Draft revision to the approved baseline and monitoring methodology AM0066

"GHG emission reductions through waste heat utilisation for pre-heating of raw materials in sponge iron manufacturing process"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on the proposed new methodology NM0231 "Baseline methodology for green house gas reductions through waste heat and / or waste gas recovery and utilisation for pre-heating of raw material(s) in furnace / kiln operations" prepared by Hare Krishna Metallic Private Limited, India.

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

- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion";
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- "Combined tool to identify the baseline scenario and demonstrate additionality";
- "Tool to calculate the emission factor for an electricity system".

For more information regarding the proposed new methodology and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"

and

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

Definitions

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

Raw material. Raw material is defined as unfinished goods used in the manufacture of an intermediate / final product, which is recorded on a company's balance sheet in the current assets section. Raw material does not include water, steam and air.

Product. Product is the output from the furnace(s) / kiln(s) being part of the project activity. The output may be an intermediate or finished product.

Furnace. Furnace is equipment where a phase change (e.g. melting) of the raw material(s) undergoing heat treatment takes place. For the purpose of this methodology the term 'furnace' does not include boiler furnaces, which are used for the steam generation.

Kiln. Kiln is defined as equipment where no phase change reaction of the raw material undergoing heat treatment takes place (e.g. a reduction process).

Waste heat. Waste heat is by-product heat of the furnace / kiln operation.

Production output. Production output refers to the total output from the production process including rejects.

Reject: Output of the production process, which does not meet quality requirements.

Applicability

This methodology applies to project activities that utilise waste heat released from furnace(s) / kiln(s) in a sponge iron manufacturing facility to pre-heat raw material(s) before feeding it into the furnace(s) / kiln(s). It covers both existing[1] and Greenfield facilities.

The methodology is applicable under the following conditions:

- The project activity is implemented either for an individual furnace / kiln or a group of furnaces / kilns producing the same type of output in a sponge iron manufacturing facility;
- The methodology is not applicable to processes wherein scrap/product rejects are used in the furnace(s) / kiln(s);
- Waste heat utilized under the project activity should be generated only from the same furnace(s) / kiln(s) that are part of the project activity and not from any other source;
- The raw material(s) to be preheated under the project activity is limited only to solid matter fed to furnace(s) / kiln(s), which operate in continuous or batch process;
- The raw material(s) after passing through the preheating equipment installed under the project activity is directly fed to the furnace(s) / kiln(s);
- For existing facilities, historical data on fossil fuel and electricity consumption, composition of raw material(s) used and final product (in particular the percentage of metallisation) and production levels shall be available for at least three most recent years prior to the start of the project activity. These data have to be included in the CDM-PDD and validated by a DOE;
- There should be a possibility to feed the raw material(s) directly to the furnace / kiln, without the pre-heater equipment, to facilitate the establishment of the baseline emission factor;
- A list of the parameters that may affect specific energy consumption (e.g. chemical composition and physical state of raw materials and the product output, including the percentage of the metallisation; production output level; type and quality of fossil fuels used) shall be provided in the CDM-PDD and validated by the DOE;

[1] Existing facility is a facility that has been in operation for at least three years at the time of validation of the project activity.

- The project activity should not lead to an increase in remaining lifetime of existing equipment if it is implemented in an existing facility;
- Waste heat that is generated under abnormal operation (emergencies, shut down) of the facility shall not be accounted for;
- For existing facilities, the waste heat utilised in the project activity was not used and would not be used in the absence of the project activity[2]. This shall be proved by either one of the following:
    - **Energy balance** of relevant sections of the plant to prove that the waste heat was not a source of energy before the start of the implementation of the project activity. For the energy balance the representative process parameters are required. The energy balance must demonstrate that the waste heat was not used;
    - **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) was 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 using waste heat and sold to other facilities and / or the grid. The bills and financial statements should be audited by competent authorities;
    - **Process plant** manufacturer's original specification / information, schemes and diagrams from the construction of the facility could be used as an estimate of quantity and energy content of waste gas / heat produced for rated plant capacity / per unit of product produced;
    - **Site visit by DOE** prior to the start of the project activity may include the check that no equipment for waste heat recovery and utilization was installed at the facility.

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

II. BASELINE METHODOLOGY PROCEDURE

Identification of the baseline scenario and demonstration of additionality

Project participants shall apply the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality".

In applying Step 1a, alternative baseline scenarios should be separately determined regarding:

(a) What would happen to the waste heat in the absence of the project activity?
(b) How would the raw materials be pre-heated in the absence of the project activity?

(a) Plausible alternative scenarios for the utilisation of the waste heat may include, but are not limited to the following:

[2] In case the waste heat was utilized for electricity generation and / or other purposes prior to the start of the project activity, project participants should propose a revision to this methodology.

W1 Waste heat utilization for the power generation for captive use and / or export to the grid;
W2 Waste heat utilization for pre-heating of any solid raw material other than that used in the project activity;
W3 Waste heat utilization for heating air and / or water and / or any other fluid,[3] which is further utilized in the process /space heating / cooling or any other application;
W4 The release of waste heat from the furnace(s) / kiln(s) into the atmosphere. For existing facilities this may represent the continuation of the current practice;
W5 Waste heat utilization for pre-heating of raw materials without being registered as a CDM project activity.

(b) Plausible alternative scenarios for pre-heating of raw materials may include, but are not limited to the following:

R1 Pre-heating of raw materials using fossil fuels;
R2 Pre-heating of raw materials using renewable sources, e.g. renewable biomass;
R3 Pre-heating of raw materials using the waste heat generated by the furnace(s) / kiln(s) without being registered as a CDM project activity;
R4 Feeding of raw materials to the furnace(s) / kiln(s) without pre-heating.

