CLEAN DEVELOPMENT MECHANISM

ACM0012

Large-scale Consolidated Methodology

Waste energy recovery

Version 05.0

Sectoral scope(s): 01 and 04

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 projects	Energy from waste heat, waste gas or waste pressure in an existing or new industrial facility is recovered and used for in-house consumption or for export, by installation of a new power and/or heat and/or mechanical energy generation equipment, by installation of a more-efficient useful energy generation equipment than already existing, or by upgrade of existing equipment but with better efficiency of recovery
Type of GHG emissions mitigation action	Energy efficiency: Waste energy recovery in order to displace more-carbon-intensive energy/technology

2. Scope, applicability, and entry into force

2.1. Scope

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

2.2. Applicability

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

(a) Generation of electricity;

(b) Cogeneration;

(c) Direct use as process heat source in as unit process/chemical reactor;

(d) Generation of heat in element process;

(e) Generation of mechanical energy; or

(f) Supply of heat of reaction with or without process heating.

4. In the absence of the project activity, the following situations for the WECM stream(s) would occur:

   (a) WECM would not be recovered[1] and therefore would remain unutilized (e.g. flared or released to the atmosphere) at the existing or Greenfield WEG facility; or

   (b) WECM would be partially recovered and/or recovered in less efficient equipment of recipient facility, and the unrecovered portion of WECM stream would remained unutilised at the existing or Greenfield WEG facility. In this case, the type of useful energy produced from this WECM by the project activity shall be the same type of useful energy that is produced in the absence of project activity implementation using partially recovered WECM and/or less efficient use of WECM (e.g. if the WECM is partially used to produce electricity in the absence of project activity then the methodology is only applicable if the WECM is recovered in the project to produce electricity).

5. This methodology applies to the following two categories of project activities:

   (a) Category 1: Project activities that involve recovery of WECM as per situation in paragraph 4(a) above; and

   (b) Category 2: Project activities that involve enhanced/improved energy recovery of the WECM as compared to the baseline scenario as per situation in paragraph 4(b) above.

6. Project activities under category 2 would include improving the WECM recovery that may: (i) capture and utilise a larger quantity of WECM stream as compared to the historical situation in an existing WEG facility, or capture and utilise a larger quantity of WECM stream as compared to a “reference waste energy generating facility” for a Greenfield facility; and/or (ii) apply better energy efficient equipment to replace/modify/expand[2] waste energy recovery equipment in an existing recipient facility, or implement a better energy efficient equipment than the “reference energy generation facility” for a Greenfield facility.

7. The methodology is applicable under the following conditions:

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

   (b) For project activities which recover waste pressure, the methodology is applicable where waste pressure is used to generate electricity only and the electricity generated from waste pressure is measurable;

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[1] WECM is directly vented or released to the atmosphere with or without incineration or waste heat is vented or released to the atmosphere or waste pressure energy is not utilized.

[2] The expansion of existing equipment also covers the situation where old equipment is maintained and new capacity is built up based on additional waste energy captured in the project scenario.

(c) If the production capacity of the WEG facility is expanded as a result of the project activity, the added production capacity shall be treated as a Greenfield facility;[3]

(d) WECM that is released under abnormal operation (for example, emergencies, shut down) of the WEG facility shall not be included in the emission reduction calculations.

8. For project activities which supply useful energy from recovery and use of waste energy to existing recipient facilities, the methodology is applicable to those project activities that generate electricity and/or mechanical energy to supply up to and beyond the maximum capacity of the pre-project equipment of existing recipient facilities. The methodology, however, is not applicable to project activities that supply additional thermal energy beyond the maximum pre-project capacity of existing recipient facility(ies).[4]

9. The methodology is **not** applicable to cases where a WECM stream is partially recovered in the absence of the CDM project activity to supply the heat of reaction, and the recovery of this WECM stream is increased under the project activity to replace fossil fuels used for the purpose of supplying heat of reaction.

10. This methodology is also **not** applicable to project activities where the waste gas/heat recovery project is implemented in a single-cycle power plant (e.g. gas turbine or diesel generator) to generate power.[5] However, projects recovering waste energy from single cycle and/or combined cycle power plants or any power only generation plant for the purpose of generation of heat only can apply this methodology.

11. No emission reduction credits can be claimed at and beyond the end of the lifetime of the waste energy generation equipment.

12. In case the equipment at recipient facility(ies) that will be displaced by the project activity reaches end of its lifetime during the crediting period, separate guidance is provided in the section on the identification of baseline scenario below.

13. The extent of use of waste energy from the WEG facilities in the absence of the CDM project activity will be determined in accordance with the procedures to this methodology provided in:

(a) Appendix 1 for Greenfield project facilities; and

(b) Appendix 2 for existing project facilities.

14. If multiple WECM are available in the WEG facility and can be used interchangeably for various applications as part of the energy sources in the WEG facility, the implementation of the CDM project activity shall not result in the reduction of the recovery of any WECM, which would be totally or partially recovered in the absence of

[3] See the section on identification of baseline scenario for guidance on added capacity and Greenfield facilities.

[4] Project proponents wishing to claim emission reductions from use of additional waste energy to supply excess heat energy may propose a revision to this methodology.

[5] Project proponents can consider the approved consolidated methodology “ACM0007: Conversion from single cycle to combined cycle power generation” for such project activities.

the project activity. This shall be demonstrated by use of the guidance provided in appendix 3 of this methodology.

15. In addition, the applicability conditions included in the tools referred to below apply.

2.3. Entry into force

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

3. Normative references

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

(a) “ACM0004: Consolidated baseline methodology for waste gas and/or heat and/or pressure for power generation” based on:

(i) “NM0031-rev: OSIL - 10 MW Waste Heat Recovery Based Captive Power Project, India”, whose baseline study, monitoring and verification plan and project design document were prepared by Experts and Consultants of OSIL;

(ii) “NM0087: Baseline methodology for electricity generation using waste heat recovery in sponge iron plants”, prepared by Agrienergy Ltd, Shri Bajrang Power and Ispat Ltd;

(iii) “NM0088: Baseline methodology for electricity production from waste energy recovery in an industrial manufacturing process”, prepared by EcoSecurities B.V. and Groupe Office Cherifien des Phosphates;

(b) “AM0024: Baseline methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants” based on:

(i) “NM0079-rev: Taishan Huafeng Cement Works Waste Heat Recovery and Utilisation for Power Generation Project, China”, whose baseline study, monitoring and verification plan and Project Design Document were prepared by Westlake Associates Ltd and Natsource Europe Ltd.;

(c) “AM0032: Baseline methodology for waste gas or waste heat based cogeneration system”, based on “NM0107-rev methodology: Baseline methodology for waste gas based cogeneration system for power and steam generation" prepared by Alexandria Carbon Black Co.;

(d) “NM0179: Waste Gas and/or Waste Heat Utilization for 'Process Steam' generation or 'Process Steam and Power'” prepared by Tata Steel.

18. The consolidated baseline and monitoring methodology also uses some elements of the following proposed new methodologies:

    (a) “NM0155-rev: Baseline and monitoring methodology for waste gas and/or heat utilisation” prepared by Reliance Industries Limited;

    (b) “NM0192-rev: Baseline and Monitoring Methodology for the recovery and utilization of waste gas in refinery facilities” submitted by EcoSecurities Netherlands B.V. and YPF S.A.

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

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

    (b) “Tool for the demonstration and assessment of additionality”;

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

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

    (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”.

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

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

21. “Existing actual or historical emissions, as applicable”;

    or

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

4. Definitions

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

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

    (a) **Existing facility** – a WEG facility that has been in operation for at least three years immediately prior to the start date of the project activity;

    (b) **Greenfield facility** – a WEG facility that is either a new construction or has less than three years of operational history immediately prior to the start date of the project activity. Additionally, if the production of an existing facility is increased or replaced then the increased or replaced capacity shall be treated as a Greenfield facility;

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

(d) **Element process** - the process of generation of useful energy through fuel combustion or use of waste energy carrying medium in an equipment, which is then used in the unit process/chemical reactor. Examples of element processes 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). For each element process, energy efficiency is defined as the ratio between the useful energy (e.g. the enthalpy of the steam multiplied with the steam quantity) and the supplied energy to the element process (the net calorific values of the fuel(s) multiplied with the respective fuel quantity);

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

(f) **Reference waste energy generation facility** - a reference waste energy generation facility, identified following the guidelines in appendix 1 of this methodology to determine the following for a Greenfield waste energy generation facility: (i) the use of waste energy in absence of CDM project activity; and (ii) the extent of the generation of waste energy in the absence of project activity. The identification of the reference waste energy generation facility should not consider facilities implemented as CDM project activities;

(g) **Reference energy generation facility** - most plausible facility generating the useful energy that would be used by a Greenfield recipient facility, in absence of energy available from the proposed CDM project. The reference energy generation facility should be identified through economic analysis (including benchmark (e.g. IRR/NPV) analysis, cost-benefit analysis, or analysis of levelised cost of energy), subject to assessment of availability of such source. The reference energy generation facility should also be demonstrated to be commonly used in the relevant industry sector of the host country;

(h) **Unit process** - a process that involves a single transformation of raw materials into products or intermediate materials, as a result of chemical reactions taking place. An example of a unit process is catalytic cracking. For the purpose of this methodology, there is no fuel fired in the unit process so as to separate it from element process;

(i) **Waste energy** - energy contained in a residual stream from industrial processes in the form of heat, chemical energy or pressure, for which it can be demonstrated that it would have been wasted in the absence of the project activity. Examples of waste energy include the energy contained in gases flared or released into the atmosphere, the heat or pressure from a residual stream not recovered (i.e. wasted);

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

(k) **Waste energy generation facility (“the WEG facility”)** - the facility where the waste energy, which is to be 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 a third party in a separate facility, the “WEG facility” will encompass both the waste energy generation facility and the waste energy recovery facility.

5. Baseline methodology

5.1. Project boundary

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

(a) The “WEG facility”;

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

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

27. The relevant equipment and energy distribution system cover:

(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.

28. Where multiple WECM are available in the WEG facility, and can be used interchangeably for various applications as a part of energy sources in the facility, the guidance provided in appendix 3 shall be followed to establish the project boundary. Overview of emission sources included in or excluded from the project boundary is provided in Table 2.

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

Source		Gas	Included	Justification/Explanation
Baseline	Electricity consumption, grid or captive source	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Fossil fuel consumption in element process for thermal energy	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative

Source		Gas	Included	Justification/Explanation
	Fossil fuel consumption in cogeneration plant	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Fossil fuel consumption for generation of steam used in the flaring process, if any	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
Project activity	Fossil fuel consumption for supply of process heat and/or reaction heat	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative
	Supplemental fossil fuel consumption at the project plant	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
	Supplemental electricity consumption	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
	Electricity import to replace captive electricity, which was generated using waste energy in absence of project activity[6]	CO_2	Included	Only if captive electricity in the baseline is replaced by import electricity
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification
	Energy consumption for gas cleaning	CO_2	Included	Only if waste gas cleaning is required and leads to emissions related to the energy requirement of the cleaning
		CH_4	Excluded	Excluded for simplification
		N_2O	Excluded	Excluded for simplification

5.2. Identification of the baseline scenario

29. The baseline scenario is identified as the most plausible scenario among all realistic and credible alternative(s) and shall be identified for, both, the fate of the waste energy at the WEG facility and the generation of energy consumed by the recipient facility(ies) in the absence of the project activity.

[6] Applicable in the scenario where the facility captures and utilizes a portion of waste gas produced at the site for captive power generation in the absence of the project activity.

30. Realistic and credible alternatives should be determined for:

    (a) Waste energy use in the absence of the project activity at the WEG facility;

    (b) Power generation in the absence of the project activity for each recipient facility if the project activity involves electricity generation for that recipient facility;

    (c) Heat generation (process heat and/or heat of reaction) in the absence of the project activity, for each recipient facility if the project activity involves generation of useful heat for that recipient facility; and

    (d) Mechanical energy generation in the absence of the project activity, for each recipient facility if the project activity involves generation of useful mechanical energy for that recipient facility.

    Note: in case of (b), (c) and (d) above the assessment shall include the identification of the fuel(s) used to provide energy to the recipient facility(ies) in the absence of the project activity.

31. The information on the utilization of heat, electricity and/or mechanical energy in the absence of the CDM project activity will be sourced from the recipient facility(ies) and the information on the utilization of the waste energy in the absence of the CDM project activity will be sourced from the WEG facility. Hence, the CDM project participant shall determine baseline options, identify the most appropriate baseline scenario and demonstrate and assess additionality in consultation with the recipient facility(ies) and the WEG facility. For this purpose, the WEG facility and the recipient facility(ies), whether the WEG facility includes the recipient facility(ies) or recipient facility(ies) are located outside the WEG facility, shall be ex ante identified when preparing the PDD.

5.2.1. Identification of alternatives to the project activity consistent with current laws and regulations

32. The project participant shall exclude baseline options that:

    (a) Do not comply with legal and regulatory requirements; or

    (b) Involve fuels (used for the generation of heat, power or mechanical energy) at the recipient facility(ies) that are not produced or imported in the host country.

33. The project participant shall provide evidence and supporting documents to exclude baseline options that meet the above-mentioned criteria.

34. The baseline candidates should be considered for the following facilities:

    (a) For the WEG facility(ies) where the waste energy is generated; and

    (b) For the recipient facility(ies) where the useful energy is consumed:

        (i) The baseline identification in these cases should cover both, the type of fuel(s) used and the associated energy generation technologies;

        (ii) In cases where the project activity chooses to supply excess electricity and/or mechanical energy beyond the maximum capacity of the pre-project equipment of existing recipient facilities, the baseline scenario of electricity

and/or mechanical energy could be a combination of the “P” and/or “M” scenarios described below.

35. The project activity can be implemented using waste energy generated in an existing or a Greenfield WEG facility, supplying useful energy to existing or Greenfield recipient facility(ies). For Greenfield WEG facilities, the identification of the baseline scenarios shall be analysed based upon the guidelines included in appendix 1. At an existing WEG facility, if the production capacity is increased after the implementation of the project activity, the scenarios for added capacity may be different from those identified for the existing capacity, which displaces power, heat and mechanical energy up to the maximum capacity of existing capacity of the pre-project equipment. The approach for baseline scenarios for waste energy from added production capacity shall be same as that followed for the Greenfield facility.

36. For the use of waste energy at the WEG facility the realistic and credible alternative(s) may include, inter alia:

(a) W1: WECM is directly vented to the atmosphere without incineration;

(b) W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released (or vented) to the atmosphere or waste pressure energy is not utilized;

(c) W3: Waste energy is sold as an energy source;

(d) W4 Waste energy is used for meeting energy demand at the recipient facility(ies);

(e) W5: A portion of waste energy is recovered for generation of heat and/or electricity and/or mechanical energy, while the rest of the waste energy available to the recipient facility is either flared/released to atmosphere or remains unutilised;[7]

(f) W6: All the waste energy produced at the WEG facility is captured and used for generating electricity for export or generating steam.

37. For power generation at each recipient facility the realistic and credible alternative(s) may include, inter alia:

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

(b) P2: On-site or off-site existing fossil fuel fired cogeneration plant;[8]

(c) P3: On-site or off-site Greenfield fossil fuel fired cogeneration plant;[9]

(d) P4: On-site or off-site existing renewable energy based cogeneration plant;[10]

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[7] Scenario W5 is applicable where partial recovery is undertaken in the baseline i.e. waste energy content is fully recovered by the pre-project conversion equipment of the recipient facility but with a lower efficiency than the project activity. As per the applicability condition the methodology is not applicable for projects for supply of heat of reaction, having partial recovery in the baseline.

[8] Scenarios P2 and H2 are related to the same existing fossil fuel cogeneration plant.

[9] Scenarios P3 and H3 are related to the same Greenfield fossil fuel cogeneration plant.

(e) P5: On-site or off-site Greenfield renewable energy based cogeneration plant;[11]

(f) P6: On-site or off-site existing fossil fuel based existing identified captive power plant;

(g) P7: On-site or off-site existing identified renewable energy or other waste energy based captive power plant;

(h) P8: On-site or off-site Greenfield fossil fuel based captive plant;

(i) P9: On-site or off-site Greenfield renewable energy or other waste energy based captive plant;

(j) P10: Sourced from grid-connected power plants;

(k) P11: Existing captive electricity generation using waste energy, but at a lower efficiency or lower recovery (if the project activity is captive generation using waste energy, this scenario represents captive generation with lower efficiency or lower recovery than the project activity);

(l) P12: Existing cogeneration using waste energy, but at a lower efficiency or lower recovery.

38. For project activities supplying useful energy to existing recipient facilities the baseline scenario for power generation may be a combination of alternatives as outlined above including in situations where the power supplied by the project activity to the recipient facility is above the maximum capacity of pre-project electricity generation equipment supplying electricity to the recipient. For example an applicable baseline alternative may be a combination of the following cases: (1a) operation of the existing pre-project equipment is less than or up to its maximum capacity at the recipient facility; and (1b) import of electricity from the grid or installation of an incremental capacity for the electricity consumption beyond the existing maximum pre-project equipment capacity at the recipient facility.

