CLEAN DEVELOPMENT MECHANISM

AMS-III.Q

Small-scale Methodology

Waste energy recovery

Version 06.1

Sectoral scope(s): 04

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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)	Utilization of waste energy at existing facilities which may be for cogeneration, generation of electricity, direct use as process heat, generation of heat in an element process or generation of mechanical energy
Type of GHG emissions mitigation action	Energy efficiency. Reduction of GHG emissions by energy recovery

2. Scope, applicability, and entry into force

2.1. Scope

2. The methodology is for project activities implemented in an existing or greenfield waste energy generation (WEG) facility converting waste energy carried in the identified waste energy carrying medium (WECM) stream(s) into useful energy (i.e. electricity, mechanical or thermal) that is consumed in an existing and/or greenfield recipient facility(ies). The WEG facility may be one of the recipient facilities. In the case of electricity generation, grid may be one of the recipient facilities.

3. The useful energy generated from the utilization of waste energy carried in the WECM stream(s) may be one or a combination of the below:

(a) Cogeneration;

(b) Generation of electricity;

(c) Direct use as process heat;

(d) Generation of heat in an element process; or

(e) Generation of mechanical energy.

2.2. Applicability

4. The methodology is applicable under the following conditions:

(a) The recovery of waste energy shall be a new initiative (i.e. WECM was flared, vented or released into the atmosphere in the absence of the project activity).[1]

[1] Project activities that recover a small amount of waste energy in the baseline may apply this methodology provided that the current practice of recovering small amount of waste energy continues during the crediting period and there is no diversion of the baseline waste energy use, i.e. only energy that was otherwise flared, vented or released to atmosphere is utilized in the project activity. The project proponents may demonstrate this condition following appendix 3 “Conservative baseline emissions if multiple waste gas stream(s) with potential for interchangeable application exist in the WEG facility” of the recent version of “ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”.

The DOEs during on-site visit as part of their validation activities shall confirm that no equipment for waste energy recovery and utilisation had been installed on the specific WECM stream(s) (that is recovered under the project activity) prior to the implementation of the project activity by using one of the following options:

(i) By **direct measurements** of energy content and amount of the waste energy for at least three years prior to the start of the project activity;

(ii) **Energy balance** of relevant sections of the plant to prove that the waste energy was not a source of energy before the implementation of the project activity. For the energy balance representative process parameters are required. The energy balance shall demonstrate that the waste energy was not used and also provide conservative estimations of the energy content and amount of waste energy released;

(iii) **Energy bills** (electricity, fossil fuel) to demonstrate that all the energy required for the process (e.g. based on specific energy consumption specified by the manufacturer) has been procured commercially. Project participants are required to demonstrate through the financial documents (e.g. balance sheets, profit and loss statement) that no energy was generated by waste energy and sold to other facilities and/or the grid. The bills and financial statements should be audited by competent authorities;

(iv) **Process plant** manufacturer's original specification/information, schemes and diagrams from the construction of the facility could be used as an estimate of quantity and energy content of waste energy produced for rated plant capacity per unit of product produced;

(b) Regulations do not require the WEG facility to recover and/or utilize the waste energy prior to the implementation of the project activity;

(c) A WECM stream that is released under abnormal operations (for example: emergencies, shutdown etc.) of the WEG facility shall not be included in the emission reduction calculations;

(d) Energy (i.e. electricity or thermal heat) produced in the project activity may be exported to a grid or other industrial facilities (included in the project boundary), a contractual agreement exists between the owners of the WEG facility and the recipient facility(ies) to avoid the potential double counting of emission reductions. These procedures shall be described in the CDM Project Design Document;

(e) For project activities that use waste pressure to generate electricity the electricity generated from waste pressure shall be measurable.

5. The methodology is not applicable to project activities implemented in a single-cycle power plant (e.g. gas turbine or diesel generator) where waste energy generated on-site is not utilizable for any other purposes on-site except to generate electricity. Such project activities shall consider "AMS-III.AL.: Conversion from single cycle to combined cycle power generation". However project activities recovering waste energy from such power plants for the purpose of generation of heat can apply this methodology.

6. For a project activity that recovers waste energy for power generation from multiple sources (e.g. a kiln and a single-cycle power plant), this methodology should be used in combination with AMS-III.AL. provided that:

   (a) It is possible to distinguish two distinct waste energy sources within the project activity such that:

      (i) Waste energy source-I (e.g. the kiln) belongs to waste heat sources which are eligible under AMS-III.Q.;

      (ii) Waste energy source-II (e.g. the single-cycle power unit) belongs to waste heat sources which are eligible under AMS-III.AL.;

   (b) For waste energy source-II eligible under AMS-III.AL., all requirements under "AMS-III.AL.: Conversion from single cycle to combined cycle power generation" that relate to baseline, project emissions and monitoring shall apply;

   (c) It is possible to determine the baseline for each waste energy source, according to the specific methodology being used;

   (d) It is possible to objectively allocate the electricity produced in the project activity to each waste energy source, by means of one of the following methods:

      (i) Through separate measurements of the electricity produced by utilizing waste energy from each waste energy source; or

      (ii) Through separate measurements of the energy content of the WECM streams used for electricity production; or

      (iii) Through separate measurements of the energy content of the WECM streams that are associated with each waste energy source and used for electricity production or for the WECM generation in a common waste heat recovery system (e.g. if steam is generated by waste heat from a kiln and waste heat from an internal combustion engine in a common waste heat recovery boiler).