The suggested lists of alternative scenarios are only indicative. Project participants should include any other plausible alternatives that are relevant in their specific project context and / or eliminate some of the listed above, based on documented evidence.

From Sub-Step 1b to Step 4 project participants should follow the guidelines included in the above-mentioned methodological tool.

The methodology is only applicable to a project activity, where the combination of alternatives W4 and R4 represents the most likely baseline scenario.

In applying Step 3 of the tool, the investment analysis shall use the net present value (NPV) as an indicator, and explicitly state the following parameters for each alternative:

- Investment requirements (including break-up into major equipment costs, installation, required R&D activities);
- A discount rate appropriate to the country and sector (use government bond rates, increased by a suitable risk premium to reflect the project type, as substantiated by an independent (financial) expert);
- Current price and expected future price of the fuels and raw materials used, energy and other products. (As a default, the current prices may be assumed as future prices. Where project participants intend to use future prices that are different from current prices, the future prices have to be substantiated by a public and official publication from a governmental body or an intergovernmental institution);
- Revenues related to the increased production capacity of the facility due to the installation of the pre-heater;
- Operation and maintenance costs of the manufacturing facility.

[3] For the purpose of this methodology the term 'fluid' refers to both gases and liquids.

The information on all the above factors as well as assumptions shall be explicitly stated in the CDM-PDD.

If the project activity is to be implemented in a Greenfield facility, Step 3 of the tool is mandatory and scenario W5 along with other alternative scenarios remaining after Step 2 shall be included in the investment analysis.

Project participants shall demonstrate that the project activity is not a common practice using Step 4 of the tool. Analyse sponge iron plants that have been built within the last 5 years in the relevant geographical area. The geographical area should be selected in such a manner that it includes at least 5 recently built sponge iron plants. Registered CDM project activities shall not to be included in this analysis. By default the host country can be taken as the geographical area. If it contains less than 5 recently built sponge iron plants, the geographical area should be extended to the neighboring non-Annex I countries.

If at least 50% of sponge iron plants in the geographical area have a pre-heater installed, the project activity shall be considered a common practice and as such is not additional. Provide documented evidence and quantitative information on the above analysis in the CDM-PDD.

Project boundary

The **spatial extent** of the project boundary encompasses the furnace(s) / kiln(s), the raw material pre-heating equipment and any auxiliary process equipment using fossil fuel / electricity.

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

Table 1: Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Fossil fuel consumption by furnace / kiln and auxiliary equipment	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Electricity consumption by furnace / kiln and auxiliary equipment	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project Activity	Fossil fuel consumption by furnace / kiln, pre-heating equipment and auxiliary equipment	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Electricity consumption by furnace / kiln, pre-heating equipment and auxiliary equipment	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

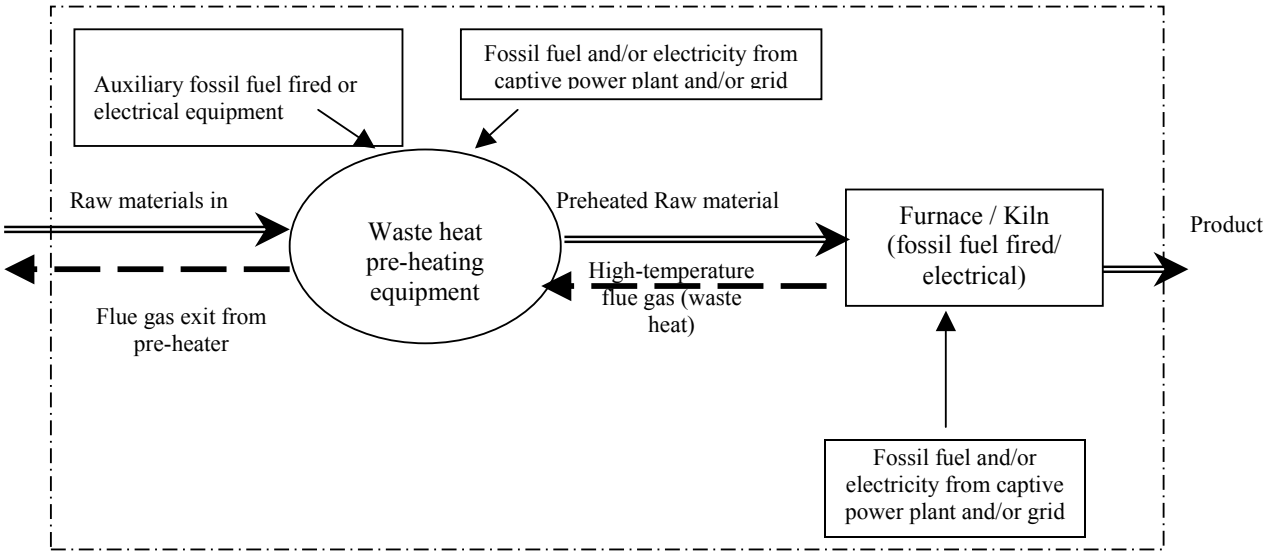

Figure 1: Schematic representation of the project boundary

Project emissions

Project emissions include:

- CO_2 emissions from combustion of fossil fuel in the furnace(s) / kiln(s), if applicable;
- CO_2 emissions from consumption of electricity in the furnace(s) / kiln(s), if applicable;
- CO_2 emissions from use of fossil fuels and / or electricity in the pre-heating equipment;
- CO_2 emissions from use of fossil fuels and / or electricity in the auxiliary equipment.

