Approved baseline methodology AM0018

"Baseline methodology for steam optimization systems"

Source

This methodology is based on the "Energy efficiency project by modification of CO_2 removal system of Ammonia Plant to reduce steam consumption", India, whose baseline study, monitoring and verification plan and project design document were prepared by Indo Gulf Fertilisers Ltd. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0037-rev: "Energy efficiency project by modification of CO_2 removal system of Ammonia Plant to reduce steam consumption" on http://cdm.unfccc.int/methodologies/approved.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"

Applicability

This methodology is applicable to steam optimization projects in production processes with homogeneous and relatively constant outputs with continuous monitoring of steam output.

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0018 ("Monitoring methodology for steam optimization systems").

Project activity

Steam optimization projects.

Additionality

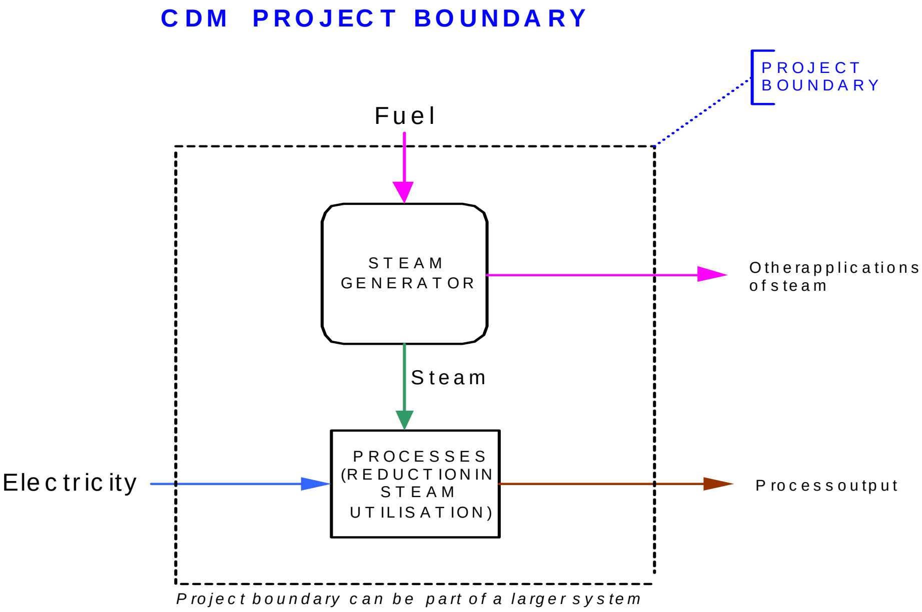
To demonstrate that the proposed project activity is additional project participants shall use the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the Executive Board[1].

Project boundary

The project boundary would cover the following:

- Steam generator
- Source of electricity for additional electrical loads (if any) due to project activity
- Process area where the steam consumption is expected to be reduced

[1] The latest version of the "Tool for the demonstration and assessment of additionality" is available on the UNFCCC CDM web site: < http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html >.



Baseline

The methodology addresses the improvement of energy efficiency by reducing steam consumption in industrial processes, in the case where the most likely baseline scenario is the continuation of production using current processes and efficiencies (though steam production efficiency may improve as indicated below).

Therefore, after assessing whether the project is additional, the next step is to determine which of the plausible alternatives scenarios as identified in Step 1 of the "Tool for the demonstration and assessment of additionality" is the most likely baseline scenario. Please provide a thorough explanation to justify your choice, based on the various factors (e.g. investment or other barriers) described in the additionality tool above. If the most likely baseline scenario is not the continuation of production using current processes and efficiencies, then this methodology does not apply.

Based on historical data from the existing process, a benchmark Specific Steam Consumption Ratio (SSCR, steam consumption per product output) is defined as the baseline energy efficiency. The improvement of the benchmark after project implementation is monitored and the corresponding steam savings and CO_2 emission reductions from fuel combustion in the boiler are determined.

The methodology addresses also possible increases in electricity consumption as a result of the project activity (using the small-scale methodology) and captures the impact of future retrofits and their impact on steam and CO_2 savings.

The baseline Specific Steam Consumption Ratio SSCR is determined in 3 steps.