39. In case the baseline scenario for a recipient facility is a combination of different sources of electricity a procedure shall be established by the project proponent on apportioning the electricity supplied by the project activity to the recipient facilities between the identified baseline sources. The validating DOE shall confirm that the apportioning of electricity between different identified baseline sources is correctly applied and reported in the CDM-PDD.

40. Where P11 or P12 are the applicable baseline scenarios for power which meets partial power requirement in the baseline, the additional power in the baseline shall be in combination with other P scenarios for the power generated and supplied by the project activity.

41. For cases where at the recipient facility the use of existing pre-project power generation equipment (continuation of current practice) is the plausible baseline scenario for a recipient facility(ies), the emission reductions based on the pre-project scenario can only

[10] Scenarios P4 and H4 are related to the same existing renewable energy based cogeneration plant.

[11] Scenarios P5 and H5 are related to the same Greenfield renewable energy based cogeneration plant.

be claimed up to the end of the lifetime of the equipment that will be displaced by the project activity. The remaining lifetime of the equipment should be determined using the latest version of the "Tool to determine the remaining lifetime of equipment". To claim emission reductions beyond the end of the lifetime of the pre-project energy generation equipment, the project participants shall choose a default efficiency of 60 per cent with the cleanest fuel available at the recipient facility at publication of the CDM-PDD.

42. For heat generation, realistic and credible alternative(s) may include, inter alia:

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

(b) H2: On-site or off-site existing fossil fuel based cogeneration plant;

(c) H3: On-site or off-site Greenfield fossil fuel based cogeneration plant;

(d) H4: On-site or off-site existing renewable energy based cogeneration plant;

(e) H5: On-site or off-site Greenfield renewable energy based cogeneration plant;

(f) H6: An existing fossil fuel based element process;

(g) H7: A new fossil fuel based element process;

(h) H8: An existing renewable energy or other waste energy based element process to supply heat;

(i) H9: A new renewable energy or other waste energy based element process to supply heat;

(j) H10: Any other source such as district heat;

(k) H11: Other heat generation technologies (e.g. heat pumps or solar energy);

(l) H12: Steam/process heat generation from waste energy, but with lower efficiency or lower recovery;

(m) H13: Cogeneration with waste energy, but at a lower efficiency or lower recovery;

(n) H14: On-site fossil fuel consumption to supply heat.

43. Where H12 or H13 are the applicable baseline scenarios for heat which meets partial heat requirement in the baseline, the additional heat generation in the baseline shall be in combination with other H scenarios for the heat generated and supplied by the project activity.

44. For cases where the existing pre-project thermal energy generation equipment (continuation of current practice) is the plausible baseline scenario for a recipient facility(ies), the emission reductions based on the pre-project scenario can only be claimed up to the end of the lifetime of the equipment that will be displaced by the project activity. The remaining lifetime of the equipment should be determined using the latest version of the "Tool to determine the remaining lifetime of equipment". For emission reductions beyond the end of the lifetime of the pre-project energy generation equipment, the project participants shall choose a default efficiency of 100 per cent with the cleanest fuel available at the recipient facility at publication of the CDM-PDD.

45. For mechanical energy, realistic and credible alternatives may include, inter alia:

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

(b) M2: Steam produced by existing fossil fuel based boilers driving mechanical turbines;

(c) M3: Steam produced by new fossil fuel based boilers driving mechanical turbines;

(d) M4: Steam produced by existing renewable energy or other waste energy based boilers driving mechanical turbines;

(e) M5: Steam produced by new renewable energy or other waste energy based boilers driving mechanical turbines;

(f) M6: Waste gas pressure based mechanical energy generation;

(g) M7: Existing electrical motors are used as motive power to generate mechanical energy;

(h) M8: New electrical motors are used as motive power to generate mechanical energy.

46. For project activities supplying energy to existing recipient facility(ies) the baseline scenario for mechanical energy generation may be a combination of alternatives as outlined above including in situations where the mechanical energy supplied by the project activity to the recipient facility(ies) is above the maximum capacity of pre-project mechanical energy generation equipment. For example the applicable baseline scenarios may be a combination of the following cases: (2a) operation of the existing pre-project electric motor is less than up to its maximum capacity at the recipient facility; and (2b) installation of an incremental capacity for mechanical energy consumption beyond the existing maximum pre-project capacity of the electric motor at the recipient facility.

47. In case the baseline scenario for a recipient facility is a combination of different sources of mechanical energy a procedure shall be established by the project proponent on how to apportion the mechanical energy supplied by the project activity to the recipient facilities between the identified baseline sources. The validating DOE shall confirm that the apportioning of electricity between different identified baseline sources is correctly applied and reported in the CDM-PDD.

48. For cases where the existing pre-project mechanical energy generation equipment (continuation of current practice) is the plausible baseline scenario for a recipient facility(ies), the emission reductions based on the pre-project scenario can be claimed up to the end of the lifetime of the equipment that will be displaced by the project activity at the recipient facility(ies). The remaining lifetime of the equipment should be determined using the latest version of the "Tool to determine the remaining lifetime of equipment". For emission reductions beyond the end of the lifetime of the pre-project energy generation equipment, the project participants shall choose a default efficiency of 100 per cent with the cleanest fuel available at the recipient facility at publication of the CDM-PDD.

5.2.2. Elimination of non-feasible baseline options: Step 2 and/or Step 3 of the latest approved version of the “Tool for the demonstration and assessment of additionality” shall be used to identify the most plausible baseline scenarios by eliminating non-feasible options (e.g. alternatives where barriers are prohibitive or which are clearly economically unattractive).

49. The project participants shall use investment analysis for the identification of the baseline scenario for the following situations.

(a) Where, for an existing WEG facility, the WECM utilised by the project activity was totally or partially recovered in the absence of the CDM project activity;

(b) Where the project activity is implemented in a Greenfield WEG facility. In this case the baseline scenario is based on a “reference waste energy generation facility”. To establish the reference WEG facility and thereby the associated reference baseline technology for the project activity, the investment in the entire Greenfield facility shall be compared against investments in real alternative facilities.[12] The baseline scenario shall be demonstrated by applying investment comparison analysis to each of the design options that are realistic alternatives to the proposed Greenfield project;

(c) Where the project activity supplying the useful energy to a Greenfield recipient, the likely baseline scenario is based on a “reference energy generation facility”. The energy generation technology for such a reference facility as well as the fuels[13] used should be determined based on the investment analysis;

(d) Where power and/or mechanical energy supplied by the project activity is over and above the maximum capacity of the existing pre-project energy generation equipment of the recipient facility.

50. In applying investment analysis for the use of WECM for energy generation, the project proponents shall provide a detailed breakdown of project related costs and avoid an internal price for the waste stream.

5.2.3. Conclusion. If more than one credible and plausible alternative scenario remain, the alternative with the lowest baseline emissions shall be considered as the baseline scenario

51. This methodology is only applicable if the baseline scenario for all the waste energy generator(s) and the recipient facility(ies) identified, is one of the scenarios described in Table 3 below.

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[12] Where the alternative design is same as the project activity but with or without different waste heat recovery components, then the investment comparison of various waste heat recovery components can be performed to identify the baseline scenario. This investment comparison analysis should be performed based on financial parameters for various options at the time when the analysis is undertaken.

[13] The fuels to be considered should include all the fuels available in the host country, including those which can be imported in the host country without any supply constraint.

Table 3. Combinations of baseline scenarios applicable under different project situations to which this methodology is applicable

Baseline scenario	Combination of baseline scenarios			
	Waste energy	Power	Heat	Mechanical Energy
Baseline scenario-1 1. The total or part of WECM(s) recovered in the projects is released to atmosphere/flared/unutilised; 2. The electricity is obtained from a Greenfield or existing identified captive power only plant and/or from the grid; 3. Heat is obtained from a new or existing fossil fuel based element process; 4. Mechanical energy is obtained by existing or new electrical motors or steam turbines	W1, W2, W5	P6, P8, P10, P11	H6, H7, H12	M2, M3, M7, M8
Baseline scenario-2 1. The total or part of WECM(s) recovered in the projects is released to atmosphere/ flared/ unutilised; 2. The electricity and/or heat are generated by an existing/Greenfield cogeneration plant; 3. Mechanical energy is generated by existing/new electrical motors or steam turbine; 4. All the recipients of project energy are (or would have been) supplied with energy from a common fossil fuel based cogeneration source	W1, W2, W5	P2, P3, P12	H2, H3, H13	M2, M3, M7, M8

5.3. Additionality

52. The additionality of the project activity shall be demonstrated and assessed using the latest version of the “Tool for the demonstration and assessment of additionality” agreed by the Board, available at the UNFCCC CDM website.[14]

53. The project participants shall use investment analysis for demonstrating additionality for the following cases.

(a) Where, for an existing WEG facility, the WECM utilised by the project activity was totally or partially recovered in the absence of the CDM project activity;

(b) Where the project activity is implemented in a Greenfield facility. In this case the baseline scenario is based on a “reference waste energy generation facility”. To

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

establish the reference WEG facility and thereby the associated reference baseline technology for the project activity, the investment in the entire Greenfield WEG facility shall be compared against investments in real alternative facilities. The baseline scenario shall be demonstrated shall be demonstrated by applying investment comparison analysis to each of the design options that are realistic alternatives to the proposed Greenfield project;

(c) Where the project activity supplying the useful energy generated to a Greenfield recipient, the likely baseline scenario is based on a “reference energy generation facility”. The energy generation technology for such a reference facility as well as the fuels[15] used should be determined based on the investment analysis;

(d) Where power and/or mechanical energy supplied by the project activity is over and above the maximum capacity of the existing pre-project energy generation equipment of the recipient facility.

54. In applying investment analysis for the use of WECM for energy generation, the project proponents shall provide a detailed breakdown of project related costs, as mentioned above, and avoid an internal price for the waste stream.

55. The project participants shall consider the guidance provided in appendix 4 in determining the appropriate financial benchmark for the project activity.

5.4. Baseline emissions

(a) Flow chart for determination of baseline emissions (Figure 1);

(b) Matrix for determination of baseline emissions based on the type of useful energy generated in the project (Table 4).

[15] The fuels to be considered should include all the fuels available in the host country, including those which can be imported in the host country without any supply constraint.

Figure 1. Baseline emissions

Section 5.4.1: Baseline emissions from energy generated by the project activity

Sec. 5.4.1.1. No recovery of the WECM stream(s) in the absence of CDM project

Sec.5.4.1.1.1: Baseline emissions for baseline scenario 1 (refer table 3)

Sec.5.4.1.1.2: Baseline emissions for baseline scenario 2 (refer table 3)

5.4.1.1.1.1 Determine baseline emissions from electricity for:

Case 1: WECM is used to generate electricity, where:
Case 1a: electricity supply by the project activity is less or up to maximum capacity of existing pre-project equipment
Case 1b: electricity supply by project activity is beyond maximum capacity of existing pre-project equipment

Case 2: WECM used to provide mechanical energy that would have been supplied by electrical motor
Case 2a: mechanical energy supply by the project activity is less than or up to maximum capacity of existing pre-project power generation equipment
Case 2b: mechanical energy supply by project activity beyond maximum capacity of pre-project power generation equipment

5.4.1.1.1.2 Determine baseline emissions for generation of thermal energy and steam generated mechanical energy (mechanical equipment driven by steam turbine in baseline)

Thermal energy supplied to Unit process/element process/chemical reactor:
A. Determine heat supplied for process heat:
- waste energy supplied to steam boilers
- waste energy supplied to hot water/oil/air generator
B. Determine heat supplied to chemical reactor for supply of "heat of reaction"

Section 5.4.1.2: Partial recovery of the WECM stream(s) in the absence of CDM

Calculation of baseline emissions for the energy generated by the project activity as per **section 5.4.1.1** and make adjustments as per **section 5.4.1.2***

* *Section 5.4.1.2.1 for 'adjustment for an existing WEG facility'*
Section 5.4.1.2.2 for 'adjustment for a Greenfield WEG facility'

Section 5.4.2: Baseline emissions from use of fossil fuel for flaring of waste gas in absence of the project activity:

These emissions are added to baseline emission from energy generation to calculate total baseline emissions

Section 5.4.3: Determine:

(1) factor to calculate % of energy generated by waste energy (*fwcm*);

(2) factor for capping of baseline emissions (*fcap*)

The factors determined by this section are applied in all related equations for estimating baseline emissions depending on the relevant project baseline situation

Table 4. Matrix for determination of baseline emissions based on the type of useful energy generated in the project

Section	Sub-section				Equation
5.4.1				**Baseline emissions from energy generated by the project activity ($BE_{En,y}$)**	
5.4.1.1				**No recovery of the WECM streams in absence of the project activity**	
	5.4.1.1.1			Baseline emissions for **baseline scenario 1**	2
		5.4.1.1.1.1		Baseline emissions from electricity and mechanical energy generation ($BE_{Elec,y}$)	3
		Electricity (P)	Case 1	Baseline emissions corresponding to electricity supplied by the project activity to recipient facilities	
			Case 1a	Recipients whose project level electricity consumption is less than or up to maximum capacity of the existing pre-project equipment	4
			Case 1b	Recipients whose project level electricity consumption is beyond the maximum capacity of the existing pre-project equipment	
			Case 1b(i)	Recipient facility *j* is a new standalone captive power plant to supply the entire electricity received from the project activity	5
			Case 1b(ii)	Recipient facility *j* would have: (a) operation of existing pre-project equipment (up to its maximum capacity); and (b) additional electricity either from grid or installation of a new standalone power plant	6
		Mechanical (M)	Case 2	Baseline emissions corresponding to the mechanical energy supplied by the project activity to recipient facilities	
			Case 2a	Recipient whose project level mechanical energy consumption is less than or up to maximum capacity of the existing pre-project equipment	7
			Case 2b	Recipient whose project level mechanical energy consumption is beyond the maximum capacity of the existing pre-project equipment	
			Case 2b(i)	Recipient facility *j* is a new standalone electric motor to supply the entire mechanical energy received from the project activity	8
			Case 2b(ii)	Recipient facility *j* would have: (a) operation of existing pre-project equipment (up to its maximum capacity); and (b) additional electricity by installation of a new electric motor	9
		5.4.1.1.1.1.1		Determination of $\mathbf{EF_{elec,i,j,y}}$ and $\mathbf{EF_{incr,i,j,y}}$	10
		5.4.1.1.1.1.2		Determination of $\mathbf{EF_{NEW,EL,j,y}}$	11
		5.4.1.1.1.2		Baseline emissions for generation of thermal energy and steam generated mechanical energy ($BE_{Ther,y}$)	12
		Heat (H)		Net quantity of heat supplied to the unit process/element process/reactor *n*	13
		5.4.1.1.1.2.1		Determination of $\mathbf{HG_{n,process,j,y}}$	14

Section	Sub-section				Equation
				(a) For steam boiler	14-18
				(b) For hot water/oil/air generator	
		5.4.1.1.1.2.2		Determination of $\mathbf{HG}_{\mathbf{n,chemical,j,y}}$	19-21
	5.4.1.1.2	*cogeneration*		Baseline emissions for **baseline scenario 2**	22
5.4.1.2				**Partial recovery of the WECM stream(s) in the baseline scenario**	
	5.4.1.2.1	*P, M, H*		Adjustment for an existing WEG facility (*see together with appendix 2, section 5.4.1.1.1.1, section 5.4.1.1.1.2*)	23-26
	5.4.1.2.2	*P, M, H*	$f_{practice}$	Adjustment for a Greenfield WEG facility (*see together with appendix 1, section 5.4.1.1.1.1, section 5.4.1.1.1.2*)	27-30
5.4.2				**Baseline emissions from flaring of waste gas ($\mathbf{BE}_{\mathbf{flst,y}}$)**	31
5.4.2.1				**Flaring with fossil fuels**	32-33
5.4.2.2				**Flaring with steam**	34-35
5.4.3				**Estimation of various baseline factors**	
5.4.3.1			f_{WCM}	**Fraction of energy produced by the project activity**	
	5.4.3.1.1			Electricity and heat generation from WECM and fossil fuels	36-38
	5.4.3.1.2			Steam generation from WECM and fossil fuels	39
5.4.3.2			f_{cap}	**Capping Factors (*estimation of WECM available in the baseline*)**	
	5.4.3.2.1			Method-1: historical data on energy released by the WECM is available	
			Case 1	• WECM in the form of waste heat	40
			Case 2	• WECM in the form of waste pressure	41
			Case 3	• WECM in the form of enthalpy	42
	5.4.3.2.2			Method 2: historical data not available, use of manufacturer's production data	43-44
	5.4.3.2.3			Method 3: No data available, based on indirect information of specific parameter	
			Case 1	Energy is recovered from WECM and converted into final output energy	45
			Case 2	Energy is recovered from WECM in an intermediate energy recovery equipment	

56. The baseline emissions for the year *y* shall be determined as follows:

$$BE_y = BE_{En,y} + BE_{flst,y}$$ Equation (1)

Where:

BE_y	=	The total baseline emissions during the year *y* in t CO_2
$BE_{En,y}$	=	The baseline emissions from energy generated by the project activity during the year *y* in t CO_2
$BE_{flst,y}$	=	Baseline emissions from fossil fuel combustion, if any, either directly for flaring of waste gas or for steam generation that would have been used for flaring the waste gas in the absence of the project activity (t CO_2), calculated as per equation (31) This is relevant for those project activities where in the baseline steam is used to flare the waste gas

5.4.1. Baseline emissions from energy generated by the project activity (***$BE_{En,y}$***)

57. The calculation of baseline emissions (*$BE_{En,y}$*) depends on the applicable baseline scenarios described in Table 3. The baseline emissions shall be calculated separately for each recipient facility.