Project emissions are calculated as follows:

$$PE_y = PE_{FC,y} + PE_{EC,y} \quad \textbf{(1)}$$

Where:

PE_y = Project emissions in year *y* (t CO_2e/year)

$PE_{FC,y}$ = Project emissions from fossil fuel combustion in the furnace(s) / kiln(s), pre-heating and auxiliary equipment in year *y* (t CO_2e/year)

$PE_{EC,y}$ = Project emissions from consumption of electricity, generated at a captive power plant and / or imported from the grid,[4] in the furnace(s) / kiln(s), pre-heating and auxiliary equipment in year *y* (t CO_2e/year)

[4] The grid is defined as in the latest approved version of the "Tool to calculate the emission factor for an electricity system".

Project emissions from fossil fuel consumption

$PE_{FC,y}$ should be calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion", where the process *j* corresponds to combustion of fossil fuel in the furnace(s) / kiln(s), pre-heating and auxiliary equipment respectively.

Project emissions from electricity consumption

$PE_{EC,y}$ should be calculated using the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

Baseline emissions

Furnace(s) / kiln(s) are designed with their main source of energy as either fossil fuel or electricity. Fossil fuel and / or electrical energy are also required for auxiliary / supplementary firing and / or for a number of auxiliary electrical equipments connected to the furnace / kiln.

1. *Ex ante* estimation of the baseline specific energy consumption

For the purpose of the CDM-PDD elaboration, the baseline emissions are calculated based on fixed *ex ante* specific energy consumption values as per the following steps. However, if the *ex ante* specific energy consumption value for the baseline as hereafter determined is more conservative than the one calculated *ex post* as determined in 2 below, it should be utilized for emission reductions calculations.

Fixed *ex ante* specific energy consumption values

Specific energy consumption can correspond to thermal energy (TJ/t of product) and / or electrical energy (kWh/t of product). The fixed *ex ante* specific energy consumption values are determined as follows:

- For existing facilities, the calculation of specific energy consumption is based on historical data for the last three years prior to the start of the project activity;
- For new installations, the design specific energy consumption provided by the manufacturer is considered as baseline specific energy consumption.

Historical specific energy consumption values for existing facilities

In this case, historical data on specific energy consumption should be available for at least three years prior to the start of the project activity.

(a) Thermal energy

$$BSEC_{hist,th} = \text{Average of the three lowest values of } BSEC_{hist,monthly/batch,th,m} \quad \textbf{(2)}$$

Where:

$BSEC_{hist,th}$ = Baseline specific thermal energy consumption established from historical data, (TJ/t of product)

$BSEC_{hist,monthly/batch,th,m}$ = Monthly (for continuous processes) or batch wise historical specific thermal energy consumption in month / batch *m,* (TJ/t of product)

m = All months / batches considered in determination of the historical specific energy consumption

$$BSEC_{hist,monthly/batch,th,m} = TFE_{hist,m} / P_{hist,m} \quad \textbf{(3)}$$

Where:

$TFE_{hist,m}$ = Total energy consumption from the fossil fuel combustion (in the furnace / kiln and auxiliary equipment) in month / batch *m*, (TJ)

$P_{hist,m}$ = Production output for month / batch *m*, (t of product)

$$TFE_{hist,m} = \sum_{j} Q_{hist,j,m} \cdot NCV_{hist,j} \quad \textbf{(4)}$$

Where:

$Q_{hist,j,m}$ = Quantity of fossil fuel *j* consumed in month / batch *m*, (t or m^3)

$NCV_{hist,j}$ = Net calorific value per mass or volume unit of fossil fuel *j,* (TJ/t or m^3)

j = Index for fossil fuels used within the project boundary. This includes fossil fuel(s) combusted as the main energy source in the furnace(s) /kiln(s) and fossil fuel(s) fired in auxiliary equipment (e.g. for transportation within the project boundary)

(b) Electrical energy

$BSEC_{hist,el}$ = Average of the three lowest values of $BSEC_{hist,monthly/batch,el,m}$ **(5)**

Where:

$BSEC_{hist,el}$ = Baseline specific electrical energy consumption established from historical data, (kWh/t of product)

$BSEC_{hist,monthly/batch,el,m}$ = Monthly (for continuous processes) or batch wise baseline specific electrical energy consumption in month / batch *m* (kWh/t of product)

m = All months / batches considered in determination of the historical specific energy consumption

$$BSEC_{hist,monthly/batch,el,m} = TEE_{hist,m} / P_{hist,m} \quad \textbf{(6)}$$

Where:

$TEE_{hist,m}$ = Total electrical energy consumption (in the furnace / kiln and auxiliary equipment within the project boundary) in month / batch *m*, (kWh). This includes electricity generated by an on-site captive power plant and imported from the grid

$P_{hist,m}$ = Production output for month / batch *m*, (t of product)

Design estimate of specific energy consumption values for new installations

In the case of project activity being implemented in a Greenfield facility, project participants shall use design / nameplate manufacturer specifications of the furnace / kiln used in the project activity as provided by the equipment supplier. Design / nameplate parameters for specific energy consumption shall be adjusted for the actual product of the facility and the type of raw materials used.

The design estimate will result in the following values:

$BSEC_{design,th}$	=	Baseline design specific thermal energy consumption of the furnace / kiln including all fossil fuel consumption in the project boundary, (TJ/t of product)
$BSEC_{design,el}$	=	Baseline design specific electrical energy consumption of the furnace / kiln including all electricity consuming equipment in the project boundary, (kWh/t of product)

2. *Ex post* calculation of the baseline specific energy consumption during the project activity

The baseline specific energy consumption will be calculated using the following steps:

2.1. Identification of all the main parameters, which can affect the baseline specific energy consumption. A configuration *i* is defined as a possible combination of the fuels and raw materials used at the facility as well as other parameters[5] affecting specific energy consumption, which are in place during a certain period of time.