7. Emission reductions cannot be claimed at and beyond the end of the lifetime of the waste energy generation equipment at the WEG facility or on-site captive unit at the recipient facility. The end of the lifetime of the equipment shall be determined as per the requirements mentioned in "Tool to determine remaining lifetime of equipment".

8. The project activity shall result in emission reductions less than or equal to 60 kt CO_2 equivalent annually.

2.3. Entry into force

9. The date of entry into force is the date of the publication of the EB 83 meeting report on 16 April 2015.

3. Normative references

10. Project participants shall apply the general guidelines to small-scale (SSC) clean development mechanism (CDM) methodologies, and the "Methodological tool: Demonstration of additionality of small-scale project activities" at

<http://cdm.unfccc.int/Reference/Guidclarif/index.html#meth> and <http://cdm.unfccc.int/Reference/tools/index.html> mutatis mutandis.

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

(a) “ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”;

(b) “AMS-III.AL.: Conversion from single cycle to combined cycle power generation”;

(c) “Tool to calculate the emission factor for an electricity system”;

(d) “Tool to determine the baseline efficiency of thermal or electric energy generation systems”;

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

(f) “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”;

(g) “Tool to determine remaining lifetime of equipment”;

(h) “Methodological tool: Demonstration of additionality of small-scale project activities””.

4. Definitions

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

13. For the purpose of this methodology the following definitions apply:

(a) **Cogeneration** - the simultaneous production of electricity and useful thermal energy from a common fuel source;

(b) **Element process** - the process of generation of thermal energy through fuel combustion or transfer of heat in equipment. Examples of an element process are steam generation by a boiler and hot air generation by a furnace. Each element process should generate a single output (such as steam or hot air or hot oil) by using single or multiple energy sources. For each element process, energy efficiency is defined as the ratio of the useful energy (the enthalpy of the steam multiplied with the steam quantity) and the supplied energy to the element process (the net calorific value of the fuel multiplied with the respective fuel quantity);

(c) **Existing facility** (includes the WEG facility and the recipient facility) - existing facility is a facility that has been in operation for at least three years immediately prior to the start date of the project activity;[2]

(d) **Greenfield facility** (includes the WEG facility and the recipient facility) – Greenfield facility is either a new facility constructed and operated at a site where no facility was operated prior to the implementation of the project activity or a

[2] See Glossary of CDM Terms, available at: <https://cdm.unfccc.int/Reference/index.html>.

facility which has less than three years of operational history immediately prior to the start date of the project activity. In case of capacity expansion or replacement, the increased or replaced capacity shall be treated as a greenfield facility;

(e) **Recipient facility** - the facility that receives useful energy generated using waste energy under the project activity in the waste energy generation facility. It may be the same waste energy generation facility;

(f) **Waste energy** - Energy contained in residual streams from industrial processes in the form of heat or pressure, for which it can be demonstrated that it would not have been recovered in the absence of the project activity. Examples of waste energy include the energy contained in gases flared, vented or released into the atmosphere, the heat or pressure from a residual stream is not recovered and therefore is wasted. Gases that have an intrinsic value in a spot market as an energy carrier or chemical (e.g. natural gas, hydrogen, liquefied petroleum gas, or their substitutes) are not eligible under this category;

(g) **Waste energy carrying medium (WECM)** - the medium carrying the waste energy in the form of heat or pressure. Examples of WECM include gas, air or steam;

(h) **Waste energy generation facility (“WEG facility”)** - the facility where the waste energy which is utilized by the CDM project activity is available. The project activity can be implemented by the owner of the facility or by a third party (e.g. ESCO). If the waste energy is recovered by another facility, i.e. a third party in a separate facility, the “WEG facility” will encompass both the waste energy generation facility and the waste energy recovery facility. In a situation where waste gas is exported instead of supplying useful energy to a recipient plant, then the WEG facility shall include the recipient facility.

5. Baseline methodology

5.1. Project boundary

14. The geographical extent of the project boundary shall include the relevant WECM stream(s), equipment and energy distribution system in following facilities:

    (a) WEG facility;

    (b) Recipient facility(ies), which may be the same as the “WEG facility”.

