

AM0044

Large-scale Methodology

Energy efficiency improvement projects -
boiler rehabilitation or replacement in
industrial and district heating sectors

Version 02.0.0

Sectoral scope(s): 01



United Nations
Framework Convention on
Climate Change

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1. Introduction

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

Table 1. Methodology key elements

Typical projects	Projects that results in thermal energy efficiency improvement of fossil-fuel-fired boilers, at multiple locations, through rehabilitation or replacement of the boilers implemented by the project participant, who may be the owner of boilers or owner of all the sites or part of the sites where the boilers are to be installed or a third party that owns all the project boilers during the project period
Type of GHG emissions mitigation action	(a) Energy efficiency. Switch to more energy-efficient technology

2. Scope, applicability, and entry into force

2.1. Scope

2. The methodology is applicable to project activities that results in thermal energy efficiency improvement of boilers, at multiple locations, through rehabilitation or replacement of the boilers implemented by the project participant. In case the project participant is a third party, a contractual agreement with project activity sites where the boiler(s) efficiency improvement activity are implemented will be entered into.

2.2. Applicability

3. The following conditions apply to the methodology:
 - (a) The project activity is to rehabilitate boilers and/or the replacement of boilers with some remaining lifetime;
 - (b) The owner of the boilers implements all the rehabilitation/installation of the boilers included in the project boundary;
 - (c) The geographical extent of the project boundary can be clearly established;
 - (d) The project activity is limited to rehabilitation/installation of the boilers to improve efficiency and no fuel switching is undertaken within the project boundary;
 - (e) There are no enforced regulations on minimum efficiency ratings that are applicable to boiler(s) within the project boundary. The project participants shall confirm this through documented evidence, that is building code documents, etc.;

- (f) The installed capacity of each baseline and respective boiler shall be determined using a performance test, which is to be conducted in accordance with well-recognized international standards, that is ASME PTC 4-1998;¹
- (g) Only one type of fuel is used by each of the boiler included in the project boundary.

2.3. Entry into force

- 4. The date of entry into force of the revision is the date of the publication of the EB 70 meeting report on 23 November 2012.

3. Normative references

- 5. This baseline and monitoring methodology is based on elements from the following proposed new methodology:
 - (a) “NM0144-rev: Energy efficiency improvements carried out by an Energy Services Company (ESCO) through boiler rehabilitation or replacement” prepared by Clean Energy Finance Committee, Mitsubishi UFJ Securities (MUS).
- 6. This methodology also refers to the latest approved versions of the following documents:
 - (a) “Tool for the demonstration and assessment of additionality”;
 - (b) “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”;
 - (c) “Tool to determine the remaining lifetime of equipment”;
 - (d) British Standard Methods for Assessing the Thermal Performance of Boilers for Steam, Hot Water and High Temperature Heat Transfer Fluids;
 - (e) American Society of Mechanical Engineers Performance Test Codes for Steam Generators: ASME PTC 4 - 1998; Fired Steam Generators.
- 7. For more information regarding the proposed new methodologies and tools as well as their consideration by the Executive Board (hereinafter referred to as the Board) of the clean development mechanism (CDM) please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

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

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

4. Definitions

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

¹ American Society of Mechanical Engineers Performance Test Codes for Steam Generators: ASME PTC 4 – 1998; Fired Steam Generators.

10. For the purposes of this methodology the project participant is herein defined as the owner of the boilers during the project activity period. The “owner of the boilers” may be the owner of all the sites or part of the sites where the boilers are to be installed or a third party that owns all the project boilers during the project activity period.

5. Baseline methodology

5.1. Project boundary

11. All project activity sites where the boilers are rehabilitated/replaced during the implementation of the project activity² are included in the project boundary. The geographical extent of the project boundary (e.g. town, city, etc.) shall be clearly stated in the CDM project design document (PDD). The officially accepted map (encompassing the region) shall be used to demarcate the project boundary of the project activity.
12. Only CO₂ sources are included in the project boundary for estimating the baseline and project emissions.