2.2. Determination of initial values for baseline and project specific energy consumption as follows:

- The initial configuration *ini* has to be determined, which corresponds to the combination of fuels and raw materials used at the facility at the start of the project activity;
- At the start of the project activity baseline thermal and electrical energy consumption are measured on a daily basis for one week. The lowest among the measured values is taken as initial values of the baseline thermal and electrical energy consumption ($BSEC_{ini,th}$ and $BSEC_{ini,el}$ respectively). The baseline specific energy consumption has to be measured using by-pass, i.e. raw materials are delivered directly to the furnace(s) / kiln(s) without pre-heating in the heat recovery exchanger (pre-heating equipment);
- After the completion of the one-week measurement of the initial values for baseline thermal and electrical energy consumption, project thermal and electrical energy consumption are measured on a daily basis for one week. The average of the measured values is taken as the initial values for the project thermal and electrical energy consumption ($PSEC_{ini,th}$ and $PSEC_{ini,el}$ respectively). In this case raw materials are delivered to the furnace(s) / kiln(s) after pre-heating in the heat recovery exchanger.

[5] If parameters other than the fuel quality and the raw materials quality are identified as having impact on specific energy consumption, project participants should propose a procedure to take these parameters into account through a revision of the approved methodology.

2.3. Determination of the initial value of ratio R for thermal energy and electrical energy consumption. R is defined as:

$$R_{ini,th} = BSEC_{ini,th}/PSEC_{ini,th} \quad \textbf{(7)}$$

$$R_{ini,el} = BSEC_{ini,el}/PSEC_{ini,el} \quad \textbf{(8)}$$

Where:

$R_{ini,th}$	=	Ratio for thermal specific energy consumption defined at the start of the project activity
$R_{ini,el}$	=	Ratio for electrical specific energy consumption defined at the start of the project activity
$BSEC_{ini,th}$	=	Baseline specific thermal energy consumption established at the start of the project activity, (TJ/t of product)
$PSEC_{ini,th}$	=	Project specific thermal energy consumption established at the start of the project activity, (TJ/t of product)
$BSEC_{ini,el}$	=	Baseline specific electrical energy consumption established at the start of the project activity, (kWh/t of product)
$PSEC_{ini,el}$	=	Project specific electrical energy consumption established at the start of the project activity, (kWh/t of product)

Values $R_{ini,th}$ and $R_{ini,el}$ are used for the period of time until the initial configuration *ini* changes as described below.

2.4. Continuous monitoring of the project specific energy consumption (PSEC) for thermal energy as well as for electrical energy use on a daily basis.

2.5. It is considered that a new configuration *i* is in place, when the project specific energy consumption (either thermal or electric) increases or decreases by more than 5% in comparison with the previously defined value (i.e. $PSEC_{ini,th}$ and $PSEC_{ini,el}$ at the start of the project activity or $PSEC_{i,th}$ and $PSEC_{i,el}$ if the configuration *i* has changed previously). To determine that the configuration *i* changed, the increase / decrease in the project specific energy consumption has to be observed for at least one week. Once the configuration *i* changes, new ratios $R_{i,th}$ and $R_{i,elh}$ are to be determined by measuring BSEC and PSEC under the configuration *i*. $BSEC_{i,th}$ and $BSEC_{i,el}$ are measured for one day after the change of the configuration *i* using by-pass of the pre-heating equipment as described in 2.2 above.

Two main parameters (the fuel quality and the raw materials quality) are likely to affect specific energy consumption. The fuel quality for gas and liquid fuels are highly consistent, with insignificant variation. The quality of the raw material and solid fuel would be normally consistent for an industry if they were purchased from the same geographical area of mining. Specific energy consumption is therefore not likely to change very often. Such a change may take effect when the project facility starts utilising a new raw material and / or fuel with different characteristic and / or other parameters affecting specific energy consumption changed (i.e. due to regular maintenance or relining of the kiln).

$$R_{i,th} = BSEC_{i,th}/PSEC_{i,th} \quad \textbf{(9)}$$

$$R_{i,el} = BSEC_{i,el}/PSEC_{i,el} \quad \textbf{(10)}$$

Where:

$R_{i,th}$	=	Ratio for thermal specific energy consumption defined for configuration *i*
$R_{i,el}$	=	Ratio for electrical specific energy consumption defined for configuration *i*
$BSEC_{i,th}$	=	Baseline specific thermal energy consumption defined for configuration *i*, (TJ/t of product)
$PSEC_{i,th}$	=	Project specific thermal energy consumption defined for configuration *i*, (TJ/t of product)
$BSEC_{i,el}$	=	Baseline specific electrical energy consumption defined for configuration *i*, (kWh/t of product)
$PSEC_{i,el}$	=	Project specific electrical energy consumption defined for configuration *i*, (kWh/t of product)
i	=	All configurations corresponding to combinations of fuels and raw materials used in the furnace(s)/kiln(s) and/or other parameters defined under 2.1 during year *y*.

Values $R_{i,th}$ and $R_{i,el}$ are used for the period of time until the configuration *i* changes again.