Step 1: Benchmarking baseline output
The historical data on shift-wise or batch-wise (in case of batch process) output of the process area is to be analyzed and a representative output value (P_{rep}) is to be calculated. The extreme values are to be excluded from the available values of output rate. This is because the specific steam consumption in a plant reduces with increased production rates. The methodology suggests fixing baseline specific energy consumption for representative production rate. A "normal" production range can be defined based on the relationship between production rates and energy consumption. Based on general

experience the energy consumption per unit of production is not significantly sensitive up to +/-5% of nameplate capacity. For the purpose of this methodology, a normal production range can be defined as the range in which production levels are 5% above or below the verifiable[2] nameplate capacity. If production fluctuates (from shift to shift or batch to batch) beyond this normal production range, these specific values can be excluded to derive a representative production level of the day. Similarly steam consumption values corresponding to the excluded production values can be also excluded.

The production (output) values of P_1, P_2, P_3 given in the Equation below should be selected based on the normal range of rated plant capacity.

$$P_{rep} = \frac{(P_1 + P_2 .... + P_n)}{n} \times A \qquad \textbf{(1)}$$

where

P_1, P_2,….P_n	= Shift/ batch-wise production values for the baseline
P_{rep}	= Representative production for the day
A	= number of shifts/day for continuous processes (shift-wise monitoring)
A	= number of batches/day for batch processes (batch-wise monitoring)

Step 2: Benchmarking baseline steam consumption
From the historical data for steam consumption, the values corresponding to the representative production or output values determined above need to be determined.

$$S_{rep} = \frac{(S_1 + S_2 ..... + S_n)}{n} \times A \qquad \textbf{(2)}$$

where

S_1, S_2,….S_n	= Shift/ batch-wise steam consumption values for baseline, corresponding to P_1, ….P_n
S_{rep}	= Representative steam consumption for the day, corresponding to P_{rep}
A	= number of shifts/day for continuous processes (shift-wise monitoring)
A	= number of batches/day for batch processes (batch-wise monitoring)

In the following cases, batch-wise values should be used instead of daily values:
- If the batch time is more than 24 hours;
- If the number of batches in a day is not a integer number (*e.g.* 2.3 batches per day)

The duration of the period during which historical data on production and steam consumption are monitored to determine the SSCR should represent all seasonal demand variation factors (if any) with regard to (representative) production, energy use and equipment performance. In case there is no seasonal demand variation, one-month baseline data (daily average of production values and corresponding steam consumption values) are considered adequate.

Step 3: Benchmarking of Process Specific Steam Consumption Ratio (SSCR)
The SSCR is determined by the ratio of above two parameters.

[2] E.g. on the basis of construction or design specifications

$$SSCR = \frac{S_{rep}}{P_{rep}} \quad (3)$$

where

SSCR = Specific Steam Consumption Ratio in the baseline
S_{rep} = Representative steam consumption for the day/batch
P_{rep} = Representative production for the day/batch

Leakage

No leakage is envisaged for this type of projects. The additional electrical load that may result from the project activity (and could be seen as leakage) is accounted for in the determination of emission reductions.

Emission Reductions

Emission reductions are determined ex-post by multiplying the improvement of the baseline benchmark SSCR with the actual, monitored output of the project after implementation. This is done in the following steps:

Step 1: Monitor actual output
Actual output (P_{act}) needs to be monitored shift-wise or batch-wise. This can be done either by maintaining a shift-wise/batch-wise logbook or with the help of DCS (Distributed Control System).

Step 2: Determine representative output
The representative output rate for the day or batch (P_{rep1}) is determined by selecting and averaging the representative output values (i.e. within the normal production range, as described in the baseline section above).

$$P_{rep1} = \frac{\left(P_1 + P_2 \,..... + P_m\right)}{m} xA \quad (4)$$

where

P_{rep1} = Representative production for the day
$P_1, P_2, \ldots. P_m$ = Shift/ batch-wise production values for project scenario
A = number of shifts/day for continuous processes (shift-wise monitoring)
A = number of batches/day for batch processes (batch-wise monitoring)

Step 3: Monitor steam consumption
Steam consumption needs to be monitored for every shift/batch. This may be done either by maintaining an hourly logbook or with the help of DCS (Distributed Control System).