15. The spatial extent of the grid is as defined in the “Tool to calculate the emission factor for an electricity system”, as applicable.

16. The relevant equipment and energy distribution system covers:

    (a) In a WEG facility, the WECM stream(s), waste energy recovery and useful energy generation equipment, and distribution system(s) for useful energy;

    (b) In a recipient facility, the equipment which receives useful energy supplied by the project and distribution system(s) for useful energy.

17. Where multiple waste gas streams are available in the WEG facility, and can be used interchangeably for various applications as part of energy sources in the facility, the guidance provided in appendix 3 “Conservative baseline emissions if multiple waste gas stream(s) with potential for interchangeable application exist in the WEG facility” of the recent version of “ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects” shall be followed to establish the project boundary.

18. The fossil fuel fired power unit(s), introduced in the project scenario shall be considered as part of project activity.

5.2. Additionality

19. The additionality for the project activities involving existing WEG facilities supplying electricity, mechanical energy or electricity and/or heat to existing recipient facilities and/or Greenfield recipient facilities shall be demonstrated using requirements mentioned under the “Methodological tool: Demonstration of additionality of small-scale project activities”.

20. The additionality for the project activities involving greenfield WEG facilities supplying electricity, mechanical energy, cogeneration or thermal energy to existing recipient facilities and/or greenfield recipient facilities shall be demonstrated using investment analysis.

21. The investment related to fossil fuel fired power unit(s), introduced in the project scenario shall be considered in investment analysis for demonstrating additionality.

5.3. Baseline

5.3.1. Baseline scenario

5.3.1.1. For existing WEG facilities

22. For the use of waste energy at the WEG facility the plausible baseline scenario shall be; WECM was flared, vented or released into the atmosphere in the absence of the project activity.

5.3.1.2. For existing recipient facilities

23. In case of project activities involving existing recipient facilities the baseline scenario shall be based on relevant operational data from immediately prior three years to the start date of the project activity (or the start date of validation with due justification). For existing facilities, which has three years of operation history but do not have sufficient operational data for the purpose of determining baseline, all historic information shall be available (a minimum of one year operational data is required).

24. All options for demonstrating the use of waste energy in the absence of a CDM project activity shall be based on historic information and not on a hypothetical scenario.

5.3.1.3. For Greenfield WEG facilities

25. In case of project activities involving greenfield WEG facilities the baseline scenario shall be determined in accordance with the procedure prescribed in most recent version of

"ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects" or as per the relevant requirements related to determination of baseline scenario provided in the "General guidelines for SSC CDM methodologies" for Type-II and Type-III Greenfield/capacity expansion project activities.

5.3.1.4. For Greenfield recipient facilities

26. In case of Greenfield recipient facilities the baseline scenario shall be determined as per the relevant requirements related to determination of baseline scenario provided in the "General guidelines for SSC CDM methodologies" for Type-II and Type-III Greenfield/capacity expansion project activities or as per paragraph 27 below should be applied to define the baseline scenario.

27. The baseline for greenfield recipient facilities shall be determined:

(a) Using reference plant approach - In cases where the baseline scenario consists of the installation of new systems and/or the utilization of new energy sources, a Reference Plant shall be defined as the baseline scenario. The Reference Plant shall be based on common practice for similar industrial, residential, commercial, and institutional energy generation systems and sources in the same sector and in the same country or region as the project. The identification of the reference plant should exclude plants implemented as CDM project activities. In cases where no such plant exists within the region, the economically most attractive technology and fuel type should be identified among those which provide the same service, that are technologically available, and that are in compliance with relevant regulations. The efficiency of the technology should be selected in a conservative manner, i.e. where several technologies could be used and are similarly economically attractive, the most efficient technology with the lowest baseline emissions should be defined as the baseline scenario. In addition, the least carbon intensive fuel type should be chosen in case of multiple fuels being possible choices; or

(b) The baseline scenarios shall be:

(i) For electricity generation:

a. Electricity is imported from a grid;

b. Electricity is produced in an on-site captive power plant using fossil fuel; or

c. Combination of both;

(ii) For mechanical energy:

a. Mechanical energy is obtained using electric motors operated using electricity imported either from a grid, produced in an on-site captive power plant using fossil fuel or combination of both; or

b. Mechanical energy is obtained using electric motors operated using steam generated from cogeneration unit using fossil fuel;

(iii) For cogeneration:

a. Electricity is imported from a grid and thermal energy is produced using fossil fuel;

b. Electricity is produced in an on-site captive power plant using fossil fuel and thermal energy is produced using fossil fuel;

c. Combination of both; or

d. Electricity and thermal energy are produced in a cogeneration unit using fossil fuel.

(iv) For thermal energy generation:

a. Thermal energy is either imported from other facility(ies) or produced on-site using fossil fuel.