2.6 The amount of the product P_i realized under the configuration *i* is to be monitored.

2.7 Determination of annual average values $R_{av,th,y}$ and $R_{av,el,y}$:

$$R_{av,th,y} = \frac{\sum_i R_{i,th} * P_i}{\sum_i P_i} \quad \textbf{(11)}$$

$$R_{av,el,y} = \frac{\sum_i R_{i,el} * P_i}{\sum_i P_i} \quad \textbf{(12)}$$

Where:

$R_{av,th,y}$	=	Average annual ratio for thermal specific energy consumption in year *y*
$R_{av,el,y}$	=	Average annual ratio for electrical specific energy consumption in year *y*
$R_{i,th}$	=	Ratio for thermal specific energy consumption defined for configuration *i*
$R_{i,el}$	=	Ratio for electrical specific energy consumption defined for configuration *i*
P_i	=	Amount of product produced in configuration *i*, (t of product)
i	=	All possible configurations corresponding to changes in quality of fuels and raw materials used in the furnace(s) / kiln(s) and / or other parameters defined under 2.1 during year *y*

~~2.8 Determination of the annual average project specific energy consumption during year *y*:~~

~~$PSEC_{th,y} = TFE_y / P_{y,min}$ (13)~~

~~$PSEC_{el,y} = TEE_y / P_{y,min}$ (14)~~

~~Where:~~

~~$PSEC_{th,y}$ = Project specific thermal energy consumption for year *y* (TJ/t of product)~~

~~TFE_y = Total energy consumption from fossil fuels combustion in the furnace / kiln and auxiliary equipment in the year *y* (TJ). Calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".~~

~~$PSEC_{el,y}$ = Project specific electrical energy consumption for year *y* (kWh/t of product)~~

~~TEE_y = Total electrical energy consumption in the furnace / kiln and auxiliary equipment in year *y*, (TJ). Calculated using the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"~~

~~$P_{y,min}$ = Production output for the year *y*, (t of product)~~

~~$$P_{y,min} = \min\{\sum_i P_i ; P_{opt}\} \quad (15)$$~~

~~Where:~~

~~P_i = Amount of product produced in configuration *i*, (t of product)~~

~~P_{opt} = Capacity of production of the product per year as per design specification of the furnace / kiln, without the pre-heater (t of product / year)~~

2.9 Determination of the annual average baseline specific energy consumption during year *y:*

$$BSEC_{av,th,y} = \frac{R_{av,th,y} * TFE_y}{\sum_i P_i} \quad (13)$$

~~$$BSEC_{av,el,y} = \frac{R_{av,el,y} * TFE_y}{\sum_i P_i} \quad (17)$$~~

$$BSEC_{av,el,y} = \frac{R_{av,el,y} * TEE_y}{\sum_i P_i} \quad (14)$$

Where:

$BSEC_{av,th,y}$ = Average annual baseline specific thermal energy consumption for year *y* (TJ/t of product)

$BSEC_{av,el,y}$ = Average annual baseline specific electrical energy consumption for year *y* (kWh/t of product)

TFE_y = Total energy consumption from fossil fuels combustion in the furnace / kiln and auxiliary equipment in the year *y* (TJ). Calculated using the latest approved version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

TEE_y = Total electrical energy consumption in the furnace / kiln and auxiliary equipment in year *y*, (TJ). Calculated using the latest approved version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"

P_i = Amount of product produced in configuration *i*, (t of product)

2.10 Determination of the annual baseline specific energy consumption during year *y:*

$$BSEC_{th,y} = \min\{BSEC_{av,th,y}; BSEC_{hist/design,th}\} \quad \textbf{(15)}$$

$$BSEC_{el,y} = \min\{BSEC_{av,el,y}; BSEC_{hist/design,el}\} \quad \textbf{(16)}$$

Where:

$BSEC_{th,y}$	=	Annual baseline specific thermal energy consumption for year *y* (TJ/t of product)
$BSEC_{el,y}$	=	Annual baseline specific electrical energy consumption for year *y* (kWh/t of product)
$BSEC_{av,th,y}$	=	Average annual baseline specific thermal energy consumption for year *y* (TJ/t of product)
$BSEC_{av,el,y}$	=	Average annual baseline specific electrical energy consumption for year *y* (kWh/t of product)
$BSEC_{hist/design,th}$	=	Baseline specific thermal energy consumption established from historical data for existing facilities or from design manufacturer's specifications for Greenfield project activities, (TJ/t of product)
$BSEC_{hist/design,el}$	=	Baseline specific electrical energy consumption established from historical data for existing facilities or from design manufacturer's specifications for Greenfield project activities, (kWh/t of product)

3. Calculation of baseline emissions

Baseline emissions are calculated as follows:

$$BE_y = BFE_y + BEE_y \quad \textbf{(17)}$$

Where:

BE_y	=	Baseline emissions in year *y,* (tCO_2e/year)
BFE_y	=	Baseline emissions from fossil fuels consumption in year *y,* (tCO_2e/year)
BEE_y	=	Baseline emissions from electricity consumption in year *y,* (tCO_2e/year)

$$BFE_y = BSEC_{th,y} \cdot P_y \cdot EF_{main/aux,y} \cdot 44/12 \quad \textbf{(18)}$$

Where:

$BSEC_{th,y}$	=	Annual baseline specific thermal energy consumption for year *y* (TJ/t of product)
P_y	=	Production output for the year *y*, (t of product)
$EF_{main/aux,y}$	=	Carbon emission factor per unit of energy of main or auxiliary fossil fuel in year *y*, (tC/TJ). Emission factors for the fossil fuels used should be obtained from reliable local or national data if available, otherwise country specific IPCC default values should be taken. If the furnace / kiln has fossil fuels as the main energy source, then the lowest emission factor of these fuels ($EF_{main,y}$) is used in equation (18). If the furnace / kiln has electricity as the main energy source, then the lowest emission factor of fossil fuels fired in auxiliary equipment ($EF_{aux,y}$) is used in equation (18).

$$BEE_y = BSEC_{el,y} \cdot P_y \cdot EF_{el,y} \cdot \frac{1}{1000} \quad \textbf{(19)}$$

Where:

$BSEC_{el,y}$	=	Annual baseline specific electrical energy consumption for year *y* (kWh/t of product)
P_y	=	Production output in year *y,* (t of product)
$EF_{el,y}$	=	CO_2 emission factor of the electrical energy source for operating furnace/kiln and its auxiliaries in year *y*, (tCO_2/ MWh)