Step 4: Determine average steam consumption
Average shift-wise/batch-wise steam consumption rate for the day (S_{rep1}) is determined by selecting the steam consumption rate values corresponding to representative output rates and averaging them.

$$S_{rep1} = \frac{\left(S_1 + S_2 \,...... + S_z\right)}{z} xA \quad (5)$$

where

$S_1, S_2, \ldots S_m$	= Shift/ batch-wise steam consumption values for project, corresponding to $P_1, \ldots P_m$
S_{rep1}	= Representative steam consumption for the day (corresponding to P_{rep1})
A	= number of shifts/day for continuous processes (shift-wise monitoring)
A	= number of batches/day for batch processes (batch-wise monitoring)

Step 5: Determine the Specific Steam Consumption Ratio for the day

The Specific Steam Consumption Ratio is determined by the ratio of the two parameters calculated above.

$$SSCR_1 = \frac{S_{rep1}}{P_{rep1}} \quad \textbf{(6)}$$

where

$SSCR_1$	= Specific Steam Consumption Ratio for the project activity
S_{rep1}	= Representative steam consumption for the day (corresponding to P_{rep1})
P_{rep1}	= Representative production for the day

Step 6: Estimate the difference in SSCR of baseline and project scenarios.

$$SSCR_{diff} = SSCR - SSCR_1 \quad \textbf{(7)}$$

where

$SSCR_{diff}$	= difference in SSCR of baseline and project scenarios
SSCR	= Specific Steam Consumption Ratio in the baseline
$SSCR_1$	= Specific Steam Consumption Ratio for the project activity

Step 7: Estimate net daily reduction in steam consumption

$$S_{net} = SSCR_{diff} \ x \ P_{act} \quad \textbf{(8)}$$

where

S_{net}	= Net reduction in steam consumption per day (kg/day)
$SSCR_{diff}$	= difference in SSCR of baseline and project scenarios
P_{act}	= Actual value of output on the day.

Step 8: Estimate the net daily reduction in energy due to reduction in steam consumption

$$E_{net} = S_{net} \ x \ E_s \quad \textbf{(9)}$$

where

E_{net} = Net reduction in steam energy consumption per day (kCal/day)
S_{net} = Net reduction in steam consumption per day (kg/day)
E_s = Net enthalpy of steam being supplied in boiler (kCal/kg). (To be monitored)

and

$$E_s = E_{tot} - E_{fw} \quad \textbf{(10)}$$

where

E_s = Net enthalpy of steam being supplied in boiler (kCal/kg). (To be monitored)
E_{tot} = Total enthalpy of steam at the boiler outlet (kCal/kg)
E_{fw} = Heat content of feed water (kCal/kg)

Step 9: Estimate daily reduction in input energy to the boiler

$$E_{in} = E_{net} / \eta_b \quad \textbf{(11)}$$

where

E_{in} = Energy input in boiler
E_{net} = Net reduction in steam energy consumption per day (kCal/day)
η_b = Efficiency of boiler, to be monitored periodically by direct or indirect method.

Step 10: Estimate CO_2 emission reductions (C_{er}) in the boiler per day

$$C_{er} = E_{in} \ x \ \sum(F_{fuel} x \% H_{fuel}) \quad \textbf{(12)}$$

where

C_{er} = CO_2 emission reductions in the boiler per day
E_{in} = Energy input in boiler
F_{fuel} = Carbon emission factor for fuel to be taken based on actual laboratory tests [3]
$\%H_{fuel}$ = % of hours per day for each type of fuel. (To be monitored)[4]

Step 11: Estimate additional CO_2 emissions due to additional electrical load in project scenario
If the steam optimisation project requires operation of additional electrical load, the following steps can be followed to estimate the additional CO_2 emissions.