5.4.1.1. No recovery on the WECM stream(s) in the absence of CDM project activity

58. This section describes estimation of baseline of situations where the total pre-project WECM is released to atmosphere/flared/unutilized. Section 5.4.1.1.1 describes the estimation for this situation under baseline scenario 1, which corresponds to separate generation of heat and electricity in the baseline scenario. Section 5.4.1.1.2 describes the estimation for this situation under baseline scenario 2, which corresponds to cogeneration of heat and electricity in the baseline scenario.

5.4.1.1.1. Baseline emissions for baseline scenarios 1[16]

59. Baseline scenario 1 represent the situation where: (a) the **electricity** is obtained from an identified existing or new power plant or from the grid; (b) **mechanical energy** (supplied in project situation from use of waste energy based mechanical turbines) is obtained by existing or new electric motors or steam turbines; and (c) **heat** from an existing identified or new fossil fuel based element process or process (e.g. steam boiler, hot water generator, hot air generator, hot oil generator, fossil fuel direct combustion in a process).

Note: Sub-sections 5.4.1.1.1.1 and 5.4.1.1.1.2 below shall be used for estimating the baseline, depending on the type of energy generated by the project activity (electricity, heat or mechanical energy). If the project activity uses the waste pressure to generate electricity, then only section 5.4.1.1.1.1 below is used.

$$BE_{En,y} = BE_{Elec,y} + BE_{Ther,y}$$ Equation (2)

[16] Refer to Table 3.

Where:

$BE_{Elec,y}$	=	Baseline emissions from electricity, which is used for power generation as well as electric motors used to provide mechanical energy during the year *y* (t CO_2)
$BE_{Ther,y}$	=	Baseline emissions from thermal energy (due to heat generation by elemental processes), which is used for both useful heat as well as driving steam turbines to provide mechanical energy during the year *y* (t CO_2)

5.4.1.1.1.1. Baseline emissions from electricity ($BE_{Elec,y}$) and mechanical energy generation

60. Baseline emissions from electricity represent both the power generation and mechanical energy generation based on electric motors[17] at the recipient facility and replaced by the project activity.

$$BE_{Elec,y} = f_{cap} \times f_{wcm} \times (\sum_{j} BE_{EL,j,y} + \sum_{j} BE_{ME,j,y}) \quad \text{Equation (3)}$$

Where:

$BE_{Elec,y}$	=	Baseline emissions from electricity during the year *y* (tCO_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 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. The value is estimated using the equations in section 5.4.3.2. For Greenfield facilities, f_{cap} is 1. If the procedure in appendix 1 concludes that the waste energy would have been partially utilised in the “reference waste energy generating facilities” this fact will be captured in the factor $f_{practice}$ (refer to equations in section 5.4.1.2.2 for the use of factor $f_{practice}$)
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. Depending upon the situation, this factor is estimated using the equations in section 5.4.3.1 Note: For a project activity using waste pressure to generate electricity, the electricity generated from waste pressure should be measurable and therefore this fraction is always 1
$BE_{EL,j,y}$	=	Baseline emissions corresponding to the electricity supplied in year *y* by the project activity to the recipient facility *j* as per case (1a) and case (1b) described below during the year *y* (tCO_2)

[17] Mechanical energy generation based on electric motors, where electric motors at the recipient facility is replaced by mechanical turbines in project activity.

$BE_{ME,j,y}$	=	Baseline emissions corresponding to the supply of mechanical energy by the project activity to the recipient facility *j* as per case (2a) and case (2b) described below during the year *y* (t CO_2)

61. **Case 1**: The baseline emissions corresponding to electricity supplied by the project activity to recipient facilities shall be estimated for each recipient facility in accordance with the case it belongs to as follows:

    (a) **Case 1a**: recipients whose project level electricity consumption is less than or up to the maximum capacity of the existing pre-project equipment at the recipient facility (see equation (4) below); and

    (b) **Case 1b**: recipients whose project level electricity consumption is beyond the maximum capacity of the existing pre-project equipment at the recipient facility (see equation (5) and equation (6) below).

62. **Case 1a**:

$$BE_{EL,j,y} = \sum_{i} \left(EG_{i,j,y} \times EF_{Elec,i,j,y} \right) \qquad \text{Equation (4)}$$

Where:

$EG_{i,j,y}$	=	The power supplied by the project activity to the recipient facility *j*, which in the absence of the project activity would have been sourced from baseline source *i* (e.g. '*gr'* for the grid or '*is'* for an identified source) during the year *y* as per the identified baseline scenario for recipient facility *j* (MWh)
$EF_{Elec,i,j,y}$		The CO_2 emission factor for the baseline electricity source *i* (e.g. '*gr'* for the grid, and '*is'* for an identified source), corresponding to baseline scenario for the recipient facility *j*, during the year *y* (t CO_2/MWh)

63. **Case 1b**: There are two cases within 1b: case 1b(i) and case 1b(ii) as described below.

64. **Case 1b(i)**: where in the baseline scenario the recipient facility *j* is a new standalone captive power plant to supply the entire electricity received by the recipient facility *j* from the project activity:

$$BE_{EL,j,y} = EG_{i,j,y} \times EF_{NEW,EL,j} \qquad \text{Equation (5)}$$

Where:

$EG_{i,j,y}$	=	The power supplied by the project activity to recipient facility *j* during the year *y* (MWh)
$EF_{NEW,EL,j}$	=	The CO_2 emission factor for the new standalone power plant that would have been built in the baseline scenario by the recipient facility *j* (t CO_2/MWh)

65. **Case 1b(ii)**: where the electricity supplied to the recipient *j* is greater than the baseline source of electricity. Baseline scenario for recipient facility *j* is that the electricity in the baseline is sourced from: (a) operation of the existing pre-project equipment at the recipient facility (up to its maximum capacity); and (b) additional electricity is either imported from the grid or soured by installation of a new standalone power plant.

$$BE_{EL,j,y} = \sum_i \left(\left(EG_{Bl,MAX,i,j} \times EF_{i,j,y} \right) + \max\left(0, \left(EG_{i,j,y} - EG_{Bl,MAX,i,j}\right)\right) \times EF_{incr,i,j,y} \right) \quad \text{Equation (6)}$$

Where:

$EG_{i,j,y}$	=	The power supplied by the project activity to recipient facility *j* during the year *y* (MWh)
$EG_{Bl,MAX,i,j}$	=	Maximum annual amount of electricity that can be sourced from the pre-project source *i* (it could be the maximum generation capacity of on-site pre-project equipment at recipient facility *j* and/or grid, and corresponding to the applicable baseline scenario) (MWh)
$EF_{i,j,y}$	=	The CO_2 emission factor for the electricity source *i* up to the maximum capacity of the existing pre-project equipment during the year *y* (t CO_2/MWh)
$EF_{incr,i,j,y}$	=	The CO_2 emission factor for the electricity source (grid or new standalone power plant which is the applicable baseline scenario) for the incremental capacity beyond the maximum capacity of the existing pre-project equipment during the year *y* (t CO_2/MWh)

66. **Case 2**: Waste energy is used to provide mechanical energy that would have been supplied by an electrical motor.

67. Paragraphs below describe the estimation of baseline emissions from use of electricity for mechanical energy($BE_{ME,j,y}$). The baseline emissions from generation of mechanical energy that is supplied by the project activity to the recipient facility shall be estimated separately for the following two cases, which are differentiated by the amount of mechanical energy received by the recipient facility as follows:

(a) **Case 2a**: supply of mechanical energy is less than or up to the maximum capacity of the existing pre-project electric motor in the baseline (see equation (7) below); and

(b) **Case 2b**: supply of mechanical energy by the project activity beyond the maximum capacity of the existing pre-project electric motor at the recipient facility (see equation (8) and equation (9) below).

68. **Case 2a**:

$$BE_{ME,j,y} = \sum_i \left(\frac{MG_{i,j,y,mot}}{\eta_{mech,mot,i,j}} \times EF_{Elec,i,j,y} \right) \quad \text{Equation (7)}$$

Where:

$MG_{i,j,y,mot}$	=	Mechanical energy generated by a steam turbine in the project activity and supplied to recipient facility *j,* which in the absence of the project activity would be driven by baseline electric motor *i* (MWh). In this case '*i*' is identified source in the baseline, i.e. pre-project equipment at recipient facility.
$\eta_{mech,mot,i,j}$	=	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 baseline electricity source *i* (*gr*=grid, *is*=identified source, or *rs*=reference source), as specified in the relevant baseline scenario for the recipient facility *j*, during the year *y* in t CO_2/MWh

69. **Case 2b**:

70. The equations corresponding to the two different situations of paragraph 67 above.

71. **Case 2b(i)**: where the baseline scenario for the recipient facility *j* is a new standalone electric motor to supply the entire mechanical energy received by the recipient facility *j* by the project activity:

$$BE_{ME,j,y} = \frac{MG_{i,j,y,mot}}{\eta_{mech,mot,i,j}} \times EF_{NEW,EL,j,y} \quad \text{Equation (8)}$$

Where:

$EF_{NEW,EL,j,y}$	=	The CO_2 emission factor for the electricity that would have been supplied by the electric motor in the baseline scenario for the recipient facility *j* during the year *y* (t CO_2/MWh)

72. **Case 2b(ii)**: where the steam supplied for generating mechanical energy to the recipient *j* is greater than the baseline capacity of electric motors. Baseline scenario for recipient facility *j* is a combination of operation of the existing pre-project equipment at the recipient facility (up to its maximum capacity) and additional mechanical energy generation by installation of a new electric motor.

$$BE_{ME,j,y} = \sum_i \left(MG_{Bl,MAX,i,j} \times EF_{i,j,y} \right) + \max\left(0, (MG_{i,j,y,mot} - \sum_j MG_{Bl,MAX,i,j})\right) \times EF_{incr,i,j,y} \quad \text{Equation (9)}$$

Where:

$MG_{i,j,y,mot}$	=	The mechanical energy supplied by the project activity to recipient facility *j* during the year *y* (MWh)
$MG_{Bl,MAX,i,j}$	=	Maximum annual amount of mechanical energy that can be generated by the pre-project equipment of the recipient facility *j* (MWh)

$EF_{i,j,y}$	=	The CO_2 emission factor for the electricity source *i* beyond the maximum capacity of the existing pre-project equipment, which is an applicable baseline scenario during the year *y* (t CO_2/MWh)
$EF_{incr,i,j,y}$	=	The CO_2 emission factor for the electricity source for the incremental capacity beyond the maximum capacity of the existing pre-project equipment (grid or new power alone as defined in the relevant baseline scenario for recipient plant) during the year *y* (t CO_2/MWh)

5.4.1.1.1.1.1. Determination of $EF_{elec,i,j,y}$ and $EF_{incr,i,j,y}$

73. The paragraphs below define the estimation of baseline electricity factor estimation for equations related to baseline emissions estimation defined in section 5.4.1.1.1.1 above. The emission factor of the baseline source *i* of electricity that would have supplied electricity to recipient facility *j* in year *y* ($EF_{elec,i,j,y}$) should be estimated in one of the following ways:

    (a) For an existing source of energy for the recipient facility, the emission factor $EF_{elec,i,j,y}$ should be calculated based on the fuel and efficiency of the identified baseline scenario as explained below; and

    (b) If the recipient facility is a Greenfield facility, the emission factor $EF_{elec,i,j,y}$ should be calculated based on the design data or manufacturer's information of reference energy generation facility that would have been implemented in absence of the project activity. Similarly for calculation of $EF_{incr,I,j,y}$, if applicable baseline scenario for the incremental capacity beyond the maximum capacity of pre-project equipment is installation of new standalone power plant, the design data or manufacturer's information of this new plant (referred as reference energy generation facility) should be used;

    (c) If the electricity displaced by the project activity in the recipient facility is supplied by a connected grid system, the CO_2 emission factor of the electricity shall be determined following the guidance provided in the "Tool to calculate the emission factor for an electricity system".

74. The emission factor for the baseline identified/reference electricity source (existing or Greenfield), shall be determined as follows:

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

Where:

i	=	Source *i* of electricity where *"is"* is the identified source and *"rs"* is a reference source for a Greenfield facility
$EF_{CO2,i,j}$	=	The CO_2 emission factor per unit of energy of the fossil fuel(s) used in the baseline generation source *i* in (t CO_2/TJ), obtained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors.

$\eta_{Plant,i,j}$	=	The overall efficiency of the existing/Greenfield captive power plant *i* that would be used by j^{th} recipient in the absence of the project activity

75. There are following approaches for determination of efficiency $\eta_{Plant,i,j}$:

(a) If the baseline source of electricity is an existing captive power plant, the efficiency of the power plant ($\eta_{plant,i,j}$) shall be determined in accordance with the latest approved version of "Tool to determine the baseline efficiency of thermal or electric energy generation systems". If the load-efficiency curve options are selected, the efficiency that corresponds to the average loading of the captive power plant in year *y* should be used;

(b) If the recipient facility is a Greenfield facility and its baseline source of electricity is a captive power plant, refer to the definition of "reference energy generation facility" for the identification of the reference captive power plant. The efficiency of the reference power plant ($\eta_{plant,i,j}$) shall be determined as:

(i) Highest of the efficiency values provided by two or more manufacturers for the technology of the reference power plant; or

(ii) Assume a captive power generation efficiency of 60 per cent based on the net calorific values as a conservative approach.

5.4.1.1.1.1.2. Determination of $EF_{NEW,EL,j,y}$

76. $EF_{NEW,EL,j,y}$ is the emission factor of source *i* of electricity for case 1b(i) where the applicable baseline scenario is a new standalone power plant that substitutes the existing pre-project equipment up to its maximum capacity and the incremental capacity beyond the existing maximum pre-project capacity.

77. $EF_{NEW,EL,j,y}$ should be calculated based on the design data or manufacturer's information of reference energy generation facility that would have been implemented in absence of the project activity.

78. The emission factor for the baseline energy source shall be determined as follows:

$$EF_{NEW,EL,j} = \frac{EF_{CO2,New,j}}{\eta_{Plant,New,j}} \times 3.6 \times 10^{-3} \qquad \text{Equation (11)}$$

Where:

$EF_{CO2,NEW,j}$	=	The CO_2 emission factor per unit of energy of the fossil fuel(s) used in the new reference baseline generation source (t CO_2/TJ), obtained from reliable local or national data if available, otherwise, taken from the country specific IPCC default emission factors
$\eta_{Plant,NEW,j}$	=	The overall efficiency of the new captive power plant that would be used by j^{th} recipient in the absence of the project activity

79. In the determination of efficiency $\eta_{Plant,New,j}$ refer to the definition of "reference energy generation facility" for the identification of the reference captive power plant. The efficiency of the reference power plant ($\eta_{plant,New,j}$) shall be determined as:

(a) Highest of the efficiency values provided by two or more manufacturers for the technology of the reference power plant; or

(b) Assume a captive power generation efficiency of 60 per cent based on the net calorific values as a conservative approach.

