NEW COGENERATION FACITILITES SUPPLYING LESS CARBON INTENSIVE ELECTRICITY TO GRID AND STEAM AND/OR HOT WATER TO ONE OR MORE GRID CUSTOMERS

SOURCE

This Methodology is based on elements of the following CDM methodologies:

- AM0029 V 02 " Baseline Methodology for Grid Connected Electricity Generation Plants Using Natural Gas";
- AM0048 "New Cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off grid electricity generation with more carbon intensive fuels".

This methodology also refers to the latest approved version of the following tools:

- Methodological "Tool for the demonstration and assessment of additionality";
- Methodological "Tool to calculate the emissions factor of an electricity system";
- Methodological "Combined tool to identify the baseline scenario and demonstrate additionality";
- Methodological "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

DEFINITIONS

Waste Heat A by-product thermal energy from machines or process equipment for which no useful application is found in the absence of project activity and which is demonstrated to be unused in other activities

Project Customer An industrial and/or commercial and/or residential entity receiving electricity, steam and/or hot water from the project facility. This may include the power grid, in the case of electricity and the steam and/or hot water generating facility or the entity that draws steam and/or hot water off a steam and/or hot water grid. Clusters of smaller residential or commercial customers can be considered as a single project customer.

Project Facility Combined heat and power generation facility developed as a project activity to supply electricity to the power grid and steam and/or hot water to grid/off-grid to any industrial, commercial and/or residential entities.

APPLICABILITY

- The project activity is the construction and operation of a new gas fired cogeneration plant which is connected to the electrical grid and where all the electricity produced other than that required to operate the cogeneration facility is exported to the grid;

- The geographical/physical boundaries of the baseline power grid can be clearly identified and information is publicly available to establish the grid emissions factor;

- Natural gas is sufficiently available in the region or country, for example future natural gas power capacity additions of similar size to that of the project activity are not constrained by the use of natural gas in the project activity;

- This methodology is only applicable to cases in which the steam and/or hot water that is to be displaced by the project activity is either produced for export to a steam/hot water grid or is drawn from a steam/hot water grid. It shall not be applied to situations in which it would lead to the displacement of steam and/or hot water that is generated at a project customer's installations to meet its heating/process requirements;

- Where the project activity results in the substitution of imported steam and/or hot water, the project proponent shall provide evidence to prove that the thermal energy which is displaced is that which the project customer(s) would have otherwise imported from the grid and not that which is self-generated, assuming that such option exists for the project customer(s);

- The methodology is applicable only to project customers that do not cogenerate electricity, steam and/or hot water in the baseline scenario;

- Only applicable to project customers that ensure that the equipment displaced by the project activity will not be sold for other purposes;

IDENTIFICATION OF THE BASELINE SCENARIO AND DEMONSTRATION OF ADDITIONALITY

STEP 1. Identification of realistic and credible alternative baseline scenarios that are consistent with current laws and regulations

Substep 1a. Define realistic and credible alternatives to the project activity.

Project proponents shall identify realistic and credible alternative(s) available to both the project developer and project customer(s) that enable electricity, steam and/or hot water:

- to be produced in similar quantities as by the project activity;
- to deliver similar services;
- to be provided at the same grade, quality or properties as those provided by the proposed VCS project activity .

In other words, they shall identify possible baseline scenario alternatives that enable:

- electricity to be generated and sold to the grid, for base or peak load service;
- steam at a required pressure and temperature to be generated, delivered and sold to one or more project customers;
- hot water to be generated at the required temperature and sold to one or more project customers.

The proposed VCS project activity constitutes an alternative means for both the project developer and the project customers to produce electricity and thermal energy (when the project customer is a District Heating Plant that produces steam and/or hot water) or to source or buy it from (when the project customer is a thermal energy end user connected to a District heating steam/hot water grid). Hence, project developer and project customers, be it through the actions they take or do not take, define what the most plausible baseline scenario would most likely be in the absence of the project activity. In the case of power generation, the baseline scenario is shaped by the actions taken or not by the project developer and other market players that sell power to the grid.

Hence, in establishing what the most likely baseline scenario is, baseline alternative scenarios shall be identified for both the project developer and the project customer(s). Technologies or practices that have been implemented previously or are currently being introduced in the relevant country and that constitute alternatives for an independent utility producer shall be considered as part of this exercise. Those technologies or practices that do not meet this condition, shall not be considered a baseline scenario alternative, because they would be a “first of their kind”.

Baseline alternative scenarios for the project participants are therefore related to the technology and circumstances but also to the investor’s line of business or activity.