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

Source		Gas	Included	Justification/Explanation
Baseline	Fossil fuel consumption in the boilers	CO ₂	Yes	Main GHG gas emitted
		CH ₄	No	Conservative. Excluded for simplification, as the amount is expected to be very small
		N ₂ O	No	Negligible
Project activity	Boiler fossil fuel consumption	CO ₂	No	Main GHG gas emitted
		CH ₄	No	Negligible. Excluded for simplification, as the amount is expected to be very small
		N ₂ O	No	Negligible

5.2. Procedure for estimating lifetime of the boiler(s)

13. Project proponents shall use the latest version of the “Tool to determine the remaining lifetime of equipment” to determine the remaining lifetime of the boilers.

5.3. Procedure for the selection of the most plausible baseline scenario

14. The following steps shall be used to identify the baseline scenario:

5.3.1. Step 1: Identification of alternative scenarios to the proposed CDM project activity consistent with current laws and regulations

15. Project participants shall identify all realistic and credible alternatives to the project activity that are consistent with current laws and regulations.

² The sites may be plants, factories and buildings where thermal energy is generated for internal use or for sale to surrounding customers.

16. Alternatives include, but are not limited to, the following scenarios:
 - (a) Continuation of use of the existing boilers;
 - (b) Replacement/rehabilitation of boilers by the project participant, as defined in this methodology, to increase the efficiency and reduce fossil fuel consumption (i.e., implementation of the proposed project activity without being registered as a CDM project activity).
17. In case the project participant is third party, the following scenario shall be assessed as well:
 - (a) Replacement/rehabilitation of boilers by the owners of the sites where the boilers are operated, e.g. the proposed project activity is implemented by the owners of project activity sites without being registered as a CDM project activity.

5.3.2. Step 2: Identify the most likely baseline scenario

18. The project participant shall examine each of the above candidates in order to identify the most likely baseline scenario using the Steps 2 and 3 of the latest version of the “Tool for the demonstration and assessment of additionality”.
19. If project activity is to install a project-boiler(s) with higher capacity than the baseline-boiler(s) capacity at some site(s), then for such project activity sites the most likely alternative scenario will be examined individually.
20. The following barriers, among others, may be considered while conducting a barrier analysis (Step 3 of the “Tool for the demonstration and assessment of additionality”):
 - (a) Access to capital, needed to replace/rehabilitate boiler(s), by the owners of the boilers;
 - (b) Access to capital by the third party to implement the proposed project activity is either constrained or expected returns are unacceptably low;
 - (c) Lack of technical expertise among the owner of the boilers to install/operate the new boiler that may result in additional costs due to necessity to hire consultants.
21. Project participants shall use Step 4 of the latest version of the “Tool for the demonstration and assessment of additionality” to confirm that rehabilitation/replacement of boilers to improve efficiency is not a common practice in the country where the project activity is being implemented.
22. This baseline methodology is only applicable if the baseline scenario is “continuation of use of the existing boilers”.

5.4. Additionality

23. Additionality shall be demonstrated using the latest approved version of the “Tool for the demonstration and assessment of additionality”. Guidance on its use as provided below shall be used.

5.4.1. Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

24. Project participants shall consider all the evaluated alternatives while identifying the baseline scenario.
25. If alternative Scenario 1 (i.e. continuation of use of the existing boilers) is not in compliance with mandatory laws and regulations then the proposed project activity is not additional.