- *Sub-step 1:* Monitor the shift-wise/batch-wise electrical consumption. If a monitoring facility is not available, take the maximum rating (Nameplate data) of the motor, heater or any other electricity consuming device as the consumption.
- *Sub-step 2:* Estimate the average daily electricity consumption (E_{avg}).[5] The shift-wise/batch-wise electrical consumption values corresponding to representative shift-wise/batch-wise output values

[3] In case, reliable test report unavailable, use IPCC factor or a national factor for fuel from reliable sources.
[4] In case, under direct method of boiler efficiency estimation, fuel metering/measurement facility is available, the % of fuel use is derived by actual consumption of respective fuel
[5] This sub-step is only to be used in case of actual monitoring of electricity consumption. In case of Nameplate data, the rated value is the average value.

(as given above) are to be selected and averaged out. The daily consumption is to be estimated by multiplying the representative value with the number of shifts (or batches) per day.

- *Sub-step 3:* Estimate daily input energy (E_{ine}) to the electrical energy source (in case of captive generation):

$$E_{ine} = E_{avg} / \eta_g \qquad \textbf{(13)}$$

where

E_{ine} = Daily input energy into electrical energy source
E_{avg} = Average daily electricity consumption
η_g = Minimum efficiency of Electricity Generating System (EGS) based on historical data of EGS operation during ‘normal range’ of output (assumed constant).[6]

- *Sub-step 4:* Estimate CO_2 emissions (in case of captive generation).

$$C_{er1} = E_{ine} \, x \, F_c \qquad \textbf{(14)}$$

where

C_{er1} = CO_2 emissions in case of captive generation
E_{ine} = Daily input energy into electrical energy source
F_c = Carbon emission factor for fuel (IPCC)

- *Sub-step 5:* Estimate CO_2 emissions (in case of External grid supply).

$$C_{er2} = E_{avg} \, x \, F_{grid} \qquad \textbf{(15)}$$

where

C_{er2} = CO_2 emissions in case of external grid supply
E_{avg} = Average daily electricity consumption
F_{grid} = Carbon emission factor of the selected grid.

The Carbon emission factor of the selected grid is determined by the combined margin method, mentioned in point no.29 of the UNFCCC document “Indicative simplified baseline and monitoring methodologies for selected small scale CDM project activity categories”. The Combined Margin is the average of the “approximate operating margin” and the build margin”, where:

(i) The “approximate operating margin” is the weighted average emissions factor (in kg CO_2-eq/kWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation;
(ii) The “build margin” is the weighted average emissions (in kg CO2-eq/kWh) of recent capacity additions to the system, which capacity additions are defined as the greater (in MWh) of the most recent 20% of existing plants or the 5 most recent plants.”

This grid emission factor can be applied for entire crediting period.

Step 12: Estimate the net CO_2 emission reductions due to project

[6] In case the efficiency of the power plant improves due to retrofitting or replacement, the general guideline is to select the lowest efficiency, which existed before retrofitting/replacement.

$$C_{ernet} = C_{er} - (C_{er1} + C_{er2}) \quad \textbf{(16)}$$

where

C_{ernet} = net CO_2 emission reductions due to the project
C_{er} = CO_2 emission reductions in the boiler per day
C_{er1} = CO_2 emissions in case of captive generation
C_{er2} = CO_2 emissions in case of external grid supply

Effect of future retrofitting on baseline and project emissions:
The following test should be applied while monitoring the effect of future retrofitting within the project boundary (change in output level, process change, equipment change *etc.* affecting specific steam consumption) on baseline and project emissions.

The following question should be asked if retrofit measures reduce the steam consumption within the project boundary.

Question: Does retrofitting reduce the steam consumption of the CDM project activity? (I.e. there is a reduction in estimated project emissions, though not caused by the CDM project activity itself.)
Action: The enhanced steam saving due to the impact of retrofit on CDM project activity needs to be estimated and deducted from claimed emission reductions.

Approved monitoring methodology AM0018

"Monitoring methodology for steam optimization systems"

Source

This methodology is based on the 'Energy efficiency project by modification of CO_2 removal system of Ammonia Plant to reduce steam consumption', India, whose baseline study, monitoring and verification plan and project design document were prepared by Indo Gulf Fertilisers Ltd. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0037-rev: "Energy efficiency project by modification of CO_2 removal system of Ammonia Plant to reduce steam consumption" on http://cdm.unfccc.int/methodologies/approved.

Applicability

This methodology is applicable to steam optimization projects in production processes with homogeneous and relatively constant outputs with continuous monitoring of steam output.