5.3.2. Baseline emissions for electricity

28. Electricity is obtained from an identified existing plant or from the grid. The baseline emissions can be calculated as follows:

$$BE_{elec,y} = f_{cap} \times f_{wcm} \times \sum_{j}\sum_{i}(EG_{i,j,y} \times EF_{Elec,i,j,y})$$ Equation (1)

Where:

$BE_{elec,y}$	=	Baseline emissions due to displacement of electricity during the year *y* in tons of CO_2
f_{cap}	=	The ratio of waste energy generated at a historical level, expressed as a fraction of the total waste energy used in the project activity for producing useful energy in year *y*. The ratio is 1 if the waste energy generated in project year *y* is the same or less than that generated at a historical level. Capping factor is to exclude increased waste energy utilization in the project year *y* due to increased level of activity of the plant, relative to the level of activity in the base years before project start. The value of f_{cap} shall be estimated using one of the applicable methods that applies to the situation of the project activity prescribed in the most recent version of “ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”. Where the method requires historical data, the project proponents shall follow the requirement stipulated in paragraph 23 above
f_{wcm}	=	Fraction of total electricity generated by the project activity using waste energy. This fraction is 1 if the electricity generation is purely from use of waste energy. The value of f_{wcm} shall be estimated using applicable procedures that apply to the situation of the project activity prescribed in the most recent version of “ACM0012: Consolidated baseline

methodology for GHG emission reductions from waste energy recovery projects". Where the method requires historical information, the project proponents shall follow the requirement stipulated in paragraph 23 above.
In cases where auxiliary fossil fuel is used to supplement the waste energy directly in the waste heat recovery combustion systems and the energy output cannot be demonstrably apportioned due to technical constraints (e.g. waste gas measurement and its quality) between fossil fuels and the waste energy, a value of 1 for fwcm can be used and consider the emissions resulting from the combustion of fossil fuel as project emissions using "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Note: for a project activity using waste pressure to generate electricity this fraction is 1

$EG_{i,j,y}$ = The quantity of electricity supplied to the recipient *j* by generator, that in the absence of the project activity would have been sourced from i^{th} source (*i* can be either grid or identified existing source) during the year *y* in MWh.

$EF_{Elec,i,j,y}$ = The CO_2 emission factor for the electricity source *i* (grid or identified existing source), displaced due to the project activity, during the year *y* in tons CO_2/MWh.

5.3.2.1. Determination of $EF_{elec,i,j,y}$

29. In the case where the recipient of the electricity produced by the project activity is solely the grid or if the displaced electricity for the recipient facility is solely supplied by a connected grid system, and the grid is demonstrated to be the electricity baseline; then, the CO_2 emission factor $EF_{elec,gr,j,y}$ shall be determined as per the "Tool to calculate the emission factor for an electricity system"; otherwise, if the baseline generation source is an identified existing power plant, the CO_2 emission factor shall be determined as follows:

$$EF_{Elec,i,j,y} = \frac{EF_{CO2,i,j}}{\eta_{Plant,j}} \times 3.6 \times 10^{-3}$$

Equation (2)

Where:

$EF_{CO2,i,j}$ = The CO_2 emission factor per unit of energy of the fossil fuel used in the baseline generation source *i* in (tCO_2/TJ).

$\eta_{Plant,j}$ = The overall efficiency of the identified existing plant that would be used by j^{th} recipient in the absence of the project activity.

$3.6*10^{-3}$ = Conversion factor, expressed as TJ/MWh.

30. For project activities that displace both imported grid electricity and identified existing power plant the baseline emission factor should reflect the emissions intensity of the grid and identified existing source in the baseline scenario i.e. the weighted average emission factor for the displaced electricity is calculated using values in accordance with

requirements of paragraph 23 above for historical information. In cases where historical information is deemed not suitable to determine the relative proportion of these two sources used in the baseline (e.g. the available data is not reliable due to various factors such as the use of imprecise or non-calibrated measuring equipment) then the most conservative emission factor for the two energy sources shall be used.

31. If in the baseline situation, more than one type of fossil fuel is used in the identified existing power plant, the relative contribution to the total output of each fossil fuel shall be considered and the formulas for baseline emissions shall be adjusted accordingly. The relative contribution shall be determined based on the historical data as indicated in the paragraph 23 above.

32. Efficiency of the identified existing power plant $(\eta_{Plant,j})$ shall be determined in accordance with the latest approved version of "Tool to determine the baseline efficiency of thermal or electric energy generation systems".