5.4.2. Step 2: Investment analysis

26. The investment analysis is mandatory only if the project activity is to be implemented by a third party, as financial analysis is required to confirm the additionality of the project activity. Otherwise its use is optional.
27. The benchmark analysis shall be used to compare the various alternatives. The benchmark used for analysis shall represent standard returns on investment in the market, considering the specific risk of the project type, but not linked to the subjective profitability expectations or risk profile of a particular project developer. The benchmark can be derived from government bond rates, increased by a suitable risk premium to reflect private investment and/or the project type, as substantiated by an independent (financial) expert. In this particular methodology two kinds of risk premiums are added to this bond rate to arrive at a suitable benchmark value for the project activity. The first kind is the risk of private projects in general as opposed to public ones. The second kind of risk is that associated with the country and technology.
28. The project Internal Rate of Return (IRR) shall be estimated, as explained in the “Tool for the demonstration and assessment of additionality”, and compared with the benchmark to assess the additionality.³ For each alternative scenario the project IRR shall be estimated for each of the top 10 project activity sites or the top 10 per cent of the project activity sites, whichever has the highest number. To select this group first rank the project activities site in decreasing order of the installed boiler capacity (kWth) and choose project activity sites representing the top 80 per cent of the project activity site. Then among these project activity sites rank the project activity sites by the thermal efficiency improvements achieved by implementing the project activity and choose 10 per cent or top 10 of the project activity sites. The highest IRR of all project activity sites examined shall be compared with the benchmark rate.⁴
29. In the case that the project involves 10 or less boilers, all boilers shall be subject to IRR analysis.
30. For all project activity sites where the project-boiler(s) installed is (are) of higher capacity than the one in the baseline-boiler(s), an IRR analysis shall be conducted.
31. Income based on thermal energy generation/sales must be included in the IRR analysis. In case of third party this applies only if this income is received by the third party. This

³ Project IRR is used because there could be many different potential project developers (ESCOs).

⁴ It is assumed that all the project activity sites not included in the group will have a lower IRR than the IRR of the project activity site which has the lower IRR among the project activity site included in the group.

could be the case when the total capacity is increased due to the project. Initial expenses are equivalent to the projected cash outlay used to purchase the new boiler and other equipment required to rehabilitate/replace boilers at the selected project activity sites. The operating and maintenance costs for the project participant are equivalent to all projected expenses associated with operating the project boiler.

32. As a minimum, for each boiler, the IRR will be calculated based on the following data, and supporting documentation/information made available:
 - (a) Initial investment for the boiler;
 - (b) Total income;
 - (c) Total operating and maintenance costs;
 - (d) Project life.
33. Step 2 is mandatory for this methodology if the project activity is to be implemented by a third party.
34. Step 3 can be applied by the project participants to supplement Step 2.

5.4.3. Step 3: Barrier analysis (optional)

35. Establish a complete list of barriers that would prevent alternative scenarios to occur in the absence of the CDM, using the guidance in Step 3 of the latest version of the “Tool for the demonstration and assessment of additionality”. The following text supplements the list of possible barriers that could be demonstrated to prevent implementation of one or more of the alternative scenarios.
36. Investment barrier:
 - (a) The third party or the owners of the individual project activity site are unable to access foreign equity capital and debt in absence of CDM revenues.
37. Technology barrier:
 - (a) This barrier shall be considered only if the technology used is the same across all the project activity sites.
38. Prevailing practice barrier:
 - (a) This shall be considered only if the proposed project is first of its kind and uses state-of-the-art boiler technology, which has not been used before in the host country.

5.4.4. Step 4: Common practice analysis

39. Due to the large number of boilers within certain areas, it may not be feasible/viable to check the status of every boiler individually. In this case and if in place, local legislation regarding boiler replacement (e.g. for safety policies) may be used to provide information regarding the maximum lifetime permitted for boilers. Then, such information shall be compared to the typical boiler replacement schedule in the region (using actual archived replacement schedule data/information).