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM0018 ("Baseline methodology for steam optimization systems").

Monitoring Methodology

The monitoring methodology requires monitoring of the following:

- The output rate is to be monitored shift-wise (for continuous processes) or batch-wise (for batch processes);
- The steam consumption rate for the process, where the optimisation has taken place, needs to be monitored shift-wise (for continuous processes) or batch-wise (for batch processes);
- Boiler efficiency (see below for different monitoring methodologies);
- Steam enthalpy (see below for details);
- Additional electricity consumption due to the project activity needs to be monitored shift-wise (for continuous processes) and batch-wise (for batch processes).[7];
- The fuel composition analysis and calorific value.

The following methods can be used to estimate boiler efficiency. Depending upon the method, the monitoring parameters are different.

Direct Boiler Efficiency Method (Input-Output Method):
The following parameters need to be monitored.

- Input fuel to the boiler (by fuel meter, level gauge or by weighing balance - in case of solid fuels - or any other method);
- Output steam of boiler (by steam meter). This steam is different than the steam consumed in the CDM project activity.

[7] In case of non-availability of monitoring facility of electrical equipment, the nameplate rating can be used as a basis for calculation of power consumption.

The boiler efficiency is to be estimated as follows:

$$\eta_{boiler} = E_s \div E_i \tag{17}$$

where

η_{boiler}	= Efficiency of the boiler
E_s	= Enthalpy of steam (kCal/kg)
E_i	= Input energy of fuel (kCal/hr)

$$E_s = E_{net} \text{ x } S \tag{18}$$

where

E_s	= Enthalpy of steam (kCal/hr)
E_{net}	= Net enthalpy of steam monitored as given ahead (kCal/kg). .
S	= Steam flow monitored by flow meter (kg/hr)

$$E_i = NCV_{fuel} \text{ x } F \tag{19}$$

where

E_i	= Input energy of fuel (kCal/hr)
NCV_{fuel}	= Net Calorific Value of Fuel monitored as gived ahead (kCal/kg)
F	= Fuel consumption rate monitored as given ahead (kg/hr).

Indirect Boiler Efficiency Method (Input-loss Method):
Estimating boiler efficiency using the indirect method should be done as per British Standard BS-845. The following parameters need to be monitored. For calculations of efficiency based on following monitored (and assumed radiation losses) parameters, please refer BS-845.

- Excess air or % Oxygen in dry flue gas, % Carbon Monoxide in dry flue gas, Flue Gas temperature need to be monitored (on regular intervals or continuously through DCS);
- In case of solid fuels, heat loss due to unburnt fuel in bottom ash and fly ash loss needs to be monitored. The bottom ash weight measurements in grate and fly ash weight measurement collected in cyclone needs to be done. The calorific value of bottom ash and fly ash needs to be tested separately in an in-house or external laboratory;
- Monitoring of combustion air temperature will be done, particularly in case combustion air-preheater is provided to boiler;
- Monitoring of moisture in air needs to be conducted.

Note: In case of mix fuel (generally mix solid fuel), the only method possible for efficiency estimation is ‘Direct Efficiency’ method, because fuel flow needs to be monitored in such case. Indirect efficiency method cannot be applied, because flue gas analysis will be very difficult in case of mix fuel.

Steam enthalpy
The following parameters will be monitored to evaluate the net steam enthalpy:

- Monitoring of enthalpy of steam needs to be done by recording generation pressure and temperature. Refer to steam tables for the enthalpy of steam at given pressures and temperatures;
- Monitoring of boiler Feed Water (FW) temperature needs to be conducted (before de-aerator and economizer). The mass flow of feed water (kg/hr) can either be directly measured using flow meters or an estimated or metered quantity of blow-down can be added in the steam flow to arrive

at the feed water flow. The enthalpy of FW can be estimated by multiplying the mass flow by the specific heat (1) and temperature (Deg C) of FW;

- The net enthalpy can be estimated by subtracting the enthalpy of FW from the enthalpy of steam.