5.3.3. Baseline emissions for mechanical energy

33. Mechanical energy is obtained by electric motors that displace mechanical energy generated by a steam turbine in the project activity. The baseline emissions can be calculated as follows:

$$BE_{Elec,y} = f_{cap} \times f_{wcm} \times \sum_{j} \sum_{i} \left(\frac{MG_{i,j,y,mot}}{\eta_{mech,mot,i,j}} \times EF_{Elec,i,j,y} \right)$$

Equation (3)

Where:

$BE_{elec,y}$	=	Baseline emissions due to displacement of electricity during the year y (t CO_2).
$MG_{i,j,y,mot}$	=	Mechanical energy generated by a steam turbine in the project activity and supplied to the mechanical equipment (e.g. pump, compressor) of recipient *j*, which in the absence of the project activity would be driven by electric motor *i* (MWh).
$\eta_{mech,mot,i,j}$	=	The efficiency of the baseline electric motor *i* that would provide mechanical power to recipient *j* in the absence of the project activity.
$EF_{Elec,i,j,y}$	=	The CO_2 emission factor for the electricity source *i* (grid or identified source), displaced due to the project activity, during the year *y* in tons CO_2/MWh.

5.3.4. Baseline emissions for thermal energy and steam-generated mechanical energy

34. Thermal energy is obtained from a fossil fuel based element process (e.g. steam boiler, hot water generator, hot air generator, hot oil generator, fossil fuel direct combustion in a process). The baseline emissions can be calculated as follows:

$$BE_{Ther,y} = f_{cap} \times f_{wcm} \times \sum_{i}\sum_{j}(HG_{j,y} + \mathrm{MG}_{i,j,y,tur}/\eta_{mech,tur}) \times EF_{heat,j,y}$$ Equation (4)

Where:

$BE_{Ther,y}$	=	Baseline emissions from thermal energy (as steam) during the year *y* in tons of CO_2.
$HG_{j,y}$	=	Net quantity of thermal energy (enthalpy) supplied to the recipient plant *j* by the project activity during the year *y* in TJ.
$\mathrm{MG}_{i,j,y,tur}$	=	Mechanical energy generated and supplied to the recipient *j*, which in the absence of the project activity would receive power from a steam turbine *i,* driven by steam generated in a fossil fuel boiler (TJ).
$\eta_{mech,tur}$	=	The efficiency of the baseline equipment (steam turbine) that would provide mechanical power in the absence of the project activity.
$EF_{heat,j,y}$	=	The CO_2 emission factor of the element process supplying heat that would have supplied the recipient plant *j* in the absence of the project activity, expressed in t CO_2/TJ and calculated as per equation (5) below.

5.3.4.1. Determination of $EF_{heat,j,y}$

$$EF_{heat,j,y} = \sum_{i} ws_{i,j} \frac{EF_{CO2,i,j}}{\eta_{EP,i,j}}$$ Equation (5)

Where:

$EF_{CO2,i,j}$	=	The CO_2 emission factor per unit of energy of the baseline fuel used in i^{th} element process used by recipient *j*, (t CO_2/TJ), in absence of the project activity.
$\eta_{EP,i,j}$	=	Efficiency of the i^{th} element process that would have been supplied heat to j^{th} recipient in the absence of the project activity.
$ws_{i,j}$	=	Fraction of total heat that is used by the recipient *j* in the project that in the absence of the project activity would have been supplied by the i^{th} element process.
i	=	Identified existing source.

35. Efficiency of the element process ($\eta_{EP,i,j}$) shall be one of the following:

(a) Determine the efficiency of the element process in accordance with the latest approved version of "Tool to determine the baseline efficiency of thermal or electric energy generation systems";

(b) Assume a constant efficiency of the element process and determine the efficiency, as a conservative approach, for optimal operation conditions i.e. design fuel, optimal load, optimal oxygen content in flue gases, adequate fuel conditioning (temperature, viscosity, moisture, size/mesh etc.), representative or favorable ambient conditions (ambient temperature and humidity); or

(c) Maximum efficiency of 100 per cent.

5.3.5. Baseline emissions from co-generated electricity and heat of a cogeneration plant

36. In the situation where: (i) the electricity and/or heat would be generated by an existing fossil fuel based cogeneration plant; (ii) the mechanical energy would be generated by existing electrical motors or steam turbine; (iii) all the recipient plant(s) are supplied energy from a common fuel based cogeneration source in absence of the project activity, the baseline emissions from co-generated electricity and heat of a cogeneration plant are calculated as:

(a) Electricity ($EG_{j,y}$), thermal energy (steam) ($HG_{j,y}$) and if applicable, mechanical energy (*MGj,y,mot* or *MGj,y,tur*) supplied to the recipient facility(ies); and

(b) CO_2 emission factor of the fuel used by the cogeneration plant that would have supplied the energy to the recipient facility(ies) *j* in the absence of the project activity, as follows:

$$BE_{En,y} = f_{cap} \times f_{wcm} \times \sum_j \left[\frac{HG_{j,y} + (\mathrm{MG_{j,y,tur}}/\eta_{\mathrm{mech,tur}}) + (EG_{j,y} + \mathrm{MG_{j,y,mot}}/\eta_{\mathrm{mech,mot}}) \times 3.6 \times 10^{-3}}{\eta_{Cogen}} \right] \times EF_{CO2,COGEN} \quad \text{Equation (6)}$$