It shall be noted that for the purpose of this methodology, actions taken by project customers which are energy end users (i.e. purchase thermal energy to use it for heating/ process needs as opposed to selling it on to project customers who in turn resell it to their own customers) and result in a reduction in the end user demand of energy in the form of steam and/or hot water are not considered to be alternatives to the project activity. This is because such actions do not constitute a similar product/service: the provision of electricity, steam and hot water, which in the case of the project activity is carried out in a less carbon intensive manner than that which would have otherwise occurred. i.e. from the utilization of waste heat to generate steam and/or hot water.

Energy efficiency measures that enable the production, transmission and distribution of thermal energy to the end users with a lesser amount of GHG generation which may be implemented in the future, during the crediting period however are considered for the purpose of calculating the baseline emissions, but not as part of the process for the selection of the most plausible baseline scenario, because they do not constitute alternative means to providing the same services as those provided by the project activity. Similarly, improvements in energy efficiency undertaken by the project customer(s) may lead to an increase or decrease in the efficiency with which each unit of thermal energy is produced, depending on the operating point on the boiler's efficiency – load curve. The baseline emissions calculations given in section (5) of this methodology take this into consideration.

Procedure for the identification of Baseline Scenario Alternatives to the project activity

The project proponent shall clearly indicate the amount of electricity, steam and/or hot water which the proposed project activity would generate, indicating whether the electricity which is planned to be generated is peak/base load power, as well as the conditions of the steam and hot water to be produced.

This establishes a common technical basis upon which to identify the baseline scenario alternatives.

Electricity, steam and or hot water in similar amounts, service type and quality may be delivered in a separate manner (e.g. a gas turbine generator set and steam and hot water boilers) or in an integrated manner (e.g. a Combined Heat and Power Plant).

Therefore, possible baseline scenario alternatives for the project participants (project developer and project customer(s) with regards to the production/provision of electricity, steam and hot water, may include, either a combination of different options to generate each of the utilities independently from one another (non-integrated options) or through combined heat and power systems, which provide all three of such utilities (integrated options):

Step A. Non integrated baseline scenario alternatives for the production of electricity, steam and hot water

A.1 Electricity production

The project activity involves the construction and operation of an energy plant that produces several utilities, one of which is electricity which is exported to the grid.

In assessing what baseline scenario alternatives exist for electricity generation it shall be noted that these need not consist solely of power plants of the same capacity, load factor and operational characteristics (i.e. several smaller plants or the share of a larger plant may be a reasonable alternative to this portion of the project activity). However all the options considered must be capable of delivering a similar service (e.g. peak vs. base load power).

The proponents shall include those power generation options that are available to them. In this sense, project proponents shall ensure that all relevant power plant technologies that have been recently constructed or are under construction or are being planned are considered when building the list of baseline scenario alternatives.

Alternatives for electricity generation include, amongst others, but are not limited to the following:

- grid connect power plants;
- new steam turbine power plants;
- new gas turbines power plants;
- new IC engine power plants.

The project proponents shall establish which of the identified baseline scenario alternatives can be considered credible and realistic alternatives

A.2 Thermal energy (Steam and/or hot water):

Baseline scenario alternatives that enable the production of the same quantity and grade of steam and/or hot water as the proposed project activity for export (if the project customer is a centralized district heating plant) or importing (where a project customer draws steam and/or hot water from a district heating grid) may include but are not limited to the following:

- continued generation of steam and/or hot water for export purposes to a district steam and or hot water grid, by a district heating plant;

- continued use of the existing sources of imported steam and or imported hot water by a project customer connected to the steam and/or hot water grid;

- waste heat derived steam and or hot water from waste heat sources available at the project customer's facility;

- the installation of standalone steam and or hot water generation equipment;

- the installation of steam and or hot water generation equipment for export into a district heating grid or supplying to a specific customer.

The outcome of step A will be the realistic baseline scenario alternatives for the combined production of electricity, steam and/or hot water from separate sources subject to the conditions given in Substep 1(a).

Step B. Integrated generation baseline scenario alternatives for the production electricity, steam and/or hot water (cogeneration of electricity, steam and/or hot water)

Integrated forms of generating the above mentioned utilities shall be considered, as they constitute alternatives to the production of electricity, steam and/or hot water. As indicated above, only those options that meet technical requirements and are available to the project participants established in Substep 1a shall be considered as possible baselines alternatives.

Combined heat and power baseline scenario alternatives may include:

1. Steam turbine CHP plant
    - CHP with back-pressure turbine
    - CHP with extraction / condensing turbine

2. CHP with gas turbine

3. Internal combustion (IC) reciprocating engine generator with waste heat recovery

4. Combined-cycle HP plant

The outcome of Step B will be realistic baseline alternatives for the co production of electricity, steam and/or hot water from an integrated energy facility subject to the conditions indicated in Substep 1 (a)

Outcome of Sub Step 1a: After having applied the above procedure realistic and credible alternatives baseline scenario that remain may include:

From Step A:

- One or more combinations of forms of generating electricity and thermal energy using independent technologies, and/or;

- Electricity from the grid and thermal energy from a district heating plant (continuation of existing practice).