Parameters to be monitored

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
Parameters to determine Specific Steam Consumption Ratio (SSCR)									
2.1	Output Rate	Output of process area per shift/ batch	Kg / shift or any other	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Measured by automatic or manual weighing balance or by volume in the plant premises to the best accuracy and will be monitored at the end of shift/batch (either manually or through DCS)
2.2	Steam Flow Rate	Steam flow in process area per shift/ batch	Kg/shift	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Measured by steam meter in the plant premises to the best accuracy and will be monitored bend of shift/batch (either manually or through DCS)
2.3	Additional Electricity Consumption (if any)	Electrical Consumption of additional load per hour	KWh/shift	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Monitored by kWh recording meter at the end of shift/batch (either manually or through DCS). In case meter not available, nameplate motor rating to be multiplied by no. of shift/ batch hours.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
2.4	Fuel hours (not needed if fuel consumption is measured in case of direct efficiency estimation)	Hours of each fuel in boiler	Hrs.	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Monitored based on shift logbooks, for change in fuel and time of change.
Parameters related to steam enthalpy									
2.5	Steam temperature	Temperature of steam	Deg C	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Monitored by temperature indicator at the end of shift/batch (either using instantaneous instrument or through DCS).
2.6	Steam pressure	Pressure of steam	Kg/sqcm(g)	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Monitored by pressure gauge at the end of shift/batch (either using instantaneous instrument or through DCS).
2.7	Feed water temperature	F.W. temperature per shift/ batch	Deg C	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Monitored by temperature indicator at the end of shift/batch.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
2.8	Feed water flow or blowdown water flow	Boiler feed water flow or blowdown water flow per shift/ batch	kg/shift	m	Every shift in continuous process and every batch in batch process	100%	paper	Crediting period plus 2 years	Monitored by flow recording meter at the end of shift/batch. Or blow down level indicator in case of one time blow down at the end of shift (and not continuous blow down)
Parameters related to boiler efficiency estimation by indirect method									
2.9	% Oxygen in dry flue gas	% Oxygen in dry flue gas	% on mole basis.	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Monitored by Electrochemical Analyzer/ Orsat Apparatus/ Zirconia Analyser at the end of month.
2.10	% CO in dry flue gas	% CO in dry flue gas	% on mole basis.	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Monitored by Electrochemical Analyzer/ Orsat Apparatus/ Zirconia Analyser at the end of month.
2.11	Bottom ash quantity (in case of solid fuel)	Bottom ash quantity	In Kgs or tonnes	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Monitored by weighing balance every month. (Refer guidelines on boiler efficiency monitoring)
2.12	Fly ash quantity (in case of solid fuel)	Fly ash quantity	In Kgs or tonnes	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Monitored by weighing balance every month. (Refer guidelines on boiler efficiency monitoring)

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
2.13	Flue Gas temperature	Flue Gas temperature	Deg C	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Monitored by temperature indicator at the end of month. (Refer guidelines on boiler efficiency monitoring)
2.14	Combustion air temperature	Combustion air temperature	Deg C	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Monitored by temperature indicator at the end of month. (Refer guidelines on boiler efficiency monitoring)
2.15	Moisture in combustion air	Moisture in combustion air	Kg moisture /kg air	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Monitored by humidity meter or hygrometer or drybulb and wetbulb temperature indicator and referring psychrometric chart at the end of month. (Refer guidelines on boiler efficiency monitoring)
2.16	Net Calorific Value of Bottom Ash (in case of solid fuel only)	Net Calorific value of fuel.	KCal/kg	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Ash tested by in-house or external reliable laboratory. (Refer guidelines on boiler efficiency monitoring)

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
2.17	Net Calorific Value of Fly Ash (in case of solid fuel only)	Net Calorific value of fuel.	KCal/kg	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Ash tested by in-house or external reliable laboratory. (Refer guidelines on boiler efficiency monitoring)
Parameters related to boiler efficiency estimation by direct method									
2.18	Steam Generation of Boiler	Steam Generation of Boiler	Kg/hr	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Measured by steam meter in the plant premises to the best accuracy (either manually or through DCS). (Refer guidelines on boiler efficiency monitoring)
2.19	Fuel consumption	Fuel consumption	Kg/hr or NM_3/hr	m	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Measured by fuel meter/level gauge/weighing balance or any other method in the plant premises to the best accuracy (either manually or through DCS) (Refer guidelines on boiler efficiency monitoring)