For determining $EF_{el,y}$, one of the following approaches shall be applied:

(a) If the power source is captive power generation plant:

$$EF_{el,y} = EF_{captive,y} = \frac{EF_{CO2,captive,y}}{\eta_{captive}} \cdot \frac{44}{12} \cdot \frac{3.6}{1000} \quad \textbf{(20)}$$

Where:

$EF_{captive,y}$	=	Emissions factor for captive power generation plant in year *y*, (tCO2/MWh)
$EF_{CO2,captive,y}$	=	CO_2 emissions factor of fuel used in captive power generation, (tC/TJ). Emission factor for the fossil fuel used should be obtained from reliable local or national data if available, otherwise country specific IPCC default values should be taken.
$\eta_{captive}$	=	Efficiency of the captive power generation plant
44/12	=	Carbon to carbon dioxide mass conversion factor
3.6/1000	=	TJ to MWh conversion factor

If the captive power plant fires a mix of fuels, then $EF_{captive,\,y}$ is determined as a weighted average emission factor for the fuels used.

As a conservative approach to determine the captive power plant efficiency, project participants should use the higher and realistic value between the following two:

1. Measured efficiency during the monitoring year *y*; or
2. Manufacturer nameplate data for efficiency of the captive power plant.

(b) If the power source is the grid import:

$$EF_{el,y} = EF_{grid,y} \quad \textbf{(21)}$$

Where:

$EF_{grid,y}$	=	Grid emission factor in year *y*, (tCO2/MWh), calculated in accordance with the latest approved version of the "Tool to calculate the emission factor for an electricity system"

(c) If the power source includes both captive and imported power:

In this case the emission factor is calculated as a weighted average of the emission factors of the grid and the captive power plant:

$$EF_{el,y} = S_{grid,y} \cdot EF_{grid,y} + S_{captive,y} \cdot EF_{captive,y} \quad \textbf{(22)}$$

Where:

$S_{grid,y}$ = Share of the facility electricity demand supplied by the grid in year *y*, (%)
$S_{captive,y}$ = Share of the facility electricity demand supplied by the captive power plant in year *y*, (%)

Leakage

No leakage is considered under this methodology.

Emission reductions

Emission reductions are calculated as follows:

~~$ER_y = BE_y - PE_y$~~ **(23)**

$$ER_y = (BE_y - PE_y) \times (P_{y,\min} / P_y) \quad \textbf{(23)}$$

Where:

ER_y = Emission reductions in year *y*, (t CO_2e/year)
BE_y = Baseline emissions in year *y*, (t CO_2e/year)
PE_y = Project emissions in year *y*, (t CO_2e/year)
P_y = Production output for the year *y*, (t of product)

For existing plants

$$P_{y,\min} = \min\left[P_{hist,\max}, P_y\right] \quad \textbf{(24)}$$

Where:

$P_{hist,\max}$ = Maximum annual production in the historic production data vintage, t of product.
P_y = Production output for the year *y*, (t of product)

For new installations:

$$P_{y,\min} = \min\left[P_{opt}, P_y\right] \quad \textbf{(25)}$$

Where:

P_{opt} = Capacity of production of the product per year as per design specification of the furnace / kiln, without the pre-heater (t of product / year)

P_y = Production output for the year *y*, (t of product)

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

At the renewal of the crediting period, project participants shall assess the continued validity of the baseline scenario or update it as appropriate.

Furthermore, all relevant data contained under "Data and parameters not monitored" should be updated. Regarding the grid emission factor, the provisions in the latest approved version of "Tool to calculate the emission factor for an electricity system" on the update of the emission factor apply.

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / parameter:	$BSEC_{design, th}$
Data unit:	(TJ/t of product)
Description:	Baseline design specific thermal energy consumption of the furnace/kiln including all fossil fuel consumption in the project boundary
Source of data:	Design specifications from the furnace/kiln manufacturer
Measurement procedures (if any):	
Any comment:	The scanned copies of relevant pages of design specification will have to be published along with the CDM-PDD

Data / parameter:	$BSEC_{design, el}$
Data unit:	kWh/t of product
Description:	Baseline design specific electrical energy consumption including all electrical consuming equipments in the project boundary
Source of data:	Design specifications from the furnace / kiln manufacturer
Measurement procedures (if any):	For electrical fired furnace, data should be available in the form of kWh/t of product. For auxiliary equipments, if direct electrical energy (kWh) data are not available, the connected load (kW) multiplied by number of hours of operation (for production period – yearly /daily / batch wise) and load factor of 0.8, can be considered.
Any comment:	The scanned copies of relevant pages of design specification will have to be published along with the PDD

Parameter:	$P_{hist,m}$
Data unit:	t of product / month (for continuous processes) or batch
Description:	Production output for month (for continuous processes) or batch *m* considered from historic production data (t of product)
Source of data:	Production log book
Measurement procedures (if any):	As per standard production output measurements in the facility
Any comment:	QA/QC Procedure: As per ISO 9001 procedure using calibrated instruments. Records to be maintained for crediting period + two years thereafter

Parameter:	$Q_{hist,j,m}$
Data unit:	t or m3
Description:	Mass or volume unit of fossil fuel j consumed in month (for continuous processes) /batch m from historic production data (t or m3)
Source of data:	Production / Store log book
Measurement procedures (if any):	As per standard production input measurements in the facility (like weigh feeders / weigh bins / flow meters, etc.)
Any comment:	QA/QC Procedure: As per ISO 9001 procedure using calibrated instruments. Records to be maintained for crediting period + two years thereafter

