estimation of these emission sources shall follow the procedures for these sources as identified in the project emissions section of ACM0014;

(ii) In case of baseline scenario BG2 and/or BG3, no project emissions need to be included.

5.6.8. Determination of $PE_{BC,y}$

108. If the project includes biomass from dedicated plantations, the associated project emissions shall be calculated according to the methodological tool “Project and leakage emissions from biomass”.

5.7. Leakage

109. Leakage emissions due to diversion of biomass residues from other applications shall be calculated according to the methodological tool “Project and leakage emissions from biomass”.

110. Leakage emissions due to shift of pre-project activities shall be calculated according to the methodological tool “Project and leakage emissions from biomass”.

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

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

112. At the start of the second and third crediting period for a project activity, the continued validity of the baseline scenario shall be assessed by applying the latest version of the tool “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”.

5.9. Data and parameters not monitored

113. In addition to the parameters and procedures described herein, all monitoring provisions contained in the tools referred to in this methodology also apply.

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

115. The following are not monitored data and parameters:

Data / Parameter table 1.

Data / Parameter:	Biomass categories and quantities used for the selection of the baseline scenario selection and assessment of additionality
Data unit:	- Type (i.e. bagasse, rice husks, empty fruit bunches, etc.); - Source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, from dedicated plantations etc.); - Fate in the absence of the CDM project activity (scenarios B); - Use in the project scenario (scenarios P); - Quantity (tonnes on dry-basis)
Description:	Explain and document transparently in the CDM-PDD, which quantities of which biomass categories are used in which installation(s) under the CDM project activity and what is their baseline scenario. Include the quantity of each category of biomass (tonnes). For the selection of the baseline scenario and demonstration of additionality, at the validation stage, an ex ante estimation of these quantities should be provided
Source of data:	On-site assessment of biomass categories and quantities
Measurement procedures (if any):	---
Any comment:	This parameter is related to the procedure for the selection of the baseline scenario selection and assessment of additionality

Data / Parameter table 2.

Data / Parameter:	$BR_{HIST,n,x}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues of category n used for power or heat generation at the project site in year *x* prior the date of submission of the PDD for validation of the CDM project activity (tonnes on dry-basis) prior the time of submission of the PDD for validation of the CDM 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). In case of volume meters use the fuel density to convert the measurement to mass basis
Any comment:	Biogas should be included as appropriate if applicable (in which case convenient units such as m^3 should be used)

Data / Parameter table 3.

Data / Parameter:	$BR_{n,h,x}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues of category n used in heat generator *h* in year *x* (tonnes on dry-basis)
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:	Biogas should be included as appropriate if applicable (in which case convenient units such as m^3 should be used)

Data / Parameter table 4.

Data / Parameter:	$FF_{f,h,x}$
Data unit:	mass or volume unit/yr
Description:	Quantity of fossil fuel type *f* fired in heat generator *h* in year *x* (mass or volume unit/yr)
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). In case of volume meters use the fuel density to convert the measurement to mass basis
Any comment:	---

Data / Parameter table 5.

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

Data / Parameter table 6.

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

Data / Parameter table 7.

Data / Parameter:	$HC_{BR,CG/PO,x,i/j}$
Data unit:	GJ
Description:	Quantity of process heat extracted from the heat engine *i/j* in year *x* (GJ)
Source of data:	On-site measurements

Measurement procedures (if any):	This parameter should be determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the CDM project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generators. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure
Any comment:	---

Data / Parameter table 8.

Data / Parameter:	$EL_{BR,CG/PO,x,i/j}$
Data unit:	MWh
Description:	Quantity of electricity generated in heat engine *i/j* in year *x* (MWh)
Source of data:	On-site measurements
Measurement procedures (if any):	Electricity meters
Any comment:	---

Data / Parameter table 9.

Data / Parameter:	P_x
Data unit:	Use suitable units, as appropriate
Description:	Quantity of the main product of the production process (e.g. sugar cane, rice) produced in year *x* from plants operated at the project site
Source of data:	On-site measurements
Measurement procedures (if any):	---
Any comment:	---

Data / Parameter table 10.