40. The common practice assessment shall determine whether or not existing boilers should be replaced during the project activity period and when. The control group for the common practice analysis shall be defined as plants, factories and/or buildings where thermal energy is generated for internal use or for sale to surrounding customers, excluding the projects implemented under the CDM, in the region where the project is located. The region of the control group is defined as the geographic area around the project activity that has similar legal compliance requirements as for the project activity. The common practice analysis shall be undertaken using documented information on the prevailing thermal energy generation technologies in use by plants, factories and/or buildings where thermal energy is generated for internal use or for sale to surrounding customers in the region or in the country where the project is located. If such information is not readily available, a survey of these plants, factories and/or buildings shall be conducted to obtain information on thermal generation technologies. The common practice threshold shall be applied to the control group selected prior to the start of the project and at each renewal of the crediting period.
41. If more than 33 per cent⁵ of the control group uses improved boilers that are similar to the project activity, then the project is not additional. The designated operational entity shall verify the documented evidence for the purpose of common practice evaluation.

5.5. Baseline emissions

42. The following steps shall be used to estimate the baseline emissions:

5.5.1. Step 1: Determine the thermal efficiency of each baseline boiler

43. The baseline thermal efficiency for each boiler included in the project boundary shall be determined using the following formula:

$$\eta_{BL,m,i} = \frac{EG_{BL,his,i}}{FC_{BL,his,i}} \quad \text{Equation (1)}$$

Where:

$\eta_{BL,m,i}$	=	Average baseline thermal efficiency of boiler <i>i</i> as measured using data for thermal output and fuel use as per the measurement procedures
$EG_{BL,his,i}$	=	Average historic thermal energy output from the baseline boiler <i>i</i> (MJ/yr)
$FC_{BL,his,i}$	=	Average historic fossil fuel consumption by the baseline boiler ' <i>i</i> ' (MJ/yr)

44. Where possible, the above calculation shall be based on historical data for the project activity site for the most recent three years before the implementation of the project activity. The average thermal output and fuel consumption value for the three years will be used in the equation. This data shall be reported in the CDM-PDD.

⁵ This threshold is referenced from Everett M. Rogers, 2003, Diffusion of Innovations, Fifth Edition, Simon & Schuster Inc. This value is subject to further guidance from the CDM-EB and sets no precedent.

45. Total thermal output for each baseline boiler will be determined from actual measured baseline data for steam flow, pressure and temperature, using acceptable standard methods as outlined in ASME PTC 4-1998⁶ or BS845⁷ or other recognized national or international standard. The measurement procedure for thermal output shall be in accordance with guidance provided in the monitoring methodology. An overall uncertainty coefficient will be determined for thermal efficiency as directed in the national or international standard chosen and the efficiency adjusted upwards to compensate as per equation below.

$$\eta_{BL,i} = \eta_{BL,m,i} \times u_i \quad \text{Equation (2)}$$

Where:

- | | | |
|-----------------|---|---|
| $\eta_{BL,i}$ | = | Average baseline thermal efficiency of boiler <i>i</i> |
| $\eta_{BL,m,i}$ | = | Average baseline thermal efficiency of boiler <i>i</i> as measured using data for thermal output and fuel use as per the measurement procedures |
| u_i | = | Conservativeness factor, chosen from the Table 3 below, associated with the estimated uncertainty of the thermal efficiency measurement |

46. In the case that actual baseline data for a boiler at the project activity site is not available, the following data can be used (from highest to lowest priority):
- (a) Actual measurements of thermal efficiency and adjusted for conservativeness (project participants shall select (and justify) the appropriate conservativeness factor from the Table 3 below). Methods from recognized international standards shall be used to determine thermal efficiency, and uncertainty estimated (as directed in the standard). This uncertainty level shall be used to select the appropriate conservativeness factor from the table. For example, an uncertainty of 40 per cent would mean that the project participant must multiply the baseline thermal efficiency by 1.12;
 - (b) A conservative thermal efficiency based on other boilers in the region which are similar to that of the boiler on the project activity site (in terms of age, technology, capacity, etc.). This shall be justified using data and/or published reports. The uncertainty level in this case will be assumed to be greater than 100 per cent unless based on assessment of the above data/information an independent expert justifies a lower level of uncertainty. The DOE is to check the credentials of the independent expert at the time of validation and also verify that there is no conflict of interest.
47. Note: This option is only valid for small boilers according to the definition provided by USEPA (output capacity below 29 MW). Large boilers are not allowed to use this option.