Parameter:	$NCV_{hist,j}$
Data unit:	(TJ/t or m3)
Description:	Net calorific value per mass or volume unit of fossil fuel j consumed in the historic period considered (TJ/t or m3)
Source of data:	Local values (authorized lab reports, authorized local statistics) should be used wherever possible. If no such values are available, country-specific values should be used, if not, 2006 Revised IPCC values.
Measurement procedures (if any):	Tests reports from accredited labs for local value, if applicable
Any comment:	QA/QC Procedure: Cross check with fuel source specific local statistics. Records to be maintained for crediting period + two years thereafter

Parameter:	$TEE_{hist,m}$
Data unit:	kWh
Description:	Total electrical energy consumption (in the furnace / kiln and auxiliary equipment within the project boundary) in month / batch *m*, (kWh). This includes electricity generated by an on-site captive power plant and imported from the grid
Source of data:	Production log book or DCS/PLC systems
Measurement procedures (if any):	Onsite electrical energy meter readings
Any comment:	QA/QC Procedure: As per ISO 9001 procedure using calibrated instruments. Records to be maintained for crediting period + two years thereafter

Data / Parameter:	P_{opt}
Data unit:	t of product / year
Description:	Capacity of production of the product per year as per design specification of the furnace / kiln, without the pre-heater
Source of data:	Design specifications from the furnace / kiln manufacturer
Measurement procedures (if any):	Not applicable
Any comment:	This value is used to establish an acceptable deviation range (+/-5%) for parameters affecting specific energy consumption

Data / parameter:	$BSEC_{hist, th}$
Data unit:	(TJ/t of product)
Description:	Baseline historical specific thermal energy consumption of the furnace / kiln including all fossil fuel consumption in the project boundary
Source of data:	From plant historical data
Measurement procedures (if any):	
Any comment:	~~The scanned copies of relevant pages of design specification will have to be published along with the CDM-PDD~~

Data / parameter:	$BSEC_{hist, el}$
Data unit:	kWh/t of product
Description:	Baseline historical specific electrical energy consumption including all electrical consuming equipments in the project boundary
Source of data:	From plant historical data
Measurement procedures (if any):	For electrical fired furnace, data should be available in the form of kWh/t of product. For auxiliary equipments, if direct electrical energy (kWh) data is not available, the connected load (kW) multiplied by number of hours of operation (for production period – yearly / daily / batch wise) and load factor of 0.8, can be considered.
Any comment:	~~The scanned copies of relevant pages of design specification will have to be published along with the CDM-PDD~~

III. MONITORING METHODOLOGY

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

In addition, the monitoring provisions in the tools referred to in this methodology apply.

Data and parameters monitored

Data / parameter:	Check for modification (apart from routine maintenance) and / or change in raw material quality
Data unit:	
Description:	Official declaration that there was no modification (apart from the routine maintenance) in the furnace / kiln during the year. If there is any modification (apart from the routine maintenance) in the furnace / kiln during the year, the ratios $R_{i,th}$ and $R_{i,el}$ have to be re-determined.
Source of data:	Facility management records
Measurement procedures (if any):	N/A
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / Parameter:	Chemical composition and physical state of raw materials and final product
Data unit:	
Description:	Chemical composition and physical state of raw materials
Source of data:	Authorized lab reports
Measurement procedures (if any):	Not applicable
Monitoring frequency:	Monthly
Any comment:	

Data / Parameter:	NCV_j
Data unit:	(TJ/t or m3)
Description:	Type and quality of fossil fuels j used
Source of data:	Local values (authorized lab reports, authorized local statistics) should be used wherever possible. If no such values are available, country-specific values should be used, if not, 2006 Revised IPCC values.
Measurement procedures (if any):	Not applicable
Monitoring frequency:	Monthly
Any comment:	

Data / Parameter:	P_i
Data unit:	t of product
Description:	Actual production quantity reported from the furnace / kiln for the configuration *i* characterized by given raw material(s) and given fossil fuel(s)
Source of data:	Production log book / DCS records
Measurement procedures (if any):	As per standard production output measurements in the facility
Monitoring frequency:	Measured in a daily basis and consolidated each time the project specific energy consumption $PSEC_{i,th}$ vary more than 5%
QA/QC procedures:	The meters have to be calibrated as per manufacturer guidelines or annually, whichever is earlier. The daily / batch wise records can be crosschecked with the balance sheet reports.
Any comment:	

Data / Parameter:	$P_{y,min}$
Data unit:	t of product / year
Description:	Actual production quantity for the year *y*
Source of data:	Production log book / DCS records
Measurement procedures (if any):	As per standard production output measurements in the facility
Monitoring frequency:	Daily / batch wise
QA/QC procedures:	The meters have to be calibrated as per manufacturer guidelines or annually, whichever is earlier. The daily / batch wise records can be crosschecked with the balance sheet reports.
Any comment:	

Data / Parameter:	$\eta_{captive}$
Data unit:	Absolute value (up to 3 decimals)
Description:	Efficiency of the captive power generation plant
Source of data:	Use the highest value between the following two values as a conservative approach: 1. Measured efficiency during monitoring for year *y*; or 2. Manufacturer nameplate data for efficiency of the captive power plant
Measurement procedures (if any):	For measured efficiency, as per country specific standards, once a year
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	In case of steam based power captive power generation, manufacture nameplate efficiency of captive power generation includes boiler efficiency and turbine efficiency. Records to be maintained for crediting period + two years thereafter