Data / Parameter:	$CAP_{HG,h}$
Data unit:	GJ/h
Description:	Baseline capacity of heat generator *h* (GJ/h)
Source of data:	On-site measurements or reference plant design parameters
Measurement procedures (if any):	This parameter should reflect the design maximum heat generation capacity (in GJ/h) of the baseline heat generator *h*. It should be based on the installed capacity of the heat generator. Project participants should document transparently and justify in the CDM-PDD how this parameter was determined
Any comment:	---

Data / Parameter table 11.

Data / Parameter:	$CAP_{EG,CG,i}$ $CAP_{EG,PO,j}$
Data unit:	MW
Description:	$CAP_{EG,CG,i}$ = Baseline electricity generation capacity of heat engine *i* (MW) $CAP_{EG,PO,j}$ = Baseline electricity generation capacity of heat engine *j* (MW)
Source of data:	On-site measurements or reference plant design parameters
Measurement procedures (if any):	This parameter should reflect the design maximum electricity generation capacity (in MW) of the baseline heat engines *i* and *j*. It should be based on the installed capacity of the heat engines. Project participants should document transparently and justify in the CDM-PDD how this parameter was determined
Any comment:	---

Data / Parameter table 12.

Data / Parameter:	$LFC_{HG,h}$
Data unit:	Ratio
Description:	Baseline load factor of heat generator *h* (ratio)
Source of data:	On-site measurements or reference plant design parameters
Measurement procedures (if any):	This parameter should reflect the maximum load factor (i.e. the ratio between the 'actual heat generation' of the heat generator and its 'design maximum heat generation' along one year of operation) of the baseline heat generator *h*, taking into account downtime due to maintenance, seasonal operational patterns, and any other technical constraints. Project participants should document transparently and justify in the CDM-PDD how this parameter was determined (e.g. using historical records)
Any comment:	---

Data / Parameter table 13.

Data / Parameter:	$HPR_{BL,i}$
Data unit:	Ratio
Description:	Baseline heat-to-power ratio of the heat engine *i* (ratio)
Source of data:	On-site measurements or reference plant design parameters
Measurement procedures (if any):	---
Any comment:	---

Data / Parameter table 14.

Data / Parameter:	$LFC_{EG,CG,i}$ $LFC_{EG,CG,j}$
Data unit:	Ratio
Description:	$LFC_{EG,CG,i}$ = Baseline load factor of heat engine *i* (ratio) $LFC_{EG,PO,j}$ = Baseline load factor of heat engine *j* (ratio)
Source of data:	On-site measurements or reference plant design parameters
Measurement procedures (if any):	This parameter should reflect the maximum load factor (i.e. the ratio between the ‘actual electricity generation’ of the heat engine and its ‘design maximum electricity generation’ along one year of operation) of the baseline heat engine *i* or *j*. The actual electricity generation of the heat engine should be determined taking into account downtime due to maintenance, seasonal operational patterns, and any other technical constraints. Project participants should document transparently and justify in the CDM-PDD how this parameter was determined
Any comment:	---

Data / Parameter table 15.

Data / Parameter:	$EF_{BL,CO2,FF}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of the fossil fuel type that would be used for power generation at the project site in the baseline ($t\ CO_2/GJ$)
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
Any comment:	In case of plants existing before project implementation, the lowest CO_2 emission factor should be used in case of multi fuel plants

Data / Parameter table 16.

Data / Parameter:	$\eta_{BL,FF}$
Data unit:	ratio
Description:	Efficiency of the fossil fuel power plant(s) at the project site in the baseline
Source of data:	Either use the higher value among (a) the measured efficiency and (b) manufacturer’s information on the efficiency; or use default values as provided in Appendix 1 of the “Tool to calculate the emission factor for an electricity system”; or assume an efficiency of 100%

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

Data / Parameter table 17.

Data / Parameter:	$NCV_{BR,n,x}$
Data unit:	GJ/tonnes on dry-basis
Description:	Net calorific value of biomass residues of category n in year *x*
Source of data:	Either conduct measurements or use accurate and reliable local or national data where available. Where such data is not available, use IPCC default net calorific values (country-specific, if available) if they are deemed to reasonably represent local circumstances. Choose the values in a conservative manner and justify the choice
Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards
Any comment:	The NCV is to be calculated for wet biomass as used in the heat generator (i.e. deducting the energy used for the evaporation of the water contained in the biomass residues). Biogas should be included as appropriate if applicable (in which case convenient units such as GJ/m^3 should be used)

Data / Parameter table 18.