From Step B

- One or more options of combined heat and power generation, including the VCS project activity without VER's.

Substep 1.b: Consistency with mandatory laws and regulations:

Ensure that the baseline scenario alternatives identified above comply with mandatory laws and regulations. This assessment shall be carried as described in the "Tool for Demonstration and Assessment of Additionality"

Outcome of Step 1b: Identified realistic and credible alternative scenario(s) to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the region or country and VCS decisions on national and/or sectoral policies and regulations.

STEP 2. Determination of additionality and the most plausible baseline scenario

The most plausible baseline scenario shall be the one that includes the most likely means of producing electricity, steam and hot water in the absence of the proposed VCS project activity. It is the result of the combination of the most likely baseline scenarios for both the project developer and the project customer(s).

After having applied the procedure given in Step 1, three (3) realistic baseline scenario alternative categories will have been identified. The definition of the most plausible baseline scenario shall be assessed from both the project developer and project customer(s) perspectives. The project proponent may demonstrate this by applying investment or barrier analysis as deemed appropriate.

Step 2.1: Assessment and demonstration of additionality

The project proponent shall demonstrate that the proposed project activity is not an attractive option for the project developer to undertake unless the project activity can be registered under the VCS.

Project proponent shall demonstrate additionality by applying either one or two of the following options:

Option 1: Investment analysis

Option 2: Barrier analysis

Project proponents may also elect to complete both options. The above options refer to Steps 2 and 3 of the "Tool for demonstration and assessment of additionality".

Additionality shall be demonstrated using the latest version of the "Tool for demonstration and assessment of additionality". Project participants can use either investment analysis or barrier analysis step. They may, if they wish so, use both the investment and barrier analysis steps.

OPTION 1. INVESTMENT ANALYSIS

Project proponents shall apply the latest version of the "Tool for demonstration and assessment of additionality" i.e., shall determine whether the proposed project activity is not:

(a) The most economical or financially attractive, or;

(b) Not economically attractive.

The indicator to be applied shall be either IRR, or the unit cost of producing electricity, thermal energy for steam and hot water.

The selection of the benchmark IRR shall be carried out according to the latest version of the "Tool for demonstration and assessment of additionality".

Where the unit cost of energy is the chosen indicator, the benchmark to be applied to the steam and/or hot water will depend on whether the project customer is:

a) A centralized steam and/or hot water generating facility purchasing steam and/or hot water from the project facility, in which case the benchmark is the unit purchase price or tariff of the thermal energy offered by the district heating plant to the project developer;

b) An importer of steam and or hot water from the grid, in which case the benchmark shall be the unit cost of thermal energy paid by the project customer which imports steam and or hot water from the grid.

In providing any benchmarks, the DOE shall be presented with supporting evidence, such as energy purchase agreements (in cases where the project customer is the central steam and or hot water generating facility), actual energy invoices or contracts (in the case of a project customer that imports thermal energy from the grid) where it is indicated in a transparent manner what the benchmark value is.

Calculation of the indicator

IRR

If IRR is chosen as the indicator then, the IRR calculation shall be applied to assess the additionality of the project activity following the guidance given in the latest version of the “Tool for demonstration and assessment of additionality”.

Unit cost of energy

Where unit cost of energy us the chosen indicator, the unit cost of electricity, steam and or heat to be provided by the project activity shall be calculated taking into account the investment, operation and maintenance costs, and the revenues excluding carbon but possibly including other sources of revenue as mentioned in the “Tool for Demonstration and Assessment of Additionality” and compared with that of the baseline scenario alternatives which provide those utilities. The approach used in such calculations shall be presented in a transparent manner in accordance with the “Tool for Demonstration and Assessment of Additionality”, in a way that shall enable the DOE to assess their appropriateness and reproduce the results presented by the project proponents. The calculations used to determine such indicators shall be presented to the DOE.

Present a clear comparison between the indicator values obtained for the various baseline scenario alternatives and the benchmark.

a) If the value of indicator for the project activity is such that it is not the most attractive amongst various baseline scenario options to produce the similar services and outputs, then the project activity shall be deemed additional.

b) If the indicator for the project activity is less favorable than the benchmark then the project activity cannot be considered the financially attractive or the most financially attractive and can be thus regarded as additional.

Sensitivity analysis

A sensitivity analysis shall be included to show whether the conclusion regarding the financial/economic attractiveness of the project activity without VCS is robust to reasonable variations in the critical assumptions. The investment analysis provides a valid argument in favor of additionality only if it consistently supports (for a realistic range of assumptions) that the project activity without VCS credits is unlikely to be the most financially/economically attractive option to the project developer.