⁶ American Society of Mechanical Engineers Performance Test Codes for Steam Generators: ASME PTC 4 – 1998; Fired Steam Generators.

⁷ British Standard Methods for Assessing the Thermal Performance of Boilers for Steam, Hot Water and High Temperature Heat Transfer Fluids.

Table 3. Conservativeness factors⁸

Estimated uncertainty range (%)	Assigned uncertainty band (%)	Conservativeness factor where higher values are more conservative
Less than or equal to 10	7	1.02
Greater than 10 and less than or equal to 30	20	1.06
Greater than 30 and less than or equal to 50	40	1.12
Greater than 50 and less than or equal to 100	75	1.21
Greater than 100	150	1.37

5.5.2. Step 2: Calculate fossil fuel input for each baseline boiler (MJ/yr) that would have been needed in the absence of the project activity

48. The fossil fuel input for each boiler, included in the project boundary, in the baseline is determined using the below formula:

$$FC_{BLE,i,y} = \left(\frac{EG_{PJ,i,y}}{\eta_{BL,i}} \right) \times CF_{i,y} \quad \text{Equation (3)}$$

Where:

- $FC_{BLE,i,y}$ = Calculated input of fossil fuel to baseline boiler i in year y (MJ/yr)
 $EG_{PJ,i,y}$ = Thermal energy output of project boiler i in year y (MJ/yr)
 $CF_{i,y}$ = Activity capping factor for boiler i in year y

49. The estimation of baseline fuel that would have been used is capped for case(s) where the thermal output of the boiler in a particular project activity site is higher than that of the boiler capacity in the baseline, as follows:

$$CF_{i,y} = \min \left[1; \frac{EG_{BL,his,i}}{EG_{PJ,i,y}} \right] \quad \text{Equation (4)}$$

50. The maximum value of CF can be 1.
51. The total thermal output of the project boiler is monitored ex post as stipulated in the monitoring methodology. An overall uncertainty coefficient will be determined for thermal output as directed in the international standard chosen in step 1 and the value adjusted upwards to compensate for uncertainty by multiplying the measured thermal output with

⁸ Annex III (p.24) of the following document (FCCC/SBSTA/2003/10/Add.2) Technical guidance on methodologies provides detailed guidance on the table of conservativeness factors: <http://unfccc.int/resource/docs/2003/sbsta/10a02.pdf>.

a conservativeness factor. The conservativeness factor shall be chosen from the values provided in table 2 above.

$$EG_{PJ,i,y} = EG_{PJ,i,m,y} \times utc_i \quad \text{Equation (5)}$$

Where:

$EG_{PJ,i,y}$	= Thermal energy output of project boiler i in year y (MJ/yr)
$EG_{PJ,i,m,y}$	= measured thermal output of the project boiler i in year y as per procedure provided in the monitoring methodology (MJ/yr)
utc_i	= conservative factor corresponding to uncertainty in thermal output measurement of project boiler i (MJ/yr)

52. For the purpose of ex ante emission reduction calculation in the CDM-PDD, an estimated value for thermal output based on data from the manufacturer of the project boiler should be used.