Data / Parameter:	$NCV_{FF,f,x}$
Data unit:	GJ/mass or volume unit
Description:	Net calorific value of fossil fuel type *f* in year *x* (GJ/mass or volume unit)
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:	---

Data / Parameter table 19.

Data / Parameter:	***GWP_{CH4}***
Data unit:	tCO_2e/tCH_4
Description:	GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO2/tCH4)
Source of data:	IPCC
Measurement procedures (if any):	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions
Any comment:	---

6. Monitoring methodology

6.1. Monitoring procedures

116. 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.

117. All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent of the data should be monitored if not indicated differently in the comments in the tables below.

118. In addition to the parameters and procedures described herein, all monitoring provisions contained in the tools referred to in this methodology also apply.

6.2. Data and parameters monitored

Data / Parameter table 20.

Data / Parameter:	**Biomass categories and quantities used in the CDM project activity**
Data unit:	- Type (i.e. bagasse, rice husks, empty fruit bunches, tree bark etc.); - Source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, dedicated plantations etc.); - Fate in the absence of the CDM project activity (scenarios B); - Use in the project scenario (scenarios P and H); - Quantity (tonnes on dry-basis)

Description:	Explain and document transparently in the CDM-PDDwhich quantities of which biomass categories are used in which installation(s) under the CDM project activity and what is their baseline scenario. Include the quantity of each category of biomass (tonnes on dry-basis). These quantities should be updated every year of the crediting period as part of the monitoring plan so as to reflect the actual use of biomass in the project scenario. These updated values should be used for emissions reductions calculations. Along the crediting period, new categories of biomass (i.e. new types, new sources, with different fate) can be used in the CDM project activity. In this case, a new line should be added to the table. If those new categories are of the type B1, B2 or B3, the baseline scenario for those types of biomass residues should be assessed using the procedures outlined in the guidance provided in the procedure for the selection of the baseline scenario and demonstration of additionality
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated weight meters. Adjust for the moisture content in order to determine the quantity of dry biomass
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	---

Data / Parameter table 21.

Data / Parameter:	**For biomass residues categories for which scenarios B1, B2 or B3 is deemed a plausible baseline alternative, project participants shall demonstrate that this is a realistic and credible alternative scenario**
Data unit:	Tonnes
Description:	- Quantity of available biomass residues of type *n* in the region - Quantity of biomass residues of type *n* that are utilized (e.g. for energy generation or as feedstock) in the defined geographical region - Availability of a surplus of biomass residues type *n* (which cannot 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 or statistics
Measurement procedures (if any):	---
Monitoring frequency:	At the validation stage for biomass residues categories identified ex ante, and always that new biomass residues categories are included during the crediting period
QA/QC procedures:	---
Any comment:	---

Data / Parameter table 22.

Data / Parameter:	$BR_{PJ,n,y}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass of category n used in the CDM project activity in year *y* (tonnes on dry-basis)
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated weight meters. Adjust for the moisture content in order to determine the quantity of dry biomass
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	The biomass residue quantities used should be monitored separately for (a) each type of biomass residue (e.g.) and each source (e.g. produced on-site, obtained from biomass residues suppliers, obtained from a biomass residues market, obtained from an identified biomass residues producer, etc.). Biogas should be included as appropriate if applicable (in which case convenient units such as m^3 should be used)

Data / Parameter table 23.

Data / Parameter:	$BR_{B1/B3,n,y}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues of category n used in the CDM project activity in year *y* for which the baseline scenario is B1or B3 (tonnes on dry-basis)
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated weight meters. Adjust for the moisture content in order to determine the quantity of dry biomass
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	Biogas should be included as appropriate if applicable (in which case convenient units such as m^3 should be used)

Data / Parameter table 24.

Data / Parameter:	$BR_{B4,n,y}$
Data unit:	tonnes of dry matter
Description:	Quantity of biomass residues of category n used in the CDM project activity in year *y,* for which the baseline scenario is B4 (tonnes on dry-basis)
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated weight meters. Adjust for the moisture content in order to determine the quantity of dry biomass

Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	Biogas should be included as appropriate if applicable (in which case convenient units such as m^3 should be used)

Data / Parameter table 25.