Data / Parameter:	$S_{grid,y}$
Data unit:	%
Description:	Share of facility electricity demand supplied by grid imports for the year *y*
Source of data:	Annual reports for the facility
Measurement procedures (if any):	Onsite electricity meter readings
Monitoring frequency:	Yearly
QA/QC procedures:	As reported in the balance sheet/annual report of the facility / sales receipts from power grid
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / Parameter:	$S_{captive,y}$
Data unit:	
Description:	Share of facility electricity demand supplied by captive power plant for the year *y* (%)
Source of data:	Annual reports for the facility
Measurement procedures (if any):	Onsite electricity meter readings
Monitoring frequency:	Yearly
QA/QC procedures:	As reported in the balance sheet / annual report of the facility
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$BSEC_{ini,th}$
Data unit:	(TJ/t of product)
Description:	Baseline specific energy consumption at the beginning of the project activity of the furnace / kiln including all fossil fuel consumption in the project boundary
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Once at the beginning of the project
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$PSEC_{ini, th}$
Data unit:	TJ/t of product
Description:	Project specific energy consumption at the beginning of the project (TJ/t of product) of the furnace / kiln including all fossil fuel consumption in the project boundary
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Once at the beginning of the project
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$BSEC_{ini, el}$
Data unit:	(kWh/t of product)
Description:	Baseline specific energy consumption at the beginning of the project activity of the furnace / kiln including all electrical energy ~~fossil fuel~~ consumption in the project boundary
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Once at the beginning of the project
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter. For auxiliary equipments, if kiln-wise electrical energy (kWh) data is not metered and rather metered for the entire project boundary, then $BSEC_{ini, el}$ can be determined in proportion to actual output ratio from individual kilns.

Data / parameter:	$PSEC_{ini, el}$
Data unit:	kWh/t of product
Description:	Project specific energy consumption at the beginning of the project activity of the furnace / kiln including all ~~fossil fuel~~ electrical energy consumption in the project boundary
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Once at the beginning of the project
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter. For auxiliary equipments, if kiln-wise electrical energy (kWh) data is not metered and rather metered for the entire project boundary, then $PSEC_{ini, el}$ can be determined in proportion to actual output ratio from individual kilns.

Data / parameter:	$BSEC_{i, th}$
Data unit:	(TJ/t of product)
Description:	Baseline specific thermal energy consumption determined each time when $PSEC_{i,th}$ varies more than 5% during the project implementation
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Each time the project specific energy consumption $PSEC_{i,th}$ varies more than 5%
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$PSEC_{i, th}$
Data unit:	TJ/t of product
Description:	Project specific thermal energy consumption determined on a daily / batch wise basis during the project activity implementation
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Daily / batch wise
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$BSEC_{i, el}$
Data unit:	(kWh/t of product)
Description:	Baseline specific electric energy consumption determined each time when $PSEC_{i,th}$ varies more than 5% during the project activity implementation
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Each time the project specific energy consumption $PSEC_{i,th}$ varies more than 5%
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter. For auxiliary equipments, if kiln-wise electrical energy (kWh) data is not metered and rather metered for the entire project boundary, then $BSEC_{i, el}$ can be determined in proportion to actual output ratio from individual kilns.

Data / parameter:	$PSEC_{i, el}$
Data unit:	TJ/t of product
Description:	Project specific electrical energy consumption determined on a daily / batch wise basis during the project implementation
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Daily / batch wise
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter. For auxiliary equipments, if kiln-wise electrical energy (kWh) data is not metered and rather metered for the entire project boundary, then $PSEC_{i, el}$ can be determined in proportion to actual output ratio from individual kilns

Data / parameter:	$R_{i, th}$
Data unit:	
Description:	Ratio between the baseline specific energy consumption $BSEC_{i, th}$ and the project specific energy consumption $PSEC_{i,th}$ determined each time when $PSEC_{i,th}$ varies more than 5% during the project implementation
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Each time the project specific energy consumption $PSEC_{i,th}$ varies more than 5%
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$R_{i, el}$
Data unit:	
Description:	Ratio between the baseline specific energy consumption $BSEC_{i, el}$ and the project specific energy consumption $PSEC_{i,el}$ determined each time when $PSEC_{i,el}$ varies more than 5% during the project activity implementation
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Each time the project specific energy consumption $PSEC_{i,el}$ vary more than 5%
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$BSEC_{th,y}$
Data unit:	(TJ/t of product)
Description:	Baseline specific thermal energy consumption for year *y*
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$PSEC_{th,y}$
Data unit:	TJ/t of product
Description:	Project specific thermal energy consumption for year *y*
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter

Data / parameter:	$BSEC_{el,y}$
Data unit:	(kWh/t of product)
Description:	Baseline specific electric energy consumption for year *y*
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter. For auxiliary equipments, if kiln-wise electrical energy (kWh) data is not metered and rather metered for the entire project boundary, then $BSEC_{el,y}$ can be determined in proportion to actual output ratio from individual kilns.

Data / parameter:	PSEC $_{y, el}$
Data unit:	TJ/t of product
Description:	Project specific electric energy consumption for year *y*
Source of data:	From plant measurements
Measurement procedures (if any):	
Monitoring frequency:	Yearly
QA/QC procedures:	
Any comment:	Records to be maintained for crediting period + two years thereafter. For auxiliary equipments, if kiln-wise electrical energy (kWh) data is not metered and rather metered for the entire project boundary, then PSEC $_{el,y}$ can be determined in proportion to actual output ratio from individual kilns.

Please refer to the above-mentioned methodological tool regarding parameters to be monitored for calculation of project emissions from combustion of fossil fuels and consumption of electricity.

-.-.-.-.-

History of the document

Version	Date	Nature of revision(s)
02	EB 44, Annex # 28 November 2008	• The equations 13, 14 and 15 are deleted; • Use $P_{y,min}$ to limit the emission reductions to historical levels; • Other editorial changes.
01.1	EB 39, Paragraph 22 16 May 2008	"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" replaces the withdrawn "Tool to calculate project emissions from electricity consumption".
01	EB 38, Annex 1 14 March 2008	Initial adoption.