5.5.3. Step 3: Calculate baseline emissions from combustion of fossil fuel in each baseline boiler (t CO₂/yr)

53. Baseline emissions from the combustion of fossil fuel for each boiler in the baseline is determined using the below formula:

$$BE_{i,y} = FC_{BLE,i,y} \times EF_{C,FF,i} \times OXID_{FF,i} \times 44/12 \quad \text{Equation (6)}$$

Where:

$BE_{i,y}$	= Baseline emissions for fossil fuel combustion at boiler i in year y (t CO ₂ /yr)
$FC_{BLE,i,y}$	= Calculated input of fossil fuel to baseline boiler i in year y (MJ/yr)
$EF_{C,FF,i}$	= Emission factor for the fossil fuel used in the boiler i (t C/MJ)
$OXID_{FF,i}$	= Oxidation factor for the fossil fuel used in the boiler i (fraction)
44/12	= Conversion factor: carbon equivalent to CO ₂ eq (ratio: molecular weight of CO ₂ /molecular weight of carbon)

5.5.4. Step 4: Calculated total baseline emissions from all baseline boilers

54. Total baseline emissions from all baseline boilers are determined using the below formula:

$$BE_y = \sum_{i=1}^n BE_{i,y} \quad \text{Equation (7)}$$

Where:

BE_y = Baseline emissions during the year y (t CO₂/yr)
 n = Number of boilers within the project boundary

5.6. Project emissions

55. Project emissions are calculated as follows:

$$PE_{i,y} = FC_{PJ,i,y} \times NCV_i \times EF_{C,FF,i} \times OXID_{FF,i} \times 44/12 \quad \text{Equation (8)}$$

Where:

$PE_{i,y}$ = Emissions from fossil combustion at project boiler i in year y (t CO₂/yr)
 $FC_{PJ,i,y}$ = Fossil fuel consumption at project boiler i in year y (mass of volume units/yr).
 $EF_{C,FF,i}$ = Emission factor for the fossil fuel used in the project boiler i (t C/MJ)
 NCV_i = Net calorific boiler of fossil fuel used in the project boiler i (MJ/mass or volume units)
 $OXID_{FF,i}$ = Oxidation factor for the fossil fuel used in the project boiler i (fraction)
 $44/12$ = Conversion factor: carbon equivalent to CO₂ eq (ratio: molecular weight of CO₂/molecular weight of carbon)

56. Total emissions from all project boilers are determined using the below formula:

$$PE_y = \sum_{i=1}^n PE_{i,y} \quad \text{Equation (9)}$$

Where:

PE_y = Project emissions during the year y (t CO₂/yr)
 n = Number of boilers within the project boundary

57. Project emissions shall be determined ex post using monitored data for consumption of fossil fuel. Uncertainty is deemed low since strict quality control and quality assurance procedures are in place.

58. For the purpose of completing emission reduction calculations in the CDM-PDD, an estimated value for consumption of fossil fuels should be used, based on data from the manufacturer of the project boiler.

5.7. Leakage

59. No significant leakage is expected for this type of project activity, thus leakage can be ignored.

5.8. Emission reductions

60. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (10)}$$

Where:

ER_y = Emission reductions during the year y (t CO₂/yr)

BE_y = Baseline emissions during the year y (t CO₂/yr)

PE_y = Project emissions during the year y (t CO₂/yr)

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

61. Consistent with guidance by the Board, project participants shall use the latest version of the tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period".

5.10. Data and parameters not monitored

62. The following data and parameters are included in this methodology, but do not need to be monitored during the crediting period.

Data / Parameter table 1.

Data / Parameter:	-
Data unit:	kWth
Description:	Installed capacity of baseline boiler(s)
Source of data:	Actual (direct) measurements
Measurement procedures (if any):	Determined on the basis of a standard performance test which is conducted in accordance to relevant international standards.
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Used to confirm an applicability condition and second option for thermal output

Data / Parameter table 2.

Data / Parameter:	$EG_{BL,his,i}$
Data unit:	MJ/yr
Description:	Average historic thermal energy output from the baseline boiler i
Source of data:	Actual measurements

Measurement procedures (if any):	Heat generation is determined as the difference of the enthalpy of the steam or hot water generated by the energy production facility(s) minus the enthalpy of the feed-water, the boiler blow-down and any condensate return. The respective enthalpies should be determined based on the mass (or volume) flows, the temperature and, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. Recognised international standards such as BS845 or ASME PTC 4-1998 should be used. Overall uncertainty should also be determined as directed in the international standard
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Average determined from the most recent 3 years data

Data / Parameter table 3.