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data to be kept?	Comment
Fuel Related Parameters									
2.20	Net Calorific Value of Fuel	Gross and Net Calorific value of fuel.	KCal/kg	m	With every delivery of fuel. (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Fuel tested for each delivery by in-house or external reliable laboratory. (Refer guidelines on boiler efficiency monitoring)
2.21	Ultimate Analysis of fuel	Elemental percentage on weight basis	Kg or kg-mole	m	With every delivery of fuel. (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Fuel tested for each delivery by in-house or external reliable laboratory. (Refer guidelines on boiler efficiency monitoring)
Other Parameters									
2.22	Boiler efficiency	Boiler efficiency	%	e	Monthly (Refer guidelines on boiler efficiency monitoring)	100%	paper	Crediting period plus 2 years	Either by direct method or based on BS-845 standard boiler flue gas losses and bottom and fly ash losses (for solid fuels only) to be estimated and efficiency to be determined. Radiation losses assumed constant.(Refer guidelines on boiler efficiency monitoring)
2.23	Retrofit	Event	-	m	As and when occurs.	100%	paper	Crediting period plus 2 years	Follow Retrofit Monitoring Test as given in this methodology.

Quality Control (QC) and Quality Assurance (QA) Procedures

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures * are or are not being planned
2.1	Low	Yes	The QA procedure needs to be planned because the monitoring and selection of representative data from total data is important for accurate emission reduction calculations.
2.2	Low	Yes	The QA procedure needs to be planned because the monitoring and selection of data corresponding to representative output is important for accurate emission reduction calculations.
2.3	Low	Yes	The QA procedure needs to be planned because the monitoring and selection of reliable data corresponding to emission factor due to electricity consumption is important for accurate emission reduction calculations.
2.4	Low	No	There is no procedure required for the measurement of hours of fuel use.
2.5	Low	No	There is no procedure required for the measurement of temperature of steam.
2.6	Low	No	There is no procedure required for the measurement of pressure of steam.
2.7	Low	No	There is no procedure required for the measurement of temperature of feed water.
2.8	Low	No	There is no procedure required for the measurement of flow of feed water or blow down.
2.9	Low	Yes	The measurement of %Oxygen in dry flue gas requires proper understanding of instrument and method of drawing flue gas sample. A procedure should be defined based on type of instrument used.

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures * are or are not being planned
2.10	Low	Yes	The measurement of %CO in dry flue gas requires proper understanding of instrument and method of drawing flue gas sample. A procedure should be defined based on type of instrument used.
2.11	Low	Yes	The weighing of bottom ash is a skillful process, since errors in ash collection may lead to inaccuracies. Procedure is needed for this activity
2.12	Low	Yes	The collection of fly ash from cyclone and its weighing is a skillful process, since errors in ash collection may lead to inaccuracies. Procedure is needed for this activity
2.13	Low	No	There is no procedure required for the measurement of temperature of flue gas.
2.14	Low	No	There is no procedure required for the measurement of temperature of combustion air.
2.15	Low	Yes	The value of dry bulb temperature and wet bulb temperature of air monitored by psychrometer. Based on these values the psychrometric charts should be referred to find out air moisture. Therefore a procedure is required for measurements and estimations.
2.16	Low	Yes	If in-house laboratory is used, the testing methodology should be defined.
2.17	Low	Yes	If in-house laboratory is used, the testing methodology should be defined.
2.18	Low	No	There is no procedure required for the measurement of flow of steam.
2.19	Low	No	There is no procedure required for the measurement of consumption of fuel.
2.20	Low	Yes	If in-house laboratory is used, the testing methodology should be defined.

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures * are or are not being planned
2.21	Low	Yes	If in-house laboratory is used, the testing methodology should be defined.
2.22	Low	Yes	The estimation of boiler efficiency based on measured parameters is very critical parameter for estimation of emission reduction. The methodology should be derived from British Standard BS-845.
2.23	Low	Yes	For retrofit monitoring retrofit test should be followed as given in methodology. The responsibility for monitoring of retrofit should be defined clearly.