Data / Parameter:	$BR_{B5,n,y}$
Data unit:	tonnes on dry-basis
Description:	Quantity of biomass residues of category n used in the CDM project activity in year *y* for which the baseline scenario is B5 (tonne on dry-basis)
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated weight meters. Adjust for the moisture content in order to determine the quantity of dry biomass
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Any comment:	The procedures in Step 1.4 should also be followed

Data / Parameter table 26.

Data / Parameter:	$EF_{BR,n,y}$
Data unit:	tCH_4/GJ
Description:	CH_4 emission factor for uncontrolled burning of the biomass residues category n during the year *y* (tCH4/GJ)
Source of data:	Conduct measurements or use reference default values
Measurement procedures (if any):	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 $EF_{burning,CH4,k,y}$
Monitoring frequency:	---
QA/QC procedures:	---
Any comment:	---

Data / Parameter table 27.

Data / Parameter:	$EF_{FF,y,f}$
Data unit:	T CO_2/GJ
Description:	CO_2 emission factor for fossil fuel type *f* in year *y* (t CO_2/GJ)

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 table 28.

Data / Parameter:	$EF_{CH4,BR}$
Data unit:	T CH_4/GJ
Description:	CH_4 emission factor for the combustion of biomass residues in the project plant (tCH4/GJ)
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 table 29.

Data / Parameter:	$EF_{CO2,LE}$
Data unit:	T CO_2/GJ
Description:	CO_2 emission factor of the most carbon intensive fossil fuel used in the country (t CO_2/GJ)
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 table 30.

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

Data / Parameter table 31.

Data / Parameter:	$EL_{PJ,gross,y}$
Data unit:	MWh
Description:	Gross quantity of electricity generated in all power plants which are located at the project site and included in the project boundary in year *y* (MWh)
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated electricity meters
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	The consistency of metered electricity generation should be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years)
Any comment:	---

Data / Parameter table 32.

Data / Parameter:	$EL_{PJ,imp,y}$
Data unit:	MWh
Description:	Project electricity imports from the grid in year *y* (MWh)
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated electricity meters
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	The consistency of metered electricity generation should be cross-checked with receipts from electricity purchases
Any comment:	---

Data / Parameter table 33.

Data / Parameter:	$EL_{PJ,aux,y}$
Data unit:	MWh
Description:	Total auxiliary electricity consumption required for the operation of the power plants at the project site in year *y* (MWh)
Source of data:	On-site measurements
Measurement procedures (if any):	Use calibrated electricity meters
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	The consistency of metered electricity generation should be cross-checked with receipts from electricity sales (if available) and the quantity of fuels fired (e.g. check whether the electricity generation divided by the quantity of fuels fired results in a reasonable efficiency that is comparable to previous years).
Any comment:	$EG_{PJ,aux,y}$ shall include all electricity required for the operation of equipment related to the preparation, storage and transport of biomass (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.) and electricity required for the operation of all power plants which are located at the project site and included in the project boundary (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.). In case steam tubines are used for mechanical power in the baseline situation and electric motors for the same purpose in the project situation, the electricity used to run these electric motors shall be included in $EL_{PJ,aux,y}$

Data / Parameter table 34.

Data / Parameter:	$NCV_{BR,n,y}$
Data unit:	GJ/tonnes of dry matter
Description:	Net calorific value of biomass residue of category n in year *y* (GJ/tonne on dry-basis)
Source of data:	On-site measurements

Measurement procedures (if any):	Measurements shall be carried out at reputed laboratories and according to relevant international standards. Measure the NCV on dry-basis
Monitoring frequency:	At least every six months, taking at least three samples for each measurement.
QA/QC procedures:	Check the consistency of the measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Ensure that the NCV is determined on the basis of dry biomass
Any comment:	Biogas should be included as appropriate if applicable (in which case convenient units such as GJ/m^3 should be used)

Data / Parameter table 35.

Data / Parameter:	$h_{LOW,y}$ $h_{HIGH,y}$
Data unit:	GJ/tonnes
Description:	$h_{LOW,y}$ = Specific enthalpy of the heat carrier at the process heat demand side (GJ/tonnes) $h_{HIGH,y}$ = Specific enthalpy of the heat carrier at the heat generator side (GJ/tonnes)
Source of data:	On-site measurements
Measurement procedures (if any):	The specific enthalpies should be determined based on the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure.
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	---
Any comment:	The process heat demand side refers to where heat is finally used for heating purposes by end-users and the heat generator side refers to where heat is generated

Data / Parameter table 36.