Data / Parameter:	$FC_{BL,his,i}$
Data unit:	MJ/yr
Description:	Average historic fossil fuel consumption by the baseline boiler i
Source of data:	Actual measurements
Measurement procedures (if any):	Wherever possible, all data is to be cross-checked with fuel purchase receipts. In most cases fuel data is recorded in mass or volume units. To convert it into energy content actual measured or local data for net calorific values (NCV) of fossil fuels is to be used. If measured or local data of NCV is not available, regional data should be used, and in its absence IPCC defaults can be used from the latest version of the IPCC Guidelines for National Greenhouse Gas Inventories
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Average determined from the most recent three years data

Data / Parameter table 4.

Data / Parameter:	$\eta_{BL,m,i}$
Data unit:	-
Description:	Baseline (average) thermal efficiency of boiler i
Source of data:	Actual (direct) measurements

Measurement procedures (if any):	Measurements shall be taken using recognised standards. The direct method (dividing the net thermal energy generation by the energy content of fuel fired during a representative time period) should be used where possible in preference to the indirect method (determination of fuel supply or thermal energy generation and estimation of the losses). Document measurement procedures and results and manufacturer's information transparently in the CDM-PDD. Overall uncertainty should also be determined as directed in the international standard
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	This option for baseline thermal efficiency of boilers is only to be used in the absence of three years worth of historic data. Methods from recognized international standards shall be used to determine thermal efficiency, and uncertainty estimated (as directed in the standard)

6. Monitoring methodology

6.1. Monitoring procedures

63. The following data will be collected by the project participant for each boiler listed in the CDM- PDD.⁹
64. This methodology requires the monitoring of the following items to confirm applicability conditions:
 - (a) The actual installed capacity (kW_{th}) of project boiler(s) at each project activity site.
65. This methodology requires the monitoring of the following items to complete project activity emission calculations:
 - (a) The date at which activity commences at each site after boiler rehabilitation/installation;
 - (b) Amount of fossil fuel(s) consumed in each boiler (mass or volume/year);
 - (c) Net Calorific Value (NCV) of fossil fuel(s) used (MJ/mass or volume);
 - (d) Emission factor of the fossil fuel(s) (t C/MJ);
 - (e) Oxidation factor of fossil fuels.
66. This methodology requires the monitoring of the following items to complete baseline emission calculations:

⁹ All data shall be archived for a minimum of two years after the end of the crediting period.

- (a) Total thermal output of the project boiler (MJ/yr) (enthalpies should be determined based on the mass (or volume) flows, the temperature and, the pressure.
67. Describe and specify in the CDM-PDD all monitoring procedures, including the type of measurement instrumentation used, the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. All meters and instruments should be calibrated regularly as per industry standards

6.2. Data and parameters monitored

Data / Parameter table 5.

Data / Parameter:	-
Data unit:	kW _{th}
Description:	Installed capacity of project boiler(s)
Source of data:	Actual (direct) measurements
Measurement procedures (if any):	Determined on the basis of a standard performance test which is conducted in accordance to relevant international standards
Monitoring frequency:	Yearly
QA/QC procedures:	Standard performance test which is conducted according to applicable international standards. Double check using official receipts or other information from the new boiler manufacturer
Any comment:	Boiler inspections shall be conducted yearly according to best international practices

Data / Parameter table 6.

Data / Parameter:	-
Data unit:	Date
Description:	Date of activity start
Source of data:	Recorded by project participant
Measurement procedures (if any):	Recorded as the day the newly installed / newly rehabilitated starts producing thermal energy
Monitoring frequency:	Monthly
QA/QC procedures:	Double checked against relevant documentation
Any comment:	Data gathered monthly to establish starting date for each site

Data / Parameter table 7.