Where:

$BE_{En,y}$	=	The baseline emissions from energy that is displaced by the project activity during the year *y* in tons of CO_2.
$EG_{j,y}$	=	The quantity of electricity supplied to the recipient plant *j* by the project activity during the year *y* in MWh.
$3.6*10^{-3}$	=	Conversion factor, expressed as TJ/MWh.
$HG_{j,y}$	=	Net quantity of thermal energy supplied to the recipient plant *j* by the project activity during the year *y* (TJ).
$EF_{CO2,COGEN}$	=	CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline cogeneration plant in (t CO_2/TJ), obtained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors.

η_{Cogen}	=	Efficiency of the cogeneration plant (combined heat and power generation efficiency) using fossil fuel that would have been used in the absence of the project activity.
$MG_{j,y,mot}$	=	Mechanical energy generated by steam turbine in the project activity and supplied to the mechanical equipment (e.g. pump, compressor) of recipient *j*, which in the absence of the project activity would be driven by electric motor (MWh).
$\eta_{mech,mot}$	=	The efficiency of the baseline electric motor that would provide mechanical power in the absence of the project activity.
$MG_{j,y,tur}$	=	Mechanical energy generated by steam turbine in project activity and supplied to the mechanical equipment (e.g. pump, compressor) of recipient *j*, which in the absence of the project activity would be driven by a steam turbine, operating from steam generated in a fossil fuel boiler (TJ).
$\eta_{mech,tur}$	=	The efficiency of the baseline steam turbine that would provide mechanical power in the absence of the project activity.

37. Efficiency of the cogeneration plant (η_{Cogen}) shall be one of the following:

(a) Assume a constant efficiency of the cogeneration plant and determine the efficiency, as a conservative approach, for optimal operational conditions i.e. designed fuel, designed steam extractions, optimal load, optimal oxygen content in flue gases, adequate fuel conditioning (viscosity, temperature, moisture, size/mesh etc.), representative or favorable ambient conditions (temperature, humidity); or

(b) Highest of the efficiency values provided by two or more manufacturers for similar plants as used in the project activity; or

(c) Maximum efficiency of 90 per cent, based on net calorific values (irrespective of type of cogeneration system and type of heat generated).

5.4. Project emissions

38. Project emissions due to the project activity (PE_y) include emissions due to: (i) combustion of auxiliary fuel to supplement waste gas/heat ($PE_{AF,y}$); and (ii) emissions due to consumption of electricity for cleaning of gas before being used for generation of electricity or other supplementary electricity consumption by the project activity ($PE_{EL,y}$).

$$PE_y = PE_{AF,y} + PE_{EL,y}$$ Equation (7)

39. $PE_{AF,y}$ and $PE_{EL,y}$ shall be estimated following the procedure provided in the relevant section of the most recent version of “ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”.

40. Project emissions on account of use of auxiliary fossil fuel and electricity use shall be calculated in accordance with the “Tool to calculate project or leakage CO_2 emissions

from fossil fuel combustion” and the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption “respectively.

41. If the waste gas contains carbon monoxide or hydrocarbons, other than methane, and the waste gas is vented or released into the atmosphere in the baseline situation, project emissions have to include CO_2 emissions due to the combustion of the waste gas.

5.5. Leakage

42. If the energy generating equipment introduced by the project activity is transferred from outside the boundary of the project activity, leakage is to be considered.

5.6. Emission reductions

43. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (8)}$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e/yr).
BE_y	=	Baseline emissions in year *y* (t CO_2e/yr).
PE_y	=	Project emissions in year *y* (t CO_2/yr).
LE_y	=	Leakage in year *y* (t CO_2/yr).

5.7. Data and parameters not monitored

Data / Parameter table 1.

Data / Parameter:	$\eta_{mech,mot,i,j}$, $\eta_{mech,tur,k,}$
Data unit:	-
Description:	The efficiency of the baseline equipment that would provide mechanical power to recipient *j* which in the absence of the project activity
Source of data:	Manufacturers data or data from similar plant operators or project participants data
Measurement procedures (if any):	For mechanical energy conversion equipment, apart from the options available in the baseline emission section (electrical motor or steam turbine in the baseline which is replaced by a mechanical turbine in the CDM project), use the equipment efficiency vs. the load characteristic curve from the supplier
Any comment:	-

6. Monitoring methodology

44. If the methodology is used in conjunction with “AMS-III.AL.: Conversion from single cycle to combined cycle power generation” (according to paragraph 5 and 6 above) following applies:

(a) Separate measuring of the electrical energy produced associated with the two waste energy sources or of the energy content of the two WECM streams or of the energy content of the two waste heat streams utilized for electricity production is required. Energy contents are monitored through mass flow rate and enthalpy measures. If the waste energy is used for the WECM generation in a common waste heat recovery system (e.g. if steam is generated by waste heat from a kiln and waste heat from an internal combustion engine in a common waste heat recovery boiler), the energy content of the waste heat streams is to be monitored separately, through mass flow rate and enthalpy measures;

(b) Project emissions shall be monitored in accordance with the procedures described under the most recent version of AMS-III.AL.