5.4.1.1.1.2. Baseline emissions for generation of thermal energy ($BE_{Ther,y}$) and steam-generated mechanical energy

$$BE_{Ther,y} = f_{cap} \times \sum_j \left\{ \left(\sum_n f_{wcm,n,y} \times HG_{n,j,y} + f_{wcm} \times \sum_k MG_{k,j,y,tur} / \eta_{mech,tur,k} \right) \times EF_{heat,j,y} \right\} \quad \text{Equation (12)}$$

Where:

$BE_{Ther,y}$	=	Baseline emissions from thermal energy (as steam) during the year *y* in t CO_2
$f_{wcm,n,y}$	=	Fraction of total heat generated in the unit process/element process/reactor *n* by the project activity using waste energy. This fraction is 1 if the heat generation in process *n* is purely from use of waste energy. If process *n* uses other fossil fuels along with waste energy, or the element process providing heat uses both waste and fossil fuels, this factor is estimated using equation (37)
$HG_{n,j,y}$	=	Net quantity of heat supplied to the unit process/element process/chemical reactor *n* in recipient facility *j* by the project activity during the year *y* (TJ). This can be estimated following the equation series of (13)
$MG_{k,j,y,tur}$	=	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 steam turbine *k,* operating from steam generated in a fossil fuel boiler (TJ).
$\eta_{mech,tur,k}$	=	The efficiency of the baseline equipment (steam turbine *k*) that would drive the mechanical equipment in the absence of the project activity
$EF_{heat,j,y}$	=	The CO_2 emission factor of the element process that would have supplied the heat to recipient facility *j* in absence of the project activity (t CO_2/TJ). This is calculated as per equation (21)

$$HG_{n,j,y} = HG_{n,process,j,y} + HG_{n,chemical,j,y}$$ Equation (13)

Where:

$HG_{n,process,j,y}$	=	Net quantity of heat supplied to the recipient facility *j* for element process/heating unit/chemical reactor *n* by the project activity for process heating during the year *y.* In the case of steam this is expressed as difference of energy content between the steam supplied to the recipient facility and the feed water to the boiler (TJ)
$HG_{n,chemical,j,y}$	=	Net quantity of heat supplied to the recipient facility *j* for chemical reactor *n* by the project activity for supply of heat of reaction during the year *y* (TJ)

5.4.1.1.1.2.1. Determination of $HG_{n,process,j,y}$

$$HG_{n,process,j,y} = \sum_{p} H_{p,n,j,y} - \sum_{r} H_{r,n,j,y}$$ Equation (14)

Where:

$H_{p,n,j,y}$	=	Net enthalpy of the product *p* in the product mix at the outlet of the unit process/reactor or the output (hot air, steam, hot water, hot oil etc.) of the element process n in recipient facility *j* during the year *y* (TJ)
$H_{r,n,j,y}$	=	Net enthalpy of the reactant *r* in the reactant mix at the inlet of the process/reactor/element process or the return flow to the element process n in recipient facility *j* during the year *y* (TJ)

80. If the waste heat is used in steam boilers or hot water/oil/air generator following guidance should be adopted to use equation (14) to calculate $HG_{n,process,j,y}$.

(a) **For steam boiler** (an element process) - this is expressed as the difference of energy content of steam supplied to the recipient facility ($H_{p,n,j,y}$) and energy content of feed water to the boiler ($H_{r,n,j,y}$). 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.);

(b) **For hot water/oil/air generator** (an element process) - this is expressed as the difference in enthalpy between the hot water/oil/air supplied to unit processes/reactor where the hot water/oil/air is used in the recipient facility(ies) ($H_{p,n,j,y}$) and return of the recipient facility(ies) ($H_{r,n,j,y}$).

81. If the waste heat is used in a unit process/reactor as the useful energy as process heat, in this case the difference in the enthalpy of products and reactants, with reference to 0 deg C, is used to estimate the net quantity of heat.

82. This can be determined as follows (these equations are used if output of element process is hot water/oil/air etc.):

$$H_{p,n,j,y} = \frac{1}{10^6} \times m_{p,n,j,y} \times \int_0^{to} Cp_p \times dT$$ Equation (15)

$$H_{r,n,j,y} = \frac{1}{10^6} \times m_{r,n,j,y} \times \int_0^{ti} Cp_r \times dT$$ Equation (16)

83. For steam, produced from WECM in an element process:

$$H_{p,n,j,y} = m_{p,n,j,y} \times TE_p$$ Equation (17)

$$H_{r,n,j,y} = m_{r,n,j,y} \times TE_r$$ Equation (18)

Where:

$m_{p,n,j,y}$	=	Quantity of product *p* in the product mix at the outlet of the unit process/element process/reactor *n* in recipient facility *j* during the year *y* (kg)
Cp_p	=	Specific heat of product *p* in the product mix at the outlet of the unit process/element process/reactor n (J/g/^{o}C)
t_i	=	Temperature of reactant mix at the inlet of the unit process/reactor *n* or return fluid to the element process (^{o}C)
t_o	=	Temperature of product mix at the outlet of the unit process/reactor *n* or fluid output of the element process (^{o}C)
$m_{r,n,j,y}$	=	Quantity of reactant *r* in the reactant mix at the inlet of the unit process/element process/reactor *n* in recipient facility *j* during the year *y* (kg)
Cp_r	=	Specific heat of reactant *r* in the reactant mix at the inlet of the unit process/element process/reactor n (J/g/^{o}C)
TE_p	=	Specific enthalpy of steam from steam table (TJ/kg), if steam is a product of a process (steam boiler)
TE_r	=	Specific enthalpy of steam from steam table (TJ/kg) if steam is reactant in the process (e.g. chemical reaction where steam is one of the reactants)

5.4.1.1.1.2.2. Determination of $HG_{n,chemical,j,y}$

$$HG_{n,chemical,j,y} = \sum_t HG_{n,j,chem,t}$$ Equation (19)

Where:

$HG_{n,j,chem,t}$	=	Net quantity of heat (enthalpy) supplied to the chemical reactor *n* in recipient facility *j* by the project activity for supply of heat of reaction in time interval *t* (TJ). Time interval *t* determines how the data is aggregated and can be in hour, shift, day, week, month or year depending upon the monitoring practice followed by project participants

$$HG_{n,j,chem,t} = \sum_{p} M_{p,n,j,t} \times HF_p - \sum_{r} M_{r,n,j,t} \times HF_r \qquad \text{Equation (20)}$$

Where:

$M_{p,n,j,t}$	=	Flow of product *p* in the product mix at the outlet of the unit process/reactor *n* in recipient facility *j* in time interval *t* (kMol)
HF_p	=	Standard heat of formation of product *p* in the product mix (TJ/kMol) at product outlet temperature t_o
$M_{r,n,j,t}$	=	Flow of reactant *r* in the reactant mix at the inlet of the process/reactor *n* in recipient facility *j* in time interval *t* (kMol)
HF_r	=	Standard heat of formation of reactant *r* in the reactant mix(TJ/kMol) at reactant inlet temperature t_i

5.4.1.1.1.2.3 Determination of $EF_{heat,j,y}$

$$EF_{heat,j,y} = \sum_{i} ws_{i,j} \frac{EF_{CO2,i,j}}{\eta_{EP,i,j}} \qquad \text{Equation (21)}$$

Where:

$EF_{heat,j,y}$	=	The CO_2 emission factor of the element process supplying heat that has or would have supplied the recipient facility *j* in absence of the project activity, expressed in t CO_2/TJ
$ws_{i,j}$	=	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
$EF_{CO2,i,j}$	=	The CO_2 emission factor per unit of energy of the baseline fuel used in i^{th} element process used by recipient *j,* in tCO_2/TJ, in absence of the project activity
$\eta_{EP,i,j}$	=	Efficiency of the i^{th} element process that has or would have supplied heat to j^{th} recipient in the absence of the project activity. In case where the WECM is directly used to provide heat to the unit process/reactor, the efficiency refers to the element process that would have supplied heat to the unit process/reactor in the absence of the project activity which is displaced by the WECM

84. Estimation of efficiency parameter for equation 21:

85. If the heat to recipient facility *j* would have been provided using direct combustion in the unit process itself, the efficiency of existing (or "reference") element process ($\eta_{EP,i,j}$) is assumed to be 100 per cent.

86. In all other cases, the efficiency of the existing 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". If the load-efficiency curve options are selected, the efficiency that corresponds to the average loading of the captive power plant in year *y* should be used;

(b) Assume a constant efficiency of the element process and determine the efficiency, as a conservative approach, for optimal operation conditions that is. 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.

87. If the recipient facility is a Greenfield facility and its baseline source of heat is an element process, refer to the definition of "reference energy generation facility" for the identification of the reference element process. The efficiency of "reference element process" ($\eta_{EP,i,j}$) shall be determined as follows:

(a) Highest of the efficiency values provided by two or more manufacturers for "reference" element process; or

(b) Assume an efficiency of 100 per cent based on the net calorific value as a conservative approach.

5.4.1.1.2. Baseline emissions for baseline scenario 2[18]

88. Baseline scenario 2 represents the situation where: (i) the electricity and/or heat would be generated by an existing/new fossil fuel based cogeneration plant; (ii) the mechanical energy would be generated by existing/new electrical motors or steam turbine; (iii) all the recipient facilities of project energy would have been supplied energy from a common fossil fuel based cogeneration source in absence of the project activity.

89. Baseline emissions from co-generated electricity and heat of a cogeneration plant are calculated by multiplication of following:

(a) Electricity ($EG_{j,y}$), heat (steam) ($HG_{j,y}$) and if applicable, mechanical energy ($MG_{j,y,mot}$ or $MG_{j,y,tur}$) 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:

[18] Refer to Table 3.

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

Equation (22)

Where:

$BE_{En,y}$	=	The baseline emissions from energy that is displaced by the project activity during the year *y* in t 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 in year *y*. The ratio is 1 if the waste energy generated in project year *y* is same or less than that generated at a historical level. The value is estimated using equations in section 5.4.3.2. For Greenfield facilities f_{cap} is 1. If the procedure in appendix 1 concludes that the waste energy would have been partially utilised in the “reference waste energy generating facilities” this fact in the factor $f_{practice}$ (refer to the equations in section 5.4.1.2.2 for the use of factor $f_{practice}$)
f_{wcm}	=	Fraction of total energy generated by the project activity using waste energy. This fraction is 1 if the energy generation is purely from use of waste energy in the project generation unit. Depending upon the situation, this factor is estimated using one of the equations in section 5.4.3.1
$HG_{j,y}$	=	Net quantity of heat supplied to the recipient facility *j* by the project activity during the year *y* in TJ. In the case of steam, this is expressed as the difference of energy content between the steam supplied to the recipient facility(ies) and the condensate returned by the recipient facility(ies) to the element process of the cogeneration plant. In the case of hot water/oil this is expressed as the difference in energy content between the hot water/oil supplied to and returned by the recipient facility(ies) to the element process of the cogeneration plant
$MG_{j,y,tur}$	=	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). Refer to the guidelines in the monitoring table to estimate this parameter

$\eta_{mech,tur}$	=	The efficiency of the baseline equipment (steam turbine) that would provide mechanical power in the absence of the project activity
$EG_{j,y}$	=	The quantity of electricity supplied to the recipient facility *j* by the project activity during the year *y* in MWh
$MG_{j,y,mot}$	=	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). Refer to the guidelines in the monitoring table to estimate this parameter
$\eta_{mech,mot}$	=	The efficiency of the baseline equipment (electric motor) that would provide mechanical power in the absence of the project activity
η_{Cogen}	=	Efficiency of cogeneration plant (combined heat and power generation efficiency) using fossil fuel that is or would have been used in the absence of the project activity
3.6×10^{-3}	=	Conversion factor, expressed as TJ/MWh
$EF_{CO2,COGEN}$	=	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

90. Efficiency of the existing 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 operation conditions that is 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) Maximum efficiency of 90 per cent, based on net calorific values (irrespective of type of cogeneration system and type of heat generated);

(c) Estimated from load v/s efficiency curve(s) established through measurement of the cogeneration plant(s). There are some guidelines provided in the “parameters not monitored” section. Follow international standards for estimation of efficiency of cogeneration plants;

(d) The load-efficiency function for the cogeneration plant can be used from manufacturer’s specifications.

91. If the recipient facility is a Greenfield facility and its baseline source of energy is a cogeneration plant, refer to the definition of “reference energy generation facility” for the identification of the reference cogeneration plant. The efficiency of a reference cogeneration plant *(η_{Cogen})* shall be determined as follows:

(a) Highest of the efficiency values provided by two or more manufacturers for “reference” cogeneration plant; or

(b) Assume an efficiency of 90 per cent based on the net calorific value as a conservative approach.

5.4.1.2. Partial recovery of the WECM stream(s) in the baseline scenario

92. These project activities improve the recovery of the energy of WECM steam(s) by retrofitting or replacing existing equipment or installing new equipment for additional energy recovery with an objective of (i) utilizing more quantity of the energy content of the WECM streams than that (or would have been) utilized in the absence of the project activity; or (ii) improving the efficiency of the energy recovery equipment; or (iii) both.

93. If multiple streams are recovered under one CDM project, and at least one stream would be partially recovered in the absence of the project, the partial recovery adjustment described below should be considered for all the streams together.

94. All the equations (from 4 to 22) of baseline scenarios 1 and 2 apply to the baseline emission calculation of these project activities provided the following adjustments are made.

5.4.1.2.1. Adjustment for an existing WEG facility

95. Calculation of $EG_{i,j,y}$ or $EG_{j,y}$ that is referred to in equations (4) and (22): $EG_{i,j,y}$ or $EG_{j,y}$ should be the additional electricity generated by the project activity, over and above historical generation that would have taken place in absence of project activity. It should be estimated based on the historical data of electricity generation from WECM stream in the absence of the project activity.

$$EG_{i,j,y} = F_{j,y} \times (EG_{PJ,y} - \frac{1}{3} \times \sum_{x=-1}^{x=-3} (EG_{BL,x})) \qquad \text{Equation (23)}$$

96. Note: This equation can be also used to determine $EG_{j,y}$.

Where:

$EG_{i,j,y}$	=	The quantity of electricity supplied to the recipient *j* by a generator, that in the absence of the project activity would have been sourced from i^{th} source (*i* can be either grid or identified source) during the year *y* in MWh
$EG_{PJ,y}$	=	The total quantity of electricity generated from the identified WECM stream(s) during the year *y* in MWh
$EG_{BL,x}$	=	The quantity of electricity generated in absence of project activity from the identified WECM stream(s) during the year *x* in MWh
$F_{j,y}$	=	Fraction of total electricity generated by the project activity that is supplied to recipient *j* in year *y* (%)
$x = -1\ to - 3$	=	Historical three years previous to implementation of project activity

97. Calculation of $MG_{i,j,y,mot}$ referred to in equation (7) and $MG_{j,y,mot}$ in equation (22)[19] and calculation of $MG_{k,j,y,tur}$ referred to in equation (12) and $MG_{j,y,tur}$ in equation (22): $MG_{i,j,y,mot}$ and $MG_{k,j,y,tur}$ should be the additional mechanical generated by the project activity, over and above historical generation that would have taken place in absence of project activity. It should be estimated based on the historical data of mechanical energy generation from WECM stream in the absence of the project activity.

$$MG_{i,j,y,mot} = \frac{MG_{PJ,j,y} - 1/3 \times \sum_{x=-1}^{x=-3}(MG_{BL,j,x})}{3.6 \times 10^{-6}}$$ Equation (24)

$$MG_{k,j,y,tur} = MG_{PJ,j,y} - 1/3 \times \sum_{x=-1}^{x=-3}(MG_{BL,j,x})$$ Equation (25)

98. Note: These equations can also be used to determine $MG_{j,y,mot}$ and $MG_{j,y,tur}$.

Where:

$MG_{i,j,y,mot}$	=	Mechanical energy generated by a steam turbine in the project activity and supplied to the mechanical equipment (e.g. pump, compressor) of recipient *j* in year *y,* which in the absence of the project activity would be driven by electric motor *i* (MWh)
$MG_{k,j,y,tur}$	=	Mechanical energy generated by the steam turbine in project activity and supplied to the mechanical equipment (e.g. pump, compressor) of recipient *j* in year *y,* which in the absence of the project activity would be driven by steam turbine *k*, operating from steam generated in a fossil fuel boiler (TJ)
$MG_{PJ,j,y}$	=	The total quantity of mechanical energy supplied in year *y* by the steam turbine operated by steam generated using waste energy of identified WECM stream(s) (TJ)
$MG_{BL,j,x}$	=	The total quantity of mechanical energy supplied in year *x* by the steam turbine operated by steam generated using waste energy of the identified WECM stream(s) (TJ)
3.6×10^{-6}	=	Conversion factor, expressed as TJ/MWh
$= -1\ to - 3$	=	Historical three years previous to implementation of project activity

99. Calculation of $HG_{n,j,y}$ referred to in equation (13) and $HG_{j,y}$ referred to in equation (22): $HG_{n,j,y}$ or $HG_{j,y}$ should be the additional heat generated by the project activity, over and above historical heat generation that would have taken place in absence of project activity. The following equation and guidance should be used to calculate the additional heat generation in year *y* compared to historical years.

[19] For these project activities, the scope of mechanical energy is limited to steam operated back pressure turbines as the equations and monitoring section cover the monitoring of steam energy only in the baseline. However, if the project participants wish to use this methodology for any other area of generation of mechanical energy, they can submit the revision to this methodology.

$$HG_{n,j,y} = HG_{PJ,n,j,y} - 1/3 \times \sum_{x=-1}^{x=-3} \left(HG_{BL,n,j,x}\right)$$ Equation (26)

100. Note: The $HG_{j,y}$ represent the sum of heat generated by individual element process/unit process/reactor *n*.

Where:

$HG_{PJ,n,j,y}$	=	Net quantity of heat (enthalpy) supplied to the element process/unit process/reactor *n* (only for process heating and not for heat of reaction) in recipient facility *j* during the year *y* from the identified WECM stream(s). In the case of steam this is expressed as difference of energy content between the steam supplied to the recipient facility and the feed water to the boiler (TJ)
$HG_{BL,n,j,x}$	=	Net quantity of heat (enthalpy) supplied to the to the element process/unit process/reactor *n* (only for process heating and not for heat of reaction) in recipient facility *j* in year *x* from the identified WECM stream(s). In the case of steam this is expressed as difference of energy content between the steam supplied to the recipient facility and the feed water to the boiler (TJ)
$x = -1\ to - 3$	=	Historical three years previous to implementation of project activity

5.4.1.2.2. Adjustment for a Greenfield WEG facility

101. If the energy recovery project is implemented in a Greenfield waste energy generating facility, and the “reference waste energy generating facility” identified (refer to definition of “reference waste energy generating facility” and appendix 1) shows that the WECM stream(s) would have been partially recovered or recovered with lower efficiency, the following equations should be used.