Data / Parameter:	$EG_{PJ,i,y}$ $EG_{PJ,i,m,y}$
Data unit:	MJ/yr
Description:	Thermal energy output of project boiler i in year y
Source of data:	Measurements
Measurement procedures (if any):	Heat generation is determined as the difference of the enthalpy of the steam or hot water generated by the energy production facility(s) minus the enthalpy of the feed-water, the boiler blow-down and any condensate return. The respective enthalpies should be determined based on the mass (or volume) flows, the temperature and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. Recognized international standards such as BS845 or ASME PTC 4-1998, should be used
Monitoring frequency:	Continuously, aggregated yearly
QA/QC procedures:	Flow meters should be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards. Overall uncertainty should also be determined as directed in the international standard and the value adjusted using the conservativeness tables if necessary to estimate the thermal output to be used for estimating baseline fuel consumption
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	$FC_{PJ,i,y}$
Data unit:	Mass or volume units/yr
Description:	Fossil fuel consumption at project boiler i in year y
Source of data:	Measurements
Measurement procedures (if any):	In the case of natural gas and oil-based fuels, monitoring shall be conducted with an (industrially recognised) standard flow meter and calibration conducted according to relevant international standards. Data will be compiled monthly and local data used for density if converting the units to tonnes. Coal, lignite and other solid fuels shall be recorded at the time of delivery and data aggregated monthly

Monitoring frequency:	Recorded monthly, aggregated yearly
QA/QC procedures:	Fossil fuel data double checked against receipt of purchase. The highest value of the two must be used. Flow meters should be subject to a regular maintenance and testing regime in accordance to appropriate /international standards
Any comment:	-

Data / Parameter table 9.

Data / Parameter:	NCV
Data unit:	MJ/mass or volume units
Description:	Net Calorific Value of fossil fuel(s) used in the boiler <i>i</i>
Source of data:	Actual measured or local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories
Measurement procedures (if any):	Measurements taken according to best international practices
Monitoring frequency:	Yearly
QA/QC procedures:	If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Double-checked against IPCC defaults (for consistency) if data is local or regional
Any comment:	-

Data / Parameter table 10.

Data / Parameter:	$EF_{C,FF,i}$
Data unit:	t C/MJ
Description:	Emission factor for the fossil fuel used in the boiler <i>i</i>
Source of data:	Actual measured or local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories
Measurement procedures (if any):	Measurements taken according to best international practices
Monitoring frequency:	Yearly
QA/QC procedures:	If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Double-checked against IPCC defaults (for consistency) if data is local or regional
Any comment:	-

Data / Parameter table 11.

Data / Parameter:	$OXID_{FF,i}$
Data unit:	Fraction
Description:	Oxidation factor for the fossil fuel used in the boiler
Source of data:	Actual measured or local data is to be used. If not available, regional data should be used and, in its absence, IPCC defaults can be used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories
Measurement procedures (if any):	Measurements taken according to best international practices
Monitoring frequency:	Yearly
QA/QC procedures:	If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Double-checked against IPCC defaults (for consistency) if data is local or regional
Any comment:	-

Data / Parameter table 12.

Data / Parameter:	N
Data unit:	-
Description:	Number of boilers within the project boundary
Source of data:	-
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
02.0.0	23 November 2012	EB 70, Annex 16 Revision to: <ul style="list-style-type: none">• Provide reference to the tool “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” ;• Delete guidance with regard to the remaining lifetime of the boilers and provide reference to the “Tool to determine the remaining lifetime of equipment”;• Provide other editorial improvements.
01	15 December 2006	EB 28, Annex 01 Initial adoption.
Decision Class: Regulatory Document Type: Standard Business Function: Methodology Keywords: energy efficiency, boilers		