45. The applicable requirements specified in the “General guidelines for SSC CDM methodologies” (e.g. calibration requirements, sampling requirements) are also an integral part of the monitoring guidelines.

46. All the parameters applicable for determination of f_{cap} and f_{wcm} shall be monitored in accordance with the most recent version of “ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”.

6.1. Data and parameters monitored

Data / Parameter table 2.

Data / Parameter:	$EG_{i,j,y}$, $EG_{j,y}$
Data unit:	MWh
Description:	Quantity of electricity supplied to the recipient *j* by the generator, which in the absence of the project activity would have sourced from i^{th} source (*i* can be either grid or identified source) during the year *y*
Source of data:	Recipient facility(ies) and generation plant measurement records
Measurement procedures (if any):	-
Monitoring frequency:	Monthly
QA/QC procedures:	The energy meters will undergo maintenance/calibration to the industry standards. Sales records for sold/purchased electricity/steam (e.g. invoices/receipts) and purchase receipts are used to ensure the consistency
Any comment:	Data shall be measured at the recipient facility(ies) and at the project facility for cross check. Sales receipts shall be used for verification. DOEs shall verify that total energy supplied by the generator is equal to total electricity received by recipient facility(ies). For electricity exported to a grid, the net electricity delivered shall be monitored.

Data / Parameter table 3.

Data / Parameter:	$MG_{i,j,y,mot}$ (and $MG_{j,y,mot}$) or $MG_{k,j,y,tur}$ (and $MG_{j,y,tur}$) or $MG_{j,y,mot}$
Data unit:	TJ or MWh
Description:	Mechanical energy generated by the steam turbine in the project activity and supplied to the mechanical equipment (e.g. pump, compressor) of recipient *j,* which in the absence of the project activity would be driven by electric motor *i* or steam turbine *k*
Source of data:	Estimated parameter, based on measurements by project participants, that includes pressure monitoring equipment and flow monitoring equipment. For example pressure and flow characteristics of the pump will provide the shaft power needed by pump based on its performance curve. This power represents the output delivered by the steam turbine under the project activity. Inlet steam flow, P and T and exhaust P and T provides very accurate measure of energy transferred
Measurement procedures (if any):	The number of hours that the mechanical equipment is in operation should be known. Downtime of the system (for example the boiler) providing the steam used for mechanical energy purposes should be taken into account when determining $MG_{i,j,y}$ $MG_{i,j,y}$ from mass flow rate, differential pressure and equipment performance curves, also taking into account the efficiency of the mechanical equipment (e.g. pump, compressor, blower). Inlet steam flow, pressure and temperature and exhaust pressure and temperature provide accurate measure of energy transferred combined with known turbine efficiency. Use a procedure from international or national standard, where available. Use of standard will provide the energy supplied to mechanical equipment
Monitoring frequency:	Continuous monitoring should be done where possible. If the project proponent can prove that operational conditions stay more or less constant (without start-up), then intermittent monitoring can be done (once a month at least)
QA/QC procedures:	Monitoring equipment should be calibrated and be installed as per the supplier's instruction. Equipment performance curves should be certified (for example by the supplier)
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$HG_{j,y}$
Data unit:	TJ
Description:	Net quantity of thermal energy supplied to the recipient facility *j* by the project activity during the year *y* in TJ.
Source of data:	Recipient facility(ies) actual measurement records

Measurement procedures (if any):	For the element process, thermal energy generation is determined as the difference of the enthalpy of the steam or hot water generated by the boiler(s) minus the enthalpy of the feed-water. The enthalpy of feed water to the boiler takes into account the enthalpy of condensate returned to the boiler (if any) and any other waste heat recovery (including economiser, blow down heat recovery etc.). Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. In the typical cases of waste heat recovery boilers generating steam and supplying to a turbine having extraction-cum-condensing configuration, the extraction steam of the steam turbine is sent to the recipient facility *j* and its condensate directly returns to waste heat recovery boiler. For such cases the condensate return (flow and temperature) is measured at a point before it is mixed with fresh water (or other condensate of the system e.g. that is returning from the outlet of the turbine condensing stage) to be supplied to the boiler. The difference between the enthalpy of extraction steam supplied to recipient facility *j* (e.g. turbine in this case) and the heat of condensate recovered represents $HG_{j,y}$
Monitoring frequency:	Continuously, aggregated annually or for each time interval *t*
QA/QC procedures:	This data item is a calculated value using other data items. No QA/QC required
Any comment:	For element process like boilers, net quantity of thermal energy is expressed as the difference of energy content between the steam supplied to the recipient facility and feed water to the boiler. The enthalpy of feed water to the boiler takes into account the enthalpy of condensate returned to the boiler (if any) and any other waste heat recovery (including economiser, blow down heat recovery etc.). Data shall be measured at the recipient facility(ies) and at the project facility for cross check.