102. Calculation of $EG_{i,j,y}$ or $EG_{j,y}$ that is referred to in equations (4) and (22): $EG_{i,j,y}$ or $EG_{j,y}$ should be the additional electricity generated by the project activity, over and above the generation that would have taken place in the reference waste generation facility is as follows:

$$EG_{i,j,y} = F_{j,y} \times EG_{PJ,y} \times (1 - f_{practice})$$ Equation (27)

103. Note: the equation can also be used to determine $EG_{j,y}$.

Where:

$F_{j,y}$	=	Fraction of total electricity generated by the project activity that is supplied to recipient *j* in year *y* (%)
$EG_{PJ,y}$	=	The total quantity of electricity generated from the identified WECM stream(s) during the year *y* (MWh)

$f_{practice}$	=	The factor determined by the practice of “reference waste energy generating facility”, to be calculated using the guidelines given in appendix 1. It represents the extent to which the “reference waste energy generating facility” would have recovered the electricity from identified WECM stream(s) in the baseline

104. Calculation of $MG_{i,j,y,mot}$ referred to in equations (7) and (22)[20] and calculation of $MG_{k,j,y,tur}$ referred to in equations (12) and (22): $MG_{i,j,y,mot}$ and $MG_{k,j,y,tur}$ should be the additional mechanical generated by the project activity, over and above the generation that would have taken place in reference waste generation facility.

$$MG_{k,j,y,tur} = MG_{PJ,j,y} - MG_{PJ,j,y} \times f_{practice} \quad \text{Equation (28)}$$

$$MG_{i,j,y,mot} = MG_{PJ,j,y} - MG_{PJ,j,y} \times f_{practice} \quad \text{Equation (29)}$$

105. Note: These equations can also be used to determine $MG_{j,y,mot}$ and $MG_{j,y,tur}$.

Where:

$MG_{k,j,y,tur}$	=	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 steam turbine *k,* operating from steam generated in a fossil fuel boiler (TJ)
$MG_{PJ,j,y}$	=	The total quantity of mechanical energy supplied by the steam turbine operated by steam generated using waste energy of identified WECM stream(s) (TJ in year *y)*
$MG_{i,j,y,mot}$	=	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)

106. Calculation of $HG_{n,j,y}$ referred to in equation (13) and $HG_{j,y}$ referred to in equation (22): $HG_{n,j,y}$ or $HG_{j,y}$ should be the additional heat generated by the project activity, over and above the generation that would have taken place in reference waste generation facility.

$$HG_{n,j,y} = (HG_{n,process,j,y} + HG_{n,chemical,j,y}) \times (1 - f_{practice}) \quad \text{Equation (30)}$$

107. Note: The $HG_{j,y}$ represent the sum of heat generated by individual element process/unit process/reactor *n*.

[20] For these project activities, the scope of mechanical energy is limited to steam operated back pressure turbines as the equations and monitoring section cover the monitoring of steam energy only in the baseline. However, if the project participants wish to use this methodology for any other area of generation of mechanical energy, they can submit the revision to this methodology.

Where:

$HG_{n,process,j,y}$	=	Net quantity of heat (enthalpy) supplied to the recipient facility *j* for element process/heating unit/chemical reactor *n* by the project activity for process heating during the year *y.* In the case of steam this is expressed as difference of energy content between the steam supplied to the recipient facility and the feed water to the boiler (TJ)
$HG_{n,chemical,j,y}$	=	Net quantity of heat (enthalpy) supplied to the recipient facility *j* for chemical reactor *n* by the project activity for supply of heat of reaction during the year *y* (TJ)

5.4.2. Baseline emissions from flaring of waste gas ($BE_{flst,y}$)

108. This portion of baseline emissions occurs only when the waste energy carrying medium (WECM) is waste gas and the waste gas would be flared with fossil fuel or steam in the baseline scenario. If there is no plant specific historic data available to estimate the various parameters then the emissions from this source shall be conservatively excluded from the baseline emissions.

$$BE_{flst,y} = \sum_{j} Q_{ff,st,y} \times EF_{CO2,j} \quad \text{Equation (31)}$$

Where:

$Q_{ff,st,y}$	=	Amount of fossil fuel that would have been needed in the facility either directly or to generate steam that would have been used to flare waste gas, generated in year *y,* in absence of the project activity (TJ)
$EF_{CO2,j}$	=	CO_2 emission factor of fossil fuel that would have been used at facility *j* (t CO_2/TJ)

5.4.2.1. Flaring with fossil fuels

109. For the project activities improving energy recovery as compared to the baseline; if the fossil fuel is used in the absence of project activity to flare the waste gas then the value of $Q_{ff,st,y}$ shall be calculated as:

$$Q_{ff,st,y} = \left(Q_{WG,y} - Q_{WG,BL}\right) \times FF_{WG} \quad \text{Equation (32)}$$

Where:

$Q_{WG,y}$	=	Quantity of waste gas used for energy generation during year *y* (kg or m^3 at NTP)
$Q_{WG,BL}$	=	Quantity of waste gas captured and used for energy generation in the absence of the project activity (kg or m^3 at NTP), use the maximum figure from three years historic data
FF_{WG}	=	Fossil fuel required per unit of waste gas flared, in terms of energy content (TJ/kg or m^3 at NTP)

$$FF_{WG} = \frac{Q_{ff,fl,B}}{Q_{WG,Fl,B}}$$ Equation (33)

Where:

$Q_{ff,fl,B}$	=	Fossil fuel used to flare the waste gas prior to the implementation of the project activity (TJ). Three years historic data shall be used
$Q_{WG,Fl,B}$	=	The amount of waste gas flared using fossil fuel prior to the implementation of the project activity (kg or m^3 at NTP). Three years historic data shall be used

5.4.2.2. Flaring with steam

110. If steam is used instead of fossil fuel for flaring of the waste gas, the fossil fuel consumption can be estimated as follows:

$$Q_{ff,st,y} = \frac{\left(Q_{WG,y} - Q_{WG,BL}\right) \times SF_{WG}}{\eta_{Boiler,fl}}$$ Equation (34)

Where:

SF_{WG}	=	Steam required per unit of waste gas flared, in terms of energy content, (TJ/kg or m^3 at NTP)
$\eta_{Boiler,fl}$	=	Efficiency of the boiler that would have been used to generate the steam in absence of the project activity. The guidelines for determining the efficiency for baseline element process ($\eta_{EP,i,j}$) in earlier sections, shall be used to determine this efficiency

$$SF_{WG} = \frac{Q_{st,fl,B}}{Q_{WG,Fl,B}}$$ Equation (35)

Where:

$Q_{st,fl,B}$	=	Steam used to flare the waste gas prior to the implementation of the project activity (TJ). Three years historic data shall be used
$Q_{WG,Fl,B}$	=	The amount of waste gas flared using steam prior to the implementation of the project activity (kg or m^3 at NTP). Three years historic data shall be used

5.4.3. Estimation of various baseline factors

5.4.3.1. Fraction of energy produced by the project activity

111. This is not applicable to project activities that use waste pressure to generate electricity; as for such project activities the electricity generated using waste pressure should be measurable.

5.4.3.1.1. Electricity and heat generation from WECM and fossil fuels

112. The procedure specified below should be applied when the direct measurement of the electricity/heat generated using the WECM is not possible, as other fossil fuel(s) along with WECM are used for energy generation. The relative share of the total generation from WECM is calculated by ratio of energy supplied by WECM to the total amount input energy fed by WECM and other fuels used, and the average efficiency of the plants where the energy is produced.

113. The fraction of energy produced by using the WECM in the project activity is calculated as follows:

$$f_{WCM} = \frac{\sum_{h=1}^{8760} Q_{WCM,h} \times \left(Cp_{wcm} \times \left(t_{wcm,h} - t_{ref}\right) + NCV_{WCM,y}\right)}{\sum_{h=1}^{8760} \sum_{i=1}^{I} Q_{i,h} \times \left(Cp_i \times \left(t_{i,h} - t_{ref}\right) + NCV_i\right)} \quad \text{Equation (36)}$$

114. If the WECM is used for heat generation in unit process *n*, $f_{WCM,n,y}$ can be calculated as follows.

$$f_{WCM,n,y} = \frac{\sum_{h=1}^{8760} Q_{WCM,n,h} \times \left(Cp_{wcm} \times \left(t_{wcm,n,h} - t_{ref}\right) + NCV_{WCM,y}\right)}{\sum_{h=1}^{8760} \sum_{i=1}^{I} Q_{i,n,h} \times \left(Cp_i \times \left(t_{i,n,h} - t_{ref}\right) + NCV_i\right)} \quad \text{Equation (37)}$$

Where:

f_{WCM}	=	Fraction of total electricity or mechanical energy generated by the project activity using waste energy
$Q_{WCM,h}$	=	Quantity of WECM recovered (kg) in hour *h*
Cp_{wcm}	=	Specific Heat of WECM (TJ/kg -deg C)
$t_{wcm,h}$	=	The temperature of WECM in hour *h* (deg C)
t_{ref}	=	Reference temperature (0 deg C or any other suitable reference temperature with proper justification)
$NCV_{WCM,y}$	=	Net Calorific Value of WECM in year *y* (TJ/kg)
$Q_{i,h}$	=	Amount of individual fuel (WECM and other fuel(s)) *i* consumed at the energy generation unit during hour h (kg)
Cp_i	=	Specific Heat of WECM *i* (TJ/kg -deg C or other suitable unit)
$t_{i,h}$	=	The temperature of individual fuel (WECM and other fuel(s)) *i* consumed at the energy generation unit during hour h (deg C)
NCV_i	=	Net calorific value annual average for each individual consumed fuel including WECM (TJ/ kg)
$f_{WCM,n,y}$	=	Fraction of total heat generated in the unit process/element process/reactor n by the project activity using waste energy
$Q_{WCM,n,h}$	=	Quantity of waste energy consumed in unit process *n* during hour h(kg)
$t_{wcm,n,h}$	=	Temperature of WECM in unit process *n* in hour *h* (deg C)

$Q_{i,n,h}$	=	Amount of individual fuel (WECM and other fuel(s)) *i* consumed in unit process *n* during hour *h* (kg)
$t_{i,n,h}$	=	The temperature of individual fuel (WECM and other fuel(s)) *i* consumed in the unit process n during hour h (deg C)

115. Note: If index *i* represents fossil fuels, the energy content corresponding to the sensible heat of fossil fuel *i* should be zero, as given follows.

$$Q_{i,h} \times Cp_i \times (t_{i,h} - t_{ref}) = 0$$ Equation (38)

5.4.3.1.2. Steam generation from WECM and fossil fuels

116. An alternative method that could be used when it is not possible to measure the net calorific value of the waste gas/heat and steam generated with different fuels in dedicated boilers are fed to turbine(s) through common steam header takes into account that the relative share of the total generation from WECM is calculated by considering the total steam produced and the amount of steam generated from each boiler. The fraction of energy produced by the waste gas/heat WECM in project activity is calculated as follows:

$$f_{WCM} = \frac{ST_{whr,y}}{ST_{whr,y} + ST_{other,y}}$$ Equation (39)

Where:

$ST_{whr,y}$	=	Energy content of the steam generated in waste heat recovery boiler fed to turbine via common steam header (TJ)
$ST_{other,y}$	=	Energy content of steam generated in other boilers fed to turbine via common steam header (TJ)

117. This alternative method requires that:

(a) All the boilers have to provide superheated steam;

(b) The calculation should be based on the energy supplied to the steam turbine. The enthalpy and the steam flow rate must be monitored for each boiler to determine the steam energy content. The calculation implicitly assumes that the properties of steam (temperature and pressure) generated from different sources are the same. The enthalpy of steam and feed water will be determined at measured temperature and pressure and the enthalpy difference will be multiplied with quantity measured by steam meter;

(c) Any vented steam should be deducted from the steam produced with waste gas/heat.

5.4.3.2. Capping factors

118. The methodology requires the baseline emissions to be capped irrespective of planned/unplanned or actual increase in output of plant, change in operational parameters and practices, change in fuel type and quantity resulting in an increase in generation of waste energy. The cap can be estimated using the three methods[21] described below, following this hierarchy: (i) Method-1 can be used to estimate the capping factor if required data is available; (ii) Method-2 is used if the project activities implemented in a Greenfield facility, or in existing facilities where the required data is unavailable; (iii) Method-3 is used if the project proponents demonstrate technical infeasibility in direct monitoring of waste heat/pressure of waste energy carrying medium (WECM).

5.4.3.2.1. Method-1

119. Where the historical data on energy released by the WECM is available, the baseline emissions are capped at the maximum quantity of waste energy released into the atmosphere under normal operation conditions in the three years previous to the project activity.

120. For that purpose f_{cap} is estimated as follows: The different equations are used depending upon the type of energy recovered from WECM in project activity.

121. **Case 1**: If the WECM is in the form of waste heat

$$f_{cap}=\frac{Q_{WCM,BL}\times\left(Cp_{WCM}\times\left(t_{wcm,BL}-t_{ref}\right)+NCV_{WCM,BL}+\left(P_{WCM,BL}-P_{ref}\right)\times(9.81/10^{9})/d_{wcm,BL}\right)}{Q_{WCM,y}\times\left(Cp_{WCM}\times\left(t_{wcm,y}-t_{ref}\right)+NCV_{WCM,y}+\left(P_{WCM,y}-P_{ref}\right)\times(9.81/10^{9})/d_{wcm,BL}\right)}\qquad \text{Equation (40)}$$

122. <u>Note</u>: even if primarily energy recovery is based on waste heat, there can be additional energy recovery due to increased pressure of WECM, which can be estimated using pressure differential.

123. **Case 2**: If the WECM is in the form of waste pressure

$$f_{cap}=\frac{Q_{WCM,BL}\times\left(P_{WCM,BL}-P_{ref}\right)/d_{wcm,BL}}{Q_{WCM,y}\times\left(P_{WCM,y}-P_{ref}\right)/d_{wcm,y}}\qquad \text{Equation (41)}$$

124. **Case 3**: if the WECM is in the form of enthalpy, which depends upon the pressure, and temperature of WECM (e.g. steam).

$$f_{cap}=\frac{Q_{WCM,BL}\times\left(H_{WCM,BL}-H_{ref}\right)}{Q_{WCM,y}\times\left(H_{WCM,y}-H_{ref}\right)}\qquad \text{Equation (42)}$$

[21] In case the methods for determination of capping factor described in this section do not apply to the situation of project of the project participants, they may consider submitting new approaches to determine this factor.