Data / Parameter:	P_y
Data unit:	Use suitable units, as appropriate
Description:	Quantity of the main product of the production process (e.g. sugar cane, rice) produced in year *y* from plants operated at the project site
Source of data:	On-site measurements
Measurement procedures (if any):	---
Monitoring frequency:	Data aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	---
Any comment:	---

Data / Parameter table 37.

Data / Parameter:	$V_{WW,y}$
Data unit:	m^3
Description:	Quantity of waste water generated in year *y* (m^3)
Source of data:	On-site measurements
Measurement procedures (if any):	---
Monitoring frequency:	Data monitored continuously and aggregated as appropriate, to calculate emissions reductions
QA/QC procedures:	---
Any comment:	---

Data / Parameter table 38.

Data / Parameter:	$COD_{WW,y}$
Data unit:	$tCOD/m^3$
Description:	Average chemical oxygen demand of the waste water in year *y* ($tCOD/m^3$)
Source of data:	On-site measurements
Measurement procedures (if any):	---
Monitoring frequency:	In case of measurements: At least every six months, taking at least three samples for each measurement
QA/QC procedures:	---
Any comment:	---

Data / Parameter table 39.

Data / Parameter:	$B_{o,WW}$
Data unit:	T CH_4/tCOD
Description:	Methane generation potential of the waste water (t CH_4/tCOD)
Source of data:	Reference default values (IPCC)
Measurement procedures (if any):	---
Monitoring frequency:	---
QA/QC procedures:	---
Any comment:	---

Data / Parameter table 40.

Data / Parameter:	MCF_{WW}
Data unit:	ratio
Description:	Methane correction factor for the waste water (ratio)
Source of data:	Reference default values (IPCC)
Measurement procedures (if any):	---

Monitoring frequency:	---
QA/QC procedures:	---
Any comment:	---

Data / Parameter table 41.

Data / Parameter:	LOC_y
Data unit:	Hour
Description:	Length of the operational campaign in year *y* (hour)
Source of data:	On-site measurements
Measurement procedures (if any):	Record and sum the hours of operation of the CDM project activity facilities during year *y*
Monitoring frequency:	---
QA/QC procedures:	---
Any comment:	---

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Document information

Version	*Date*	*Description*
14.0	29 November 2018	EB 101, Annex 9 Revision to include non-binding best practice examples.
13.1	31 May 2017	Editorial revision to correct paragraph numbering.
13.0	4 May 2017	EB 94, Annex 5 Revision to: • Add reference to the methodological tool “Project and leakage emissions from biomass” (TOOL16); • Streamline the provisions associated with cultivation of biomass from a dedicated plantation.
12.1.1	13 September 2012	EB 69, Annex 17 Amendment to: • Broaden the applicability of the methodology to utilization of biomass from dedicated plantations; • Change the title from “Consolidated methodology for electricity and heat generation from biomass residues” to “Consolidated methodology for electricity and heat generation from biomass”.
12.1.0	2 March 2012	EB 66, Annex 39 Editorial amendment to modify equations in pages 36 and 39 where the amount of electricity generated in the baseline is higher than the amount of energy generated in the project activity.
12.0	2 March 2012	EB 66, Annex 39