Data / Parameter table 5.

Data / Parameter:	$\mathbf{ws_{i,j}}$
Data unit:	%
Description:	Fraction of total heat that is used by the recipient *j* in the project that in absence of the project activity would have been supplied by the i^{th} element process
Source of data:	Project participants
Measurement procedures (if any):	-
Monitoring frequency:	Yearly
QA/QC procedures:	-

Data / Parameter table 6.

Data / Parameter:	$\mathbf{EF_{CO2,i,j,y}}$, $\mathbf{EF_{CO2,i,j}}$
Data unit:	Tonnes CO_2/MWh
Description:	CO_2 emission factor per unit of energy of the fossil fuel used in the baseline generation source *i* (grid or identified existing source) displaced due to the project activity, during the year *y*

Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	-
Monitoring frequency:	Yearly
QA/QC procedures:	-
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available

Data / Parameter table 7.

Data / Parameter:	$\mathbf{EF_{CO2,COGEN}}$
Data unit:	Tonnes CO_2/TJ
Description:	CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline cogeneration plant
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	-
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available

Data / Parameter table 8.

Data / Parameter:	$\mathbf{EF_{heat,j,y}}$
Data unit:	Tonnes CO_2/TJ
Description:	CO_2 emission factor of the heat source that would have supplied the recipient facility *j* in absence of the project activity, expressed in t CO_2/TJ
Source of data:	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain
Measurement procedures (if any):	-
Monitoring frequency:	Yearly
QA/QC procedures:	No QA/QC necessary for this data item
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available

Data / Parameter table 9.

Data / Parameter:	**Abnormal operation of the project facility including emergencies and shut down**
Data unit:	Hours
Description:	The hours of abnormal operation of parts of project facility that can have an impact on waste energy generation and recovery
Source of data:	Operation of project facility
Measurement procedures (if any):	-
Monitoring frequency:	Daily, aggregated annually
QA/QC procedures:	-
Any comment:	This parameter has to be monitored to demonstrate that no emission reduction is claimed for the hours during the abnormal operation of the part of project facility which have impact on waste energy generation and recovery. The abnormality can be in terms of violation of operational parameters, poor quality product, emergencies or shutdown

7. Project activity under a Programme of Activities

47. The following condition applies for use of this methodology under a programme of activities:

(a) If the project activity involves the replacement of equipment, and the leakage effect of the use of the replaced equipment in another activity is neglected, because the replaced equipment is scrapped, an independent monitoring of scrapping of replaced equipment needs to be implemented;

(b) The monitoring should include a check if the number of project activity equipment distributed by the project and the number of scrapped equipment correspond with each other. For this purpose scrapped equipment should be stored until such correspondence has been checked. The scrapping of replaced equipment should be documented and independently verified.

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Document information

Version	*Date*	*Description*
06.1	26 May 2015	Editorial revision to include the change of title of the methodology from “Waste energy recovery (gas/heat/pressure) projects” to “Waste energy recovery” at EB 83 into the document information table.
06.0	16 April 2015	EB 83, Annex 11 Revision to: • Expand the applicability to cover greenfield facilities using approaches consistent with “ACM0012: Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects”, and • Incorporate previous clarifications SSC_686 and SSC_690 issued by the SSC WG.
05.0	13 September 2012	EB 69, Annex 25 To further clarify: (i) the definition of various terms (e.g. project facility, recipient facility, existing facilities) and baseline calculation procedures consistent with ACM0012 “Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects” where appropriate; (ii) include clarification provided by the Board at its sixty-first meeting (EB 61, annex 20) to cover project activities that recover a small amount of waste energy in the baseline.
04.0	15 April 2011	EB 60, Annex 22 To include multiple fuel in the baseline and recovery of waste heat for multiple waste heat sources.
03.0	04 December 2009	EB 51, Annex 17 To include, inter alia, export of energy generated by the project activity to other facilities, definition of existing facility, procedures and formulae for the calculation of baseline emission from thermal energy generation and to exclude recovery of waste heat in a single-cycle power plant (e.g. gas turbine or diesel generator) to generate electricity.
02.0	26 September 2008	EB 42, Annex 19 To broaden the applicability of the methodology to allow other fuels to supplement the use of waste energy and to include a precise definition of waste gas and further guidance on baseline emission calculations.
01.0	19 October 2007	EB 35, Annex 26 Initial adoption.

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