Where:

$Q_{WCM,BL}$	=	Average quantity of WECM released (or flared or wasted) in atmosphere in three years prior to the start of the project activity (kg)
$Q_{WCM,y}$	=	Quantity of WECM used for energy generation during year *y* (kg)
Cp_{WCM}	=	Specific Heat of waste energy carrying medium (WECM) (TJ/kg/deg C)
$t_{wcm,y}$	=	Average temperature of Waste Energy Carrying Medium (WECM) in year *y* (deg C)
$t_{wcm,BL}$	=	Average temperature of Waste Energy Carrying Medium (WECM) in three years prior to the start of the project activity (deg C)
t_{ref}	=	Reference temperature to be used to determine available energy in WECM (either 0 deg C or 25 deg C)
$NCV_{WCM,y}$	=	Average net calorific value of waste gas in year *y* (if WECM is waste gas), which has unburnt components such as carbon particles, CO or CH_4 that will provide energy in waste energy recovery equipment from its combustion (TJ/kg)
$NCV_{WCM,BL}$	=	Average net calorific value of waste gas (if WECM is waste gas), three years prior to implementation of project activity which has unburnt components such as carbon particles, CO or CH_4 that will provide energy in waste energy recovery equipment from its combustion (TJ/kg)
$P_{WCM,y}$	=	Average pressure of WECM in year *y* (kg/m^2 (a))
$P_{WCM,BL}$	=	Average pressure of WECM in three years prior to the start of the project activity (kg/m^2 (a))
P_{ref}	=	Reference pressure of WECM (ambient pressure in kg/m^2 or other appropriate pressure with proper justification)
$H_{WCM,y}$	=	Average specific enthalpy of WECM in year *y* (TJ/kg)
$H_{WCM,BL}$	=	Average specific enthalpy of WECM in three years prior to the start of the project activity (TJ/kg)
H_{ref}	=	Reference specific enthalpy to be used to determine available energy in WECM (0 TJ/kg or other appropriate enthalpy with proper justification)
$d_{wcm,y}$	=	Average density of WECM at actual temperature and pressure in year *y* (kg/m^3 at actual conditions)
$d_{wcm,BL}$	=	Average density of WECM at actual temperature and pressure in three years prior to the start of the project activity (kg/m^3 at actual conditions)
$9.81/10^9$	=	Factor to convert kg-m into TJ

5.4.3.2.2. Method-2

125. If three-year historical data is not available, the manufacturer's data for the facility shall be used to estimate the amount of waste energy the facility generates per unit of "product". The "product" is produced by the process that generates waste energy (departmental process or process of entire WEG facility, whichever is more justifiable and accurate). If any modification is carried out by the project proponent or if the manufacturer's data is not available for an assessment, this should be carried out by independent qualified/certified external process experts such as a chartered engineer on a conservative quantity of waste energy generated by the WEG facility per unit of product manufactured by the process generating waste energy. The value arrived at based on above sources of data, shall be used to estimate the baseline cap (f_{cap}). Under this method, the following equations should be used to estimate f_{cap}.

$$f_{cap} = \frac{Q_{WCM,BL}}{Q_{WCM,y}} \qquad \text{Equation (43)}$$

$$Q_{WCM,BL} = Q_{BL,product} \times q_{wcm,product} \qquad \text{Equation (44)}$$

Where:

$Q_{WCM,BL}$	=	Quantity of waste energy generated prior to the start of the project activity (kg or m^3 at NTP or TJ or MWh of WECM or other relevant unit)
$Q_{WCM,y}$	=	Quantity of WECM used for energy generation during year *y* (kg or m^3 at NTP or TJ or MWh of WECM or other relevant unit)
$Q_{BL,product}$	=	Production associated with the relevant waste energy generation as it occurs in the baseline scenario. The minimum of the following two figures should be used: (1) average annual historical production data from start-up of the facility, if the facility's operational history is less than three years, or (2) the most relevant manufacture's data for normal operating conditions. In the case of Greenfield facilities or where data is not available, the manufacture's data for normal operating conditions shall be used (Units for product can be in no. of pieces, tons, m^3 or other appropriate unit)
$q_{wcm,product}$	=	Amount of waste energy per unit of product generated by the process (that generates waste energy) in the facility (Units in kg or m^3 at NTP/unit product, MWh/unit product or TJ/unit product or other appropriate unit)

5.4.3.2.3. Method-3

126. In some cases, it may not be possible to measure the waste energy (heat, sensible heat, heat of reaction, heat of combustion, etc.) enthalpy or pressure content of WECM (Method-1 requirement), nor the specific amount of WECM per unit of product (Method-2 requirement). In such cases, the capping shall be based on indirect information about specific parameters allowing to estimate the amount of waste energy available. These parameters should be related to the characteristics of a product or a by-product of the facility from which waste energy can be recovered (e.g. volume and heat content of hot clinker produced by a kiln in a cement plant, if this heat can be recovered using air as the WECM). These cases may be of the following two types.

127. **Case 1**: the energy is recovered from WECM and converted into final output energy through a waste heat recovery equipment. For example, the useful energy (e.g., steam) is produced using waste energy generated by a chemical reaction. For such cases f_{cap} should be the ratio of maximum energy that could be recovered (MER) by the waste heat recovery equipment implemented under the CDM project activity and the actual energy recovered under the project activity (using direct measurement). The MER should be based on information on the characteristics of the key processes/product. For existing facilities this can be obtained from historical information and for Greenfield facilities, manufacturer's specifications on these key parameters can be used.

128. **Case 2**: the energy is recovered from WECM in an intermediate energy recovery equipment using an intermediate source. For example, an intermediate source to carry energy from primary WECM may include the sources such as water, oil or air to extract waste energy entrapped in chemicals (heat of reaction) or solids (sensible heat), which is further recovered in the waste heat recovery equipment to generate final output energy. For such cases f_{cap} should be the ratio of maximum energy that could be recovered (MER) by waste heat recovery equipment implemented under the CDM project activity (considering the losses due to exchange of energy) and actual intermediate energy recovered under the project activity (using direct measurement). The MER should be based on information on the characteristics of the key processes/product. For existing facilities this can be collected from historical information and for Greenfield facilities, manufacturers' specifications on these key parameters can be used.

129. The following equation should be used to determine f_{cap}:

$$f_{cap} = \frac{Q_{OE,BL}}{Q_{OE,y}} \qquad \text{Equation (45)}$$

Where:

$Q_{OE,BL}$	=	Output/intermediate energy that can be produced (TJ), to be determined on the basis of maximum energy that could be recovered (i.e. gross or net) from the WECM (MER), which would have been released (or WECM would have been flared or energy content of WECM would have been wasted) in the absence of CDM project activity
$Q_{OE,y}$	=	Quantity of actual output/intermediate energy generated (i.e. gross or net) during year *y* (TJ)

130. Note: The calculation in equation (46) should be performed with the same definition for both parameters $Q_{OE,BL}$ and $Q_{OE,y}$, i.e. utilizing gross energy in both cases.

5.5. Project emissions

131. Project emissions include emissions due to: (1) combustion of auxiliary fuel to supplement waste gas/heat; and (2) electricity emissions due to consumption of electricity for cleaning of gas before being used for generation of energy or other supplementary electricity consumption.

$$PE_y = PE_{AF,y} + PE_{EL,y} \quad \text{Equation (46)}$$

Where:

PE_y	=	Project emissions due to the project activity (t CO_2)
$PE_{AF,y}$	=	Project activity emissions from on-site consumption of fossil fuels by the unit process(es) and/or co-generation plant(s) if they are used as supplementary fuels due to non-availability of waste energy to the project activity or due to any other reason (t CO_2)
$PE_{EL,y}$	=	Project activity emissions from on-site consumption of electricity for gas cleaning equipment or other supplementary electricity consumption (tCO_2) (as per Table 2: Summary of gases and sources included in the project boundary)

132. Note: If the electricity was consumed in gas cleaning equipment in the baseline as well, project emissions due to electricity consumption for gas cleaning can be ignored.

5.5.1. Project emissions due to auxiliary fossil fuel combusted to supplement waste energy in the project activity

133. These project emissions should be calculated only in two situations: (1) when the auxiliary fossil fuel is used to supplement the waste energy directly in the waste heat recovery combustion systems, where the energy output cannot be apportioned between fossil fuels and the waste energy; and (2) when the calculation of f_{wcm} using equation (36), (37) and (39) is practically not possible due to technical constraints (e.g. gas measurement and its quality). In all other cases, if the calculation of F_{wcm} has accounted for the use of the auxiliary fossil fuels, then the calculation of the project emissions for the auxiliary fossil fuels is not required.

134. These emissions are calculated by using latest approved tool “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.

5.5.2. Project emissions due to electricity consumption of gas cleaning equipment or other supplementary electricity consumption

135. These project emissions are calculated by using latest approved tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.

5.6. Leakage

136. No leakage is applicable under this methodology.

5.7. Emission reductions

137. Emission reductions due to the project activity during the year *y* are calculated as follows:

$$ER_y = BE_y - PE_y \tag{47}$$

Where:

ER_y	=	Total emissions reductions during the year *y* in tons of CO_2
PE_y	=	Emissions from the project activity during the year *y* in tons of CO_2
BE_y	=	Baseline emissions for the project activity during the year *y* in tons of CO_2, applicable to Scenario 2

5.8. Data and parameters not monitored

Data / Parameter table 1.

Data / Parameter:	η_{BL} ($\eta_{EP,i,j}$, $\eta_{mech,mot,i,j}$, $\eta_{mech,tur,k}$, $\eta_{Plant,j}$, η_{Cogen})
Data unit:	-
Description:	Baseline efficiency of the element process/mechanical energy conversion equipment/captive power plant/cogeneration plant in recipient plant *j*
Source of data:	Manufacturers data or data from similar plant operators or project participants data

Measurement procedures (if any):	For efficiency of captive power plant or element process, refer to the options provided in the section of baseline emissions. 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. For efficiency of cogeneration plant, apart from options available in baseline section, the following procedure should be followed: Establish an efficiency-load-function for the cogeneration plant. Use recognized standards for the measurement of the element process efficiency for cogeneration efficiency measurement. Use the direct method (dividing the net energy generation by the energy content of the fuels fired during a representative time period) and not the indirect method (determination of fuel supply or energy generation and estimation of the losses). Best practices for operation of a cogeneration plant should be followed. The measurement should be supervised by a competent independent third party (e.g. the DOE). The measurement should be conducted immediately after scheduled preventive maintenance has been undertaken and under good operation conditions (optimal load, optimal oxygen content in the flue gases, adequate fuel viscosity, representative or favorable ambient conditions for the efficiency of the boiler, etc.). During the measurement campaign, the load is varied over the whole operation range and the efficiency is measured for different steady-state load levels. The efficiency should be measured for at least 10 different load levels covering the operation range. Apply a regression analysis to the measured efficiency for different load levels. Document the measurement procedures and results (i.e. efficiency at different load levels, application of the regression analysis) transparently in the CDM-PDD or, if undertaken during the crediting period, in the monitoring report
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	$Q_{WCM,BL}$
Data unit:	kg or m^3 at NTP
Description:	Average quantity of WECM released in atmosphere in three years prior to the start of the project activity
Source of data:	Direct measurements by the generator of WECM through an appropriate metering device (e.g. turbine flow meter) for three years prior to implementation of the project activity. In the case of Method-2 (to determine f_{cap}) source of data is manufacturer's specifications or an external expert to be used to determine $Q_{WCM,BL}$

Measurement procedures (if any):	For the facility, it is determined by either of the two methods: (a) Direct measurements of amount of the waste energy for at least three years prior to the start of the project activity; (b) As described in Method-2 of Section 5.4.3.2.2, estimated based on information provided by the technology supplier and the external expert on the waste energy generation per unit of product and volume or quantity of production
Any comment:	In the case of modification of the project facility the Method-2 can be used as stated above. In the case where a portion of the waste energy is captured and utilised to generate captive electricity in the absence of the project activity, $Q_{WCM,BL}$ represents the total amount of waste energy generated at the facility and not only the waste energy flared/vented in the absence of the project activity

Data / Parameter table 3.

Data / Parameter:	$\mathbf{t_{ref}}$, $\mathbf{P_{ref}}$, $\mathbf{H_{ref}}$
Data unit:	deg C, kg/cm^2 (a), TJ/kg respectively or other appropriate unit
Description:	Reference temperature, pressure and specific enthalpy
Source of data:	Use the following values or other appropriate pressure with proper justification: 0 for reference temperature; 1 atm for reference pressure; 0 TJ/kg for reference enthalpy
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$\mathbf{t_{wcm,BL}}$
Data unit:	deg C
Description:	Average temperature of WECM in three years prior to the start of the project activity
Source of data:	To be measured using appropriate temperature measuring instrument (e.g. pressure gauge, manometer etc.)
Measurement procedures (if any):	To be averaged based on daily measured values
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$\mathbf{P_{WCM,BL}}$
Data unit:	kg/m^2
Description:	Average pressure of WECM in three years prior to the start of the project activity

Source of data:	To be measured using appropriate pressure measuring instrument (e.g. pressure gauge, manometer etc.)
Measurement procedures (if any):	To be averaged based on daily measured values
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	$\mathbf{H_{WCM,BL}}$
Data unit:	TJ/kg
Description:	Average specific enthalpy of WECM in three years prior to the start of the project activity
Source of data:	From engineering data books (e.g. steam tables)
Measurement procedures (if any):	Measure daily temperature and pressure of WECM, average it annually. At yearly averaged value of pressure and temperature, find enthalpy of WECM
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	$\mathbf{d_{wcm,BL}}$
Data unit:	kg/m^3 at actual conditions
Description:	Density of WECM at actual temperature and pressure in three years prior to the start of the project activity (T/m^3 at actual conditions)
Source of data:	From standard data books
Measurement procedures (if any):	-
Any comment:	The density figure used for calculations should correspond to the average pressure and temperature of WECM

Data / Parameter table 8.

Data / Parameter:	$\mathbf{Q_{OE,BL}}$
Data unit:	TJ
Description:	Output/intermediate energy that can be produced, to be determined on the basis of maximum energy that could be recovered from the WECM (MER), which would have been released (or WECM would have been flared or energy content of WECM would have been wasted) in the absence of CDM project activity
Source of data:	The MER should be based on information on the characteristics of the key product/by product. For existing facilities this can be collected from historical information and for Greenfield facilities, the manufacturer's specifications on these key parameters can be used
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 9.

Data / Parameter:	$Q_{ff,,fl,B}$
Data unit:	TJ
Description:	Fossil fuel used to flare (directly) the waste gas prior to the implementation of the project activity. Three years historic data should be used
Source of data:	Measured by project participants
Measurement procedures (if any):	Calibrated flow meter
Any comment:	-

Data / Parameter table 10.

Data / Parameter:	$Q_{WG,Fl,B}$
Data unit:	kg or m^3 at NTP
Description:	The amount of waste gas flared using steam prior to the implementation of the project activity. Three years historic data should be used
Source of data:	Generators of gas
Measurement procedures (if any):	Measured directly through appropriate metering device (e.g. turbine flow meter)
Any comment:	-

Data / Parameter table 11.

Data / Parameter:	$Q_{BL,product}$
Data unit:	No. of pieces, tons, m^3 or other appropriate unit
Description:	Production associated with the relevant waste energy generation as it occurs in the baseline scenario. The minimum of the following two figures should be used: (1) historical production data from start-up, if project facility operational history is less than three years, of the project facility; or (2) the most relevant manufacture's data for normal operating conditions. In the case of Greenfield facilities or where data is not available, the manufacture's data for normal operating conditions should be used
Source of data:	Project proponents and/or manufacturer
Measurement procedures (if any):	Based on audited production records, balance sheets etc. Data for three years prior to project implementation
Any comment:	-

Data / Parameter table 12.

Data / Parameter:	$q_{wcm,product}$
Data unit:	kg or m^3 at NTP/unit product, MWh/unit product or TJ/unit product or other appropriate unit)
Description:	Specific waste energy production per unit of product (departmental or project facility product which most logically relates to waste energy generation) generated as per manufacturer's or external expert's data. This parameter should be analysed for each modification in process which can potentially impact the waste energy quantity
Source of data:	Project participant, manufacturer or external expert. Data for three years prior to project implementation
Measurement procedures (if any):	From manufacturer's specification. Assessment of external expert
Any comment:	-

Data / Parameter table 13.

Data / Parameter:	TE_p
Data unit:	TJ/kg
Description:	Specific enthalpy of steam from steam table, if steam is a product of a process (steam boiler)
Source of data:	From standard data books/steam tables
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 14.

Data / Parameter:	TE_r
Data unit:	TJ/kg
Description:	Specific enthalpy of steam from steam table, if steam is reactant in the process (e.g. chemical reaction where steam is one of the reactants)
Source of data:	From standard data books/steam tables
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 15.

Data / Parameter:	HF_p
Data unit:	TJ/kMol
Description:	Standard heat of formation of product *p* in the product mix at the outlet of the reactor

Source of data:	From standard data books
Measurement procedures (if any):	-
Any comment:	Heat of formation could be positive or negative, proper mathematical sign should be used while using these values in the equation

Data / Parameter table 16.

Data / Parameter:	$\mathbf{HF_r}$
Data unit:	TJ/kMol
Description:	Standard heat of formation of reactant *r* in the reactant mix at the inlet of the reactor
Source of data:	From standard data books
Measurement procedures (if any):	-
Any comment:	Heat of formation could be positive or negative, proper mathematical signs should be used while using these values in the equation

Data / Parameter table 17.

Data / Parameter:	$\mathbf{EG_{BL,x}}$
Data unit:	MWh
Description:	The quantity of electricity generated in absence of project activity from the identified WECM stream(s) during the year *x*
Source of data:	Measured by project participants
Measurement procedures (if any):	Measured through an appropriate metering device for three years prior to implementation of project activity
Any comment:	This parameter is necessary to find out the extent to which the WECM stream(s) are already recovered in absence of project activity

Data / Parameter table 18.

Data / Parameter:	$\mathbf{EG_{BLMAX,i,j}}$
Data unit:	MWh
Description:	Maximum annual amount of electricity that can be sourced from the pre-project equipment that corresponds to the applicable baseline scenario (refer to equation (6))
Source of data:	Manufacturers specifications
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 19.

Data / Parameter:	$MG_{BLMAX,i,j}$
Data unit:	MWh
Description:	Maximum annual amount of mechanical energy that can be sourced from the pre-project equipment that corresponds to the applicable baseline scenario (refer to equation (9))
Source of data:	Manufacturers specifications
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 20.

Data / Parameter:	$MG_{BL,j,x}$
Data unit:	TJ of steam
Description:	The total quantity of mechanical energy supplied by the steam turbine operated by steam generated using waste energy of the identified WECM stream(s) (in terms of TJ in the year *x*)
Source of data:	Measured by project participants
Measurement procedures (if any):	Follow the procedure as specified for $MG_{j,y,mot}$, $MG_{j,y,tur}$ to estimate mechanical energy delivered by the turbine in absence of project activity. The share of mechanical energy delivered by the turbine, pertaining to the steam generated using waste energy can be estimated by multiplying the mechanical energy by the ratio of steam supplied by the waste energy recovery boiler using waste energy of identified WECM stream(s) and the total steam supplying to the turbine
Any comment:	This parameter is necessary to find out the extent to which the WECM stream(s) are already recovered in absence of project activity

Data / Parameter table 21.