Version	*Date*	*Description*
		Revision in order to incorporate reference to the tools: • "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of a crediting period"; • "Tool for project and leakage emissions from road transportation of freight".
11.2	29 September 2011	EB 63, Annex 16 Amendment to: • Broaden the applicability of the methodology to situations where mechanical energy is produced from process heat generated from biomass; • Broaden the applicability of the methodology by increasing the maximal share of the co-fired fossil fuels in the total fuel fired from 50% to 80% on an energy basis.
11.1	26 November 2010	EB 58, Annex 8 The methodology was revised in order to include project activities that use biogas produced from anaerobic digestion of wastewater as fuel. The revision also corrects editorial mistakes in equations and definitions of parameters.
11.0	17 September 2010	EB 56, Annex 6 • The revised methodology, now titled "Consolidated methodology for electricity and heat generation from biomass residues", is made in response to the EB 37 request to undertake a review of ACM0006 with a view to: (i) Provide more clarity on the applicability of various scenarios; (ii) Consolidate the various scenarios, where possible; (iii) Provide a simple guide for PPs to identify which scenario is applicable to their project activity and (iv) Explore the possibility of splitting the methodology if there are very distinct types of project activities to which the methodology is applicable. Consequently, this overall revision inter alia removes the scenario-based approach to determining applicability and provides an overall change in approach for determining baseline emissions and project emissions; • Due to the overall modification of the document, no highlights of the changes are provided; • Consequently, all information contained in history boxes below is not relevant to this version of the methodology.
10.1	30 July 2010	EB 55, Annex 16 Editorial revision to: • Revise the monitoring procedure of the biomass moisture content so that the parameter can be monitored for each batch of biomass, rather than continuously.
10.0	12 February 2010	EB 52, Annex 8

Version	*Date*	*Description*
		The applicability of the methodology was restricted to power and heat projects due to the approval of a new consolidated methodology ACM0018 for power-only projects. Power-only projects were excluded from this methodology.
09.0	17 July 2009	EB 48, Annex 10 Equation 15 was divided into two different equations in order to be correctly applied in case of scenario 13.
08.0	25 March 2009	EB 46, Annex 6 Scenario 22 was included in the methodology in response to the request for revision AM_REV_0118. Furthermore, scenario 21 was wrongly mentioned in the field "Any comment" in the table for parameter $BF_{k,boiler,historic,3yr}$ which was corrected.
07.0	13 February 2009	EB 45, Annex 11 The methodology was revised to include the following requests for revision and clarifications: • AM_REV_0074 - inclusion of Scenario 21; • AM_CLA_0065 - the statement "the efficiency of heat generation in the project plant is smaller or the same compared to the reference plant" was removed from the description of the scenarios to ensure internal consistency with the calculation of emissions reductions due to heat production.
06.2	02 August 2008	EB 41, Paragraph 26(g) The title of the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" changes to "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
06.1	16 May 2008	EB 39, Paragraph 22 "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" replaces the withdrawn "Tool to calculate project emissions from electricity consumption".
06.0	27 August 2007	EB 33, Annex 10 The methodology was revised: • To have its applicability broadened to project activities that install a new cogeneration facility using biomass; • To modify the equation for baseline methane emissions from avoided dumping of biomass residue to reflect the situation where only a part of the biomass residue available is in surplus which, therefore, would result in dumping leading to methane emissions; • To include the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" and the "Tool to calculate project emissions from electricity consumption".
05.0	18 May 2007	EB 31, Annex 11

Version	*Date*	*Description*
		The methodology was revised in response to the request AM_REV_0044 to expand the applicability of the approved methodology by including new scenario for project activities that improve the efficiency of biomass use in generating electricity.
04.0	02 November 2006	EB 27, Annex 6 In response to the requests AM_REV_0023 and AM_REV_0024 the methodology was revised: • To include the use of the first order decay model for calculation of avoided methane emissions from natural decay. That was implemented by incorporating the FOD tool as an option in cases where the biomass residues would be dumped under clearly anaerobic conditions in the baseline scenario; • To include a scenario for fossil fuel based electricity and heat generation in the baseline case. The approved methodology was also revised, as per the recommendation of the panel; • To have the scope of five Scenarios (5, 6, 7, 8 & 11) broadened to allow the possibility that existing fossil fuel fired power plants may also be retired as a result of the project activity; • To make the methodology consistent with AM0036, particularly with respect to the monitoring provisions; • To update emissions factors used in the methodology based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories; • To make provisions related to the lifetime of existing installations that are replaced as a result of the project activity in compliance with guidance by the Board on this matter (section C of annex 2 of EB 22).
03.0	19 May 2006	EB 24, Annex 1 • Inclusion of definitions section; • The methodology was revised in order to clarify the process for estimating the net quantity of increased electricity from implementation of project activity under Scenario 14.
02.0	03 March 2006	EB 23, Annex 11 • Inclusion of the name of the project developer; • Inclusion of Scenario 16.
01.0	30 September 2005	EB 21, Annex 13 Initial adoption.

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