Data / Parameter:	$H_{wcm,BL}$
Data unit:	TJ/kg
Description:	Average specific enthalpy of WECM in three years prior to the start of the project activity
Source of data:	Project participant's data
Measurement procedures (if any):	This energy is to be determined based on the energy supplied to the process or chemical reaction (and not received by the process or chemical reaction). For example, it should be the heat supplied by a waste heat recovery boiler to the chemical process to meet the demand of heat of reaction (and not calculated). Appropriate measurement instruments should be adopted for the type of energy supplied to process or chemical reaction
Any comment:	This indirect method is needed because the energy (heat) received by process or chemical reaction will remain the same in the project and baseline scenario. Only the fossil fuel based heat supplied in the baseline will be displaced (either fully or partly) by the recovered heat from WECM stream(s)

Data / Parameter table 22.

Data / Parameter:	$Q_{st,,fl,B}$
Data unit:	TJ
Description:	Steam used to flare the waste gas prior to the implementation of the project activity. Three years historic should be used
Source of data:	Measured by project participants
Measurement procedures (if any):	Calibrated steam meter
Any comment:	-

Data / Parameter table 23.

Data / Parameter:	$Q_{WG, BL}$
Data unit:	kg or m^3 at NTP
Description:	Quantity of waste gas captured and used for energy generation in the absence of the project activity, use the maximum figure from three years historic data
Source of data:	Project participant information
Measurement procedures (if any):	Measured by project participants (generator of energy) through an appropriate metering device (calibrated flow meters) for three years prior to implementation of project activity
Any comment:	Applicable in the case where a portion of the waste energy is captured and utilised to generate captive electricity in the absence of the project activity

Data / Parameter table 24.

Data / Parameter:	$HG_{BL,n,j,x}$
Data unit:	TJ
Description:	Net quantity of heat (enthalpy) supplied to the to the element process/unit process/reactor *n* (only for process heating and not for heat of reaction) in recipient facility *j* in year *x* from the identified WECM stream(s). In the case of steam this is expressed as the difference of energy content between the steam supplied to the recipient facility and the feed water to the boiler (TJ)
Source of data:	Project participants information
Measurement procedures (if any):	Measured by project participants through an appropriate metering device (calibrated flow meters) for three years prior to implementation of project activity
Any comment:	-

Data / Parameter table 25.

Data / Parameter:	**$NCV_{WCM,BL}$**
Data unit:	TJ/kg
Description:	Average net calorific value of waste gas (if WECM is waste gas), three years prior to implementation of project activity which has unburnt components such as carbon particles, CO or CH_4 that will provide energy in waste energy recovery equipment on combustion of gas
Source of data:	Project participants information
Measurement procedures (if any):	Measured by project participants through an appropriate device
Any comment:	Average of measured data of three years prior to implementation of project activity, to be considered

6. Monitoring methodology

138. All data collected as part of monitoring plan 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 otherwise in the comments in the tables below. The following main data shall be monitored.

6.1. Project emissions

(a) Quantity of fossil fuels used as supplementary fuel;

(b) Net calorific value of fossil fuel;

(c) CO_2 emission factor of the fossil fuel;

(d) Quantity of electricity consumed by the project operations;

(e) CO_2 emissions factor of electricity consumed by the project operations;

(f) Abnormal operation of the plant.

139. While the quantities of fossil fuels fired are measured using calibrated flow meters, other data items are only factors obtained from reliable local or national data. If local data is not available, the project participant may use default factors published by IPCC.

6.2. Baseline emissions

140. Depending on the baseline scenario, the following data items need monitoring:

(a) The heat/power/mechanical energy supplied by the WEG facility to recipient facility(ies) by recovering waste energy from WECM stream(s);

(b) Energy generation using WECM, in absence of project activity;

(c) Quantity and energy content of WECM;

(d) CO_2 emission factor of electricity or heat that would have been consumed by the recipient facility(ies) in the absence of the project activity;

(e) Properties of heat (e.g. pressure and temperature of the inlet and outlet of the streams, concentrations of the reactant/product mix etc.) supplied to the recipient facility(s);

(f) Properties of heat return to the element process (e.g. pressure and temperature of the condensate return) supplied by the recipient facility(s) to the WEG facility;

(g) Efficiencies of element process, power plant, cogeneration plant or mechanical conversion equipment that would have been used in the absence of the project activity.

141. In addition, the relevant variables of applicable tools shall be included in the monitoring plan by the project participants.

6.3. Data and parameters monitored

Data / Parameter table 26.

Data / Parameter:	**$EG_{i,,j,y}$**
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* in MWh Quantity of electricity supplied to the recipient *j* by the project activity, which represents case 1b(i) or case 1b(ii) during the year *y* in MWh (refer to equations (5) and (6))
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 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)

Data / Parameter table 27.

Data / Parameter:	**$ws_{i,j}$**
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:	Estimated from data on heat consumption by recipient *j*
Measurement procedures (if any):	-
Monitoring frequency:	Yearly

QA/QC procedures:	-
Any comment:	-

Data / Parameter table 28.

Data / Parameter:	$Q_{WCM,y}/Q_{WG,y}$
Data unit:	Mass unit (kg)
Description:	Quantity of WECM/Waste gas used for energy generation during year *y*
Source of data:	Project participants
Measurement procedures (if any):	Direct measurements by project participants through an appropriate metering device (e.g. turbine flow meter)
Monitoring frequency:	Continuously
QA/QC procedures:	Measuring equipment should be calibrated on regular appropriate intervals. During the time of calibration and maintenance, alternative equipment should be used for monitoring
Any comment:	Generally, waste gas should be measured before it enters the point of use (e.g. Waste Heat Recovery Boiler (WHRB)), reactor, heat exchangers etc.) However, if it is difficult to measure the waste gas before point of use, it can be measured in exhaust stream (e.g. outlet of the unit process), only if following conditions are satisfied. (a) There is clear demonstration by the project proponent and verified by the DOE that a technical limitation exist that prevents the measurement of waste gas at the inlet to the WHRB; (b) The flow meter is calibrated according to the temperature and pressure of waste gas at the monitoring point; (c) The waste gas is not used in combination with another fossil fuel for the same process

Data / Parameter table 29.

Data / Parameter:	$EF_{CO2,is,j}$
Data unit:	Tonnes CO_2/TJ
Description:	CO_2 emission factor per unit of energy of the fossil fuel used in the baseline generation source *i* (*i*=is) providing energy to recipient *j*
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 30.

Data / Parameter:	**$EF_{CO2,rs,j}$**
Data unit:	Tonnes CO_2/TJ
Description:	CO_2 emission factor per unit of energy of the fossil fuel used in the reference baseline generation source *i* (*i*=*rs*) providing energy to recipient *j*
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:	Emission factor should correspond to the fuel that would have been used in the reference facility supplying electricity to the recipient, in absence of the project activity

Data / Parameter table 31.

Data / Parameter:	**$EF_{CO2,COGEN}$**
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 32.

Data / Parameter:	**$EG_{j,y}$**
Data unit:	MWh
Description:	Quantity of electricity supplied to the recipient facility *j* by the project activity during the year *y* in MWh
Source of data:	Recipient facility(ies) and project facility 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 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)

Data / Parameter table 33.

Data / Parameter:	$\mathbf{F_{j,y}}$
Data unit:	%
Description:	Fraction of total electricity generated by the project activity, that is supplied to recipient *j* in year *y*
Source of data:	Recipient facility(ies) and generation facility(ies) measurement records
Measurement procedures (if any):	-
Monitoring frequency:	Monthly, aggregated annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 34.

Data / Parameter:	$\mathbf{HG_{j,y}}$
Data unit:	TJ
Description:	Net quantity of heat supplied to the recipient facility *j* by the project activity during the year *y* in TJ. For element process like boilers, this 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.).
Source of data:	Recipient facility(ies) actual measurement records

Measurement procedures (if any):	For the element process, heat generation is determined as the difference of the enthalpy of the steam or hot water generated by the boiler(s) minus the enthalpy of the feed-water. The 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 boilers, it is expressed as the difference between the steam supplied and the feed water to the boiler, both in energy units

Data / Parameter table 35.

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* Quantity of mechanical energy supplied to the recipient *j* by the project activity, which represents case 2b(i) or case 2b(ii) during the year *y* in MWh (refer to equations (8) and (9))
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. The efficiency of electric motor ($\eta_{mech,mot,i,j}$) or efficiency of the steam turbine ($\eta_{mech,tur,k}$ or $\eta_{mech,mot}$), that would have provided mechanical energy in absence of project activity, needs to be used to estimate electricity consumed by electric motor in baseline
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 36.

Data / Parameter:	$\mathbf{EF_{CO2,i,j}}$
Data unit:	Tonnes CO_2/TJ
Description:	CO_2 emission factor per unit of energy of the baseline fuel used in i^{th} element process used by recipient *j,* in t CO_2/TJ, in absence of the project activity
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 37.

Data / Parameter:	$ws_{i,j}$
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:	-
Any comment:	-

Data / Parameter table 38.

Data / Parameter:	$EF_{CO2,j}$
Data unit:	Tonnes CO_2/TJ
Description:	CO_2 emission factor of fossil fuel (t CO_2/TJ) that would have been used at facility *j* for flaring the waste gas
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 39.

Data / Parameter:	$Q_{i,h}$ or $Q_{i,n,h}$
Data unit:	kg
Description:	Amount of individual fuel (and other fuel(s)) *i* consumed at the energy generation unit/or unit process *n* during hour *h*
Source of data:	Project participants
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 40.

Data / Parameter:	$Q_{wcm,h}$ **or** $Q_{wcm,n,h}$
Data unit:	kg
Description:	Amount of individual fuel (WECM and other fuel(s)) *i* consumed at the energy generation unit or unit process *n* during hour *h*
Source of data:	Generator of WECM
Measurement procedures (if any):	Direct measurements by project participants through an appropriate metering device (e.g. turbine flow meter)
Monitoring frequency:	Continuously
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 41.

Data / Parameter:	NCV_i **or** $NCV_{WCM,y}$
Data unit:	(TJ/kg)
Description:	Net calorific value annual average for each individual consumed fuel and/or WECM
Source of data:	For fuels, 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. For WECM, the NCV should be determined based on laboratory results. Laboratory can be either under control of project participants or external recognised laboratory
Measurement procedures (if any):	-
Monitoring frequency:	Yearly for fuel and monthly for WECM. If it can be established that the NCV of WECM does not change much, the frequency can be reduced to once in six months
QA/QC procedures:	Instruments used for collection of sample and measurement of NCV of WECM should have proper calibration done. Sampling and testing procedure should be defined if the NCV is determined by WECM generators
Any comment:	IPCC guidelines/Good practice guidance provide for default values where local data is not available

Data / Parameter table 42.

Data / Parameter:	Cp_{wcm} **or** CP_i
Data unit:	TJ/kg-deg C
Description:	Specific Heat of WECM or fuel
Source of data:	From standard engineering data books/textbooks. Example reference “Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Claus Borgnakke; 4º Edition, 1994, John Wiley & Sons, Inc.”

Measurement procedures (if any):	-
Monitoring frequency:	Once every six-month for the first year. If it can be established that the CP of WECM does not change, one constant figure can be used for the entire crediting period
QA/QC procedures:	-
Any comment:	There is no necessity to use the specific heat of fuel if the index *i* in equations in section 5.5.3.1 represents fuel as sensible heat of fuel is considered to be zero

Data / Parameter table 43.

Data / Parameter:	$\mathbf{Cp_p}$ **or** $\mathbf{Cp_r}$
Data unit:	TJ/kg-deg C
Description:	Specific heat of product *p* of product mix or reactant *r* of reactant mix to an unit process *n*
Source of data:	From standard engineering data books/textbooks. Example reference "Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Claus Borgnakke; 4º Edition, 1994, John Wiley & Sons, Inc."
Measurement procedures (if any):	In the case of gaseous mixtures the specific heat is a function of absolute temperature, normally expressed as $Cp = a + bT + cT^2 – d/T$. Hence the temperature of the gas to be measured and other coefficients are available in standard engineering data books
Monitoring frequency:	For those components where the Cp do not vary with temperature, one constant figure can be used for entire crediting period. Else temperatures should be measured online and daily average should be taken for calculation
QA/QC procedures:	Appropriate QA/QC to be used for temperature measurement
Any comment:	-

Data / Parameter table 44.

Data / Parameter:	$\mathbf{t_{wcm,h}}$ **or** $\mathbf{t_{i,h}}$
Data unit:	(deg C)
Description:	The temperature of WECM (or fuel) in hour *h*
Source of data:	To be measured using appropriate temperature recorder (temperature data logger)
Measurement procedures (if any):	Use appropriate instrument (e.g. digital temperature data logger)
Monitoring frequency:	Measured continuously, averaged hourly
QA/QC procedures:	-
Any comment:	There is no necessity to measure temperature of fuel if index *i* in equation (38) or (39) represents fuel as sensible heat of fuel is considered to be zero

Data / Parameter table 45.

Data / Parameter:	**t_o and t_i**
Data unit:	deg C
Description:	Temperature of the product mix at the outlet of the process/reactor *j* (^oC) and Temperature of the reactant mix at the inlet of the process/reactor *j* (^oC)
Source of data:	To be measured using appropriate temperature measuring instrument
Measurement procedures (if any):	Use appropriate instrument (e.g. digital temperature indicator)
Monitoring frequency:	Measured daily, averaged yearly
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 46.

Data / Parameter:	**$EG_{PJ,y}$**
Data unit:	MWh
Description:	The total quantity of electricity generated from the identified WECM stream(s) during the year *y*
Source of data:	Measured by project participants
Measurement procedures (if any):	Measured through an appropriate electricity metering device. The cumulative electricity supply is to be monitored for year *y*
Monitoring frequency:	Measured continuously, aggregated annually
QA/QC procedures:	Regular calibration of the electricity meter is required
Any comment:	-

Data / Parameter table 47.

Data / Parameter:	**$MG_{PJ,j,y}$**
Data unit:	TJ
Description:	The total quantity of mechanical energy supplied by steam turbine operated by steam generated using waste energy of identified WECM stream(s) (TJ in year *y*)
Source of data:	Measured by project participants
Measurement procedures (if any):	Follow the procedures for $MG_{i,j,y,mot}$ and $MG_{k,j,y,tur}$ to estimate Mechanical energy delivered by the turbine in absence of project activity
Monitoring frequency:	Measured continuously, aggregated annually
QA/QC procedures:	Regular calibration of steam meter is required
Any comment:	-

Data / Parameter table 48.

Data / Parameter:	**$HG_{PJ,n,j\ y}$**
Data unit:	TJ
Description:	Net quantity of heat (enthalpy) supplied to the element process/unit process/reactor *n* (only for process heating and not for heat of reaction) in recipient facility *j* during the year *y* from the identified WECM stream(s). In the case of steam this is expressed as difference of energy content between the steam supplied to the recipient facility and the feed water to the boiler
Source of data:	Measured by project participants
Measurement procedures (if any):	Measured by project participants through an appropriate metering device (calibrated flow meters) for three years prior to implementation of project activity
Monitoring frequency:	Measured continuously, aggregated annually
QA/QC procedures:	Regular calibration of steam meter is required
Any comment:	-

Data / Parameter table 49.

Data / Parameter:	**$H_{wcm,y}$**
Data unit:	TJ
Description:	Energy supplied, using WECM stream(s), as heat for process and/or as a heat of reaction to chemical reaction, in project year *y*
Source of data:	Measured by project participants
Measurement procedures (if any):	This energy is to be determined based on energy supplied to the process or chemical reaction (and not received by the processor chemical reaction). For example, it should be the heat supplied by a waste heat recovery boiler to the chemical process to meet the demand of heat of reaction (and not calculated)
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	Meter should be calibrated regularly
Any comment:	This indirect method is needed because the energy (heat) received by process or chemical reaction will remain same in the project and baseline scenario. Only the fossil fuel based heat supplied in baseline will be displaced (either fully or partly) by the recovered heat from WECM stream(s)

Data / Parameter table 50.

Data / Parameter:	**$t_{wcm,y}$**
Data unit:	deg C
Description:	Average temperature of Waste Energy Carrying Medium (WECM) in year *y*
Source of data:	To be measured using appropriate temperature measuring instrument
Measurement procedures (if any):	Use appropriate instrument (e.g. digital temperature indicator)

Monitoring frequency:	Measured daily, averaged yearly
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 51.

Data / Parameter:	$P_{WCM,y}$
Data unit:	kg/m^2 (a)
Description:	Average pressure of WECM in year *y*
Source of data:	-
Measurement procedures (if any):	Use appropriate instrument (e.g. pressure gauge, manometer etc.)
Monitoring frequency:	Measured daily, averaged yearly
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 52.

Data / Parameter:	$H_{WCM,y}$
Data unit:	TJ/kg
Description:	Average enthalpy of WECM in year *y*
Source of data:	Engineering data books (e.g. steam tables)
Measurement procedures (if any):	Measure temperature and pressure at which the enthalpy has to be determined
Monitoring frequency:	Temperature and pressure measured daily, averaged yearly. Determine enthalpy at average temperature and pressure of WECM (e.g. steam)
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 53.

Data / Parameter:	$d_{wcm,y}$
Data unit:	kg/m^3 at actual conditions
Description:	Average density of WECM at actual temperature and pressure in year *y*
Source of data:	From standard data books
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Value of density to be used for calculations should correspond to the average pressure and temperature of WECM

Data / Parameter table 54.

Data / Parameter:	$Q_{OE,y}$
Data unit:	TJ
Description:	Quantity of actual output/intermediate energy generated during year *y*
Source of data:	From standard data books
Measurement procedures (if any):	Directly measure the actual output/ intermediate energy produced by the project activity
Monitoring frequency:	Measured daily, aggregated annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 55.

Data / Parameter:	$m_{,p,n,j,y}$/$m_{,r,n,j,y}$
Data unit:	kg
Description:	Quantity of product *p* in the product mix at the outlet of the process (or reactor) '*n*' in recipient facility *j* during the year *y*/Quantity of reactant *r* in the reactant mix at the inlet of the process (or reactor) *n* during the year *y*
Source of data:	Actual measurements at the project site
Measurement procedures (if any):	For single component flow - actual mass flow meter or volumetric flow meter with density/temperature measurement. For a product/reactant mix - concentration of individual component in the mix to be measured and total flow to be measured. Accordingly massflow rate of individual component to be calculated
Monitoring frequency:	Measured daily, averaged annually
QA/QC procedures:	Usual procedures for concentration and flow measurement
Any comment:	-

Data / Parameter table 56.

Data / Parameter:	$M_{,p,n,j,t}$/$M_{,r,n,j,t}$
Data unit:	kmol
Description:	Flow of product *p* in the product mix at the outlet of the process (or reactor) *n* in recipient facility *j* in time interval *t*/flow rate of reactant *r* in the reactant mix at the inlet of the process (or reactor) *n* in time interval *t*
Source of data:	Actual measurements at the project site
Measurement procedures (if any):	For single component flow - actual mass flow meter or volumetric flow meter with density measurement. Mass to Mol can be converted by dividing with compound's molecular weight. For a product/reactant mix - concentration/partial pressure (in the case of gases) of individual component in the mix to be measured and total flow to be measured. Accordingly mass flow/molar flow rate of individual component to be calculated

Monitoring frequency:	Measured hourly for gaseous mix/daily for liquid or solid mix
QA/QC procedures:	Usual procedures for concentration and flow measurement
Any comment:	Time interval '*t*' determines how the data is aggregated and can be in hour, shift, day, week, month or year depending upon the monitoring practice followed by project participants

Data / Parameter table 57.

Data / Parameter:	$ST_{whr,y}$
Data unit:	TJ
Description:	Energy content of the steam generated in the waste heat recovery boiler fed to the turbine via a common steam header
Source of data:	Steam tables
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 58.

Data / Parameter:	$ST_{other,y}$
Data unit:	TJ
Description:	Energy content of the steam generated in other boilers and fed to the turbine via a common steam header
Source of data:	Steam tables
Measurement procedures (if any):	-
Monitoring frequency:	Continuously
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 59.

Data / Parameter:	$EF_{heat,j,y}$
Data unit:	tCO_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
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 60.

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

Appendix 1. Assessment of extent of use of WECM and determination of baseline practice factor for CDM project activity implemented in Greenfield facilities using a reference waste energy generating facility (or “reference facility” for the purpose of this annex) and manufacturer’s specifications

1. Option 1: Assessment of other existing facilities

1. The following steps shall be applied in identifying the facilities for analysis and estimating the baseline use of WECM:

   (a) The Greenfield (or new) facility generating the WECM used in the CDM project activity should be categorised based on following criteria applicable to the Greenfield WEG facility: (i) industry sector; (ii) product manufactured, its specifications and applications; (iii) production capacity; (iv) quality of raw material used; (v) process flow or technology type; (vi) configuration of the facility; (vii) facilities implemented in the previous 10 years;

   (b) Based on the literature from recognised sources, or from surveys in the relevant industry sector, facilities[1] which follow the criteria mentioned above should be listed. The selected facilities can vary by +/-10 per cent in terms of capacity of the facility as compared to the proposed facility under CDM;

   (c) These facilities should not cover those which are already registered (or under validation) under CDM for waste energy recovery projects from the same source that is recovered under the proposed project under CDM;

   (d) The difference between the Greenfield WEG facility and the selected facilities would be the use of WECM from the source that is recovered under proposed project activity;

   (e) A list of the facilities identified above should be considered for the use of WECM. Check if the relevant information is available. Remove from the list those facilities for which information is not available. This final list should comprise a minimum of seven facilities. The following can be the possible uses of waste energy by these facilities: (i) the waste energy is completely used, (ii) waste energy is partially used, (iii) waste energy not used but incinerated, flared or released to atmosphere;

   (f) Analyse the practice of more than 75 per cent facilities in the list. These facilities shall be randomly selected within the subset of facilities in this list. For example the following situations can apply:

[1] Use operational information or manufacturer's specification of these facilities.

(i) If more than 80 per cent of the analysed facilities in the list do not use waste energy, it can be decided that the proposed Greenfield facility also would have wasted the energy in the absence of waste energy recovery CDM project;

(ii) If more than 80 per cent of the analysed facilities in the list use the waste energy partially, the baseline emissions can be capped using the most conservative baseline practice factor ($f_{practice}$) of the facilities. For example if 60 per cent usage of waste energy is most conservative baseline practice in the list, then *fpractice* is 0.6;

(iii) If more than 20 per cent of the analysed facilities recover the waste energy fully, the methodology is not applicable as it cannot be demonstrated that waste energy would not have been recovered in the absence of CDM project.

(g) In case none of the above practices are followed by more than 50 per cent of facilities, the most conservative practice decides the baseline emissions practice factor ($f_{practice}$).

2. The outcome of the above assessment shall be considered in the determination of the baseline scenario.

2. Option 2: Assessment of alternative design of the WEG facility

3. This option is to be used if the project participants are not able to arrive at five facilities of similar type as the Greenfield WEG facility. The project proponent shall submit an alternative design including the usage of WECM that is recovered under project. The project participants have to demonstrate through investment analysis that the use (or no use) of WECM(s) of such alternative design would have been the baseline scenario for the waste energy generated in the Greenfield WEG facility. The alternative design provides the value of factor "$f_{practice}$" that is referred in Option 1 above.

Appendix 2. Assessment of extent of use of WECM in the existing facility

1. It shall be demonstrated that the waste energy utilized in the project activity was flared or released into the atmosphere or remained unutilised in the absence of the project activity at the existing facility by either one of the following methods:[2]

2. DOEs during their on-site visit as part of their validation activities, shall confirm that no equipment for waste energy recovery and utilisation was installed on the specific WECM stream(s) (that is recovered under the project activity) prior to the implementation of the project activity. In cases where the project activity improves the energy recovery from already existing WECM stream(s), the DOEs validation shall confirm that the unrecovered portion of the WECM stream(s) was not used prior to the implementation of the project activity:

    (a) By direct measurements of the amount of the waste energy produced for at least three years prior to the start of the project activity;

    (b) Providing an energy balance of the relevant sections of the facility to prove that the waste energy that is recovered in project activity, was not a source of energy before the implementation of the project activity. For the energy balance applicable process parameters are required. The energy balance must demonstrate that the waste energy was not used and also provide conservative estimations of the amount of waste energy released;

    (c) 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;

    (d) Process plant manufacturer's commissioning report from the facility could be used as an estimate of the quantity and energy content of the waste energy produced for the rated plant capacity/per unit of product produced;

    (e) For the project activity, improving energy efficiency of existing waste heat recovery equipment, the demonstration of low energy recovery of WECM steam(s) should be done by estimating the energy efficiency of the electricity and/or heat generation equipment(s) and demonstrating the amount of heat and/or captive electricity generated for at least three years prior to the start of the project activity.

[2] If it cannot be demonstrated through procedures listed in sub-bullets that the WECM has been flared/combusted or released into atmosphere or the pressure has been wasted in absence of project activity, the project proponent can propose a procedure for indirect measurements (in the context of specific industrial applications) as a revision to the methodology.

Appendix 3. Conservative baseline emissions if multiple waste gas stream(s) with potential for interchangeable application exist in the WEG facility

1. If several waste gas streams are available in the WEG facility, and can be used interchangeably for various applications or are commonly used as a part of energy sources in the facility, there is always a possibility that the potential for leakage exists due to the implementation of the CDM project. For example, in an integrated iron & steel plant the Coke Oven Gas, Blast Furnace gas and Basic Oxygen Furnace gas (LD gas) can be used independently or as a mixture of gases for various applications and therefore use of waste energy recovery from any of these gases for a specific CDM project can lead to the emissions due to firing of fossil fuel to meet the requirement of energy at some other applications in the facility or even outside of the facility. The following table, for example, can define the profile of the potential application areas of these gases.

Table 1. Potential application areas

By-product gas	Application area								
	Coke oven	Sinter plant	Blast furnace	Basic oxygen furnace	Casting and rolling	Flaring	Power generation	Sale to external consumers	Any other uses
Coke oven gas									
Blast furnace gas									
Basic oxygen furnace gas (LD gas)									
Other fossil fuel used (coal/ natural gas/ fuel oil) solely as fuel									

2. Therefore, it has to be ensured that any decrease of waste gas energy recovery of one source due to recovery of waste gas energy of another source is properly adjusted to ensure conservativeness of emission reduction.

3. The following steps can be followed in this regard.

1. Define an extended boundary of the project

4. If the waste gas energy recovered under the CDM project is usable in the other applications in the facility either independently, or by mixing with similar other waste gas energy sources in the facility, the project boundary should include the generation of all

other waste gas streams and the potential applications. For example, for a blast furnace energy recovery project in an existing or a Greenfield iron & steel plant, it is well recognized that a mixture of gases can be used in the baseline to supply to the energy requirements of many applications. Based on the above table, for this CDM project, an extended boundary for the mixture of waste fuel gases can be defined as follows:

Table 2. Extended boundary for the mixture of waste fuel gases

WECM	Extended system boundary						
	Coke oven	Sinter plant	Blast furnace	Casting and rolling	Flaring	Power generation	Sale to external consumer
Common waste fuel gas (COG, BFG, LD gas combined)	Yes	Yes	Yes	Yes	Yes	Yes	No

2. Determination of conservative baseline emissions for the CDM project in an existing facility

5. An energy balance is to be established for the demand and supply of energy in all the applications covered in extended project boundary identified above, based on the historical data of one year prior to implementation of CDM project. This energy balance should be checked by the DOE on-site, and only if it is established that there is no likelihood of decrease in energy recovery of other WECM stream(s) under the extended project boundary, the methodology is deemed applicable to the project.

6. This should be monitored by the verifying DOE every year, and if there is a decrease in the energy recovery of WECM(s) in the extended boundary excluding the project activity WECM, a technical justification along with energy balance should be demanded explaining why the reduction in recovery is not due to the CDM project. If this explanation is not satisfactory and there are possibilities of increase in emissions due to the project activity within the extended project boundary, the methodology cannot be applied to the project activity anymore and no CERs can be claimed for the rest of the monitoring period. Detailed monitoring procedures corresponding to this requirement shall be provided in the PDD.

Appendix 4. Guidance on the application of appropriateness of benchmarks for project activities utilizing waste heat/waste gas for power generation

1. For projects in which the electricity is produced for captive consumption the benchmark of the core business is considered to be appropriate, as the project is considered to be an investment in the operation of the core business.

2. For projects in which the electricity is exported to the grid, the benchmark of the core business is not considered to be appropriate, as the project is considered to be an investment in power production and therefore to face a risk profile different to that of the core business of the project developer.

3. In undertaking this assessment for appropriateness benchmark the below shall be considered:

    (a) If 75 per cent or more of the power output was meant for consumption by users (recipient facilities) other than the industrial (WEG) facilities from which the waste heat/waste gas/waste pressure is derived, the proposed CDM project activity can be considered as predominantly exporting to the grid; and

    (b) If 75 per cent or more was meant to be consumed within the industrial (WEG) facilities from which the waste heat/waste gas/waste pressure is derived the proposed CDM project activity can be considered as predominantly for captive consumption;

    (c) In any other cases than those covered in 3(a) and 3(b) above, use the weighted average (based on the percentage of electricity supplied) of the financial benchmarks of the sectors which the industrial (WEG) facility belong to.

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Document information

Version	*Date*	*Description*
05.0	16 April 2015	EB 83, Annex 6 Revision to: • Consolidates this methodology Provide new definitions, streamlines the sections for applicability, procedure for baseline scenario identification, additionality and baseline emissions; • Include previously issued clarifications and Board decisions such as the "Information note: previous rulings related to the appropriateness of benchmarks for project activities utilizing waste heat/waste gas for power generation" that relates to this methodology; • Expand the application of the methodology to claim additional emission reduction to those project activities that generate electricity and mechanical energy from recovery and use of waste energy beyond the maximum capacity of the pre-existing equipment at the recipient facilities; • Change the title from "Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects" to "Waste energy recovery".
04.0.0	15 April 2011	EB 60, Annex 5 The revision makes the following changes in the methodology: • Consolidates this methodology with AM0024 "Methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants"; • Provides several definitions in order to improve clarity; • Makes several changes in applicability section to improve clarity; • Broadens applicability of methodology to include more project activities for which a partial recovery of waste energy exists in the baseline; • Redefines project boundary more clearly; • Redefines the baseline scenarios, including scenarios for the Greenfield project activities; • Makes explicit requirement of financial analysis to determine baseline scenario and demonstrate additionality for certain types of project situations; • Includes flowchart for determination of baseline emissions; • Avoids categorization of project activities according to different "types" but allow calculation of the baseline emissions depending upon the extent of recovery of the waste energy in the absence of project activity; • Includes the approaches to calculate the baseline emissions, if waste energy under the project activity is recovered and supplied to meet the requirement of the heat of reaction of unit processes;

Version	*Date*	*Description*
		• Improves the guidance on baseline efficiency and emission factors, including those for "reference energy generating facility"; • Improves the description of method 3 to determine capping factor for baseline emissions; • Provides separate guidance (Annex 1) for Greenfield facility for the purpose of estimation of baseline emissions; • Provides guidance (Annex 3) for the conservative estimation of baseline emissions where multiple waste gas streams exist in the project facilities with potential for interchangeability of application; • Revises project emission section to remove some sources of emissions; • Provides explicit situations to calculate project emissions due to combustion of auxiliary fuel along with waste energy; • Refers the tools "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", "Tool to determine the baseline efficiency of thermal or electric energy generation systems" and "Tool to determine the remaining lifetime of equipment"; • Includes the monitoring requirements for return condensate in the configuration of extraction cum condensing turbine; • Deletes/add/changes several parameters in monitoring section. • Modifies the structure of methodology and carries out several textual changes to improve clarity of methodology. Due to the overall modification of the document, no highlights of the changes are provided.
03.2	04 December 2009	EB 51, Annex 10 Editorial revision: • The editorial revision in the description text of equation (1h) in the section of baseline emissions (Case 1 and Case 2 of Method-3 for capping of baseline emissions).
03.1	28 November 2008	EB 44, Annex 13 Editorial revision: • The parameter $HG_{j,y}$ further described; • Editorial changes carried out in equation 1b).
03	02 August 2008	EB 41, Annex 6 Revision to incorporate the following changes: • Inclusion of project activity under applicability of methodology, which is based on replacement of electrical or steam-driven drives in baseline with steam turbine, which is driven by steam recovered from waste energy; • Inclusion of Type-2 project activities where part of waste gas energy was recovered in baseline for the purpose of power generation and project intends to improve utilisation of waste gas energy with high efficiency heat recovery equipment for the

Version	*Date*	*Description*
		purpose of power generation; • Clarity provided on fcap calculations where project proponents do not have baseline data of waste energy for three years prior to implementation of project activity; • Clarity provided in waste gas streams. Applicability condition added for Type-1 activities to cover scenario where in baseline there are other non-CDM projects recovering waste energy and as a result of CDM project, their energy generation is reduced and diverted to CDM project; • Consistency is provided in use of terms waste gas/heat/pressure. In many instances this is replaced by the common term "waste energy"; • Provided new capping procedure (Method-3) for waste energy, further elaborated Method-1; • Monitoring tables amended to incorporate parameters of new and modified capping procedures; • Added new definitions of waste energy and waste energy carrying medium. Modified definition of cogeneration; • Added new applicability condition for waste pressure recovery projects.
02	19 October 2007	EB 35, Para 24 Revision to incorporate the use of the "Tool to calculate the emission factor for an electricity system".
01	22 June 2007	EB 32, Annex 8 Initial adoption.

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