The project proponent, who applies the new VCS methodology, shall provide evidences for the figures applied and used in the excel work sheets in order to be able to fully retrace the assumptions and calculations made under the investment analysis.

Determination of the most plausible baseline scenario

The most plausible baseline scenario shall be considered to be either of the following:

- the most economically attractive of the realistic and credible baseline scenario alternatives identified in Substep 1 b above that is in compliance with existing regulations, provided the emissions that would result from its implementation would be less than those resulting from the "continuation of existing practice" or "business-as-usual" baseline scenario alternative. If this is not the case, the baseline scenario shall be considered to be the continuation of the existing practice;

- the continuation of existing practice, in cases in which the only other possible baseline scenario alternative is for a project developer to invest in the project activity, but which has been determined not to be the most likely baseline scenario given the outcome of the investment analysis described above.

OPTION 2. BARRIER ANALYSIS

Determine whether the proposed project activity faces barriers that:

a) prevent the implementation of this type of project activity; and

b) do not prevent the implementation of at least one of the alternatives

The identified barriers are only sufficient grounds for demonstration of additionality if they would prevent the project developer from carrying out the proposed project activity undertaken without being registered as a VCS project activity. Barriers that prevent customers from purchasing the Electricity and thermal energy which the project activity produces are taken as barriers which the developer must also overcome.

The following sub-steps shall be used

Substep 2a: Identify the barriers that would prevent the implementation of the proposed VCS project activity

(1) Identify realistic and credible barriers that would prevent the implementation of the proposed project activity from being carried if the project activity was not

registered as a VCS project. Barriers must be addressed for both the project developer and the project customer (s).

(a) Investment barriers, other than economic/financial barriers in Step 2 above, inter alia:

   i. similar cogeneration activities have been implemented, but only through grants or other non commercial terms. Similar activities being those that rely on a broadly similar technology or practices, are of a similar scale, take place in a comparable energy sector environment with respect to the regulatory framework and are undertaken in the relevant country/region

   ii. no private capital is available from domestic or international capital markets due to real or perceived risks, as demonstrated by the country credit ratings or other country investment reports of a reputed origin

   iii. the investment required to deliver the energy produced by the project facility to the project customer (e.g. power lines, steam and hot water piping) is significant and the project developer is unable or unwilling to undertake it

(b) Technological barriers, inter alia:

   i. Skilled and/or properly trained labor to operate and maintain the technology are not available in the relevant country/region, which leads to an unacceptably high risk of equipment disrepair and malfunctioning or other underperformance.

   ii. Lack of infrastructure for implementation and logistics for maintenance of the technology.

   iii. Risk of technological failure: the technology failure risk in the local circumstances is significantly greater than for other technologies that provide the electricity, steam and/or hot water in quantities, grades and quality as those of the proposed project activity, as demonstrated by relevant scientific literature or technology manufacturer information. This is risk being a concern to both the project developer and the project customer.

(c) Barriers due to prevailing practice

   i. the project is the “first of its kind” either from a technological or business standpoint

(d) Barriers that prevent project customers from purchasing electricity, steam and/or hot water from the project facility

(e) Other barriers that the project developer or the project customer may face

Substep 2b. Show that the identified barriers would not prevent the implementation of at least one of the baseline scenario alternatives besides the propose project activity

(2) if the identified barriers also affect other baseline scenario alternatives identified as part of step 1, explain in what way those baseline scenario alternatives are less strongly affected by them than the proposed VCS project activity is. In other words, demonstrate that the identified barriers do not prevent the implementation of at least one of the baseline scenario alternatives. Any baseline scenario alternative that would be prevented by any barriers indicated above cannot be considered a "viable" alternative to the proposed project activity and shall thus be eliminated from further consideration.

Determination of additionality and the most plausible baseline scenario

- if there is only one baseline scenario alternative that is not prevented by any of the identified barriers and this scenario is not the project activity without being registered under the VCS, then this baseline scenario alternative shall be taken as the most plausible baseline scenario. In this case it shall be explained as indicated in the "Combined tool to identify the baseline scenario and demonstrate additionality" by using qualitative or quantitative arguments, how the registration of the VCS project activity will alleviate the barriers that prevent the proposed project activity from occurring.

- if there are more than one baseline scenario alternatives that are not prevented by any of the barriers, and these alternatives do not include the project activity without taking into account VERs, the project proponent shall explain how the registration of the VCS project activity will alleviate the barriers that prevent the proposed project activity from occurring.

  If the VCS alleviates those barriers, the project proponent may apply investment analysis to identify the most economically attractive of the baseline scenario alternatives that are not prevented by any of the barriers that the project activity faces. If the most economically attractive baseline scenario is a more carbon intensive alternative than the continuation of current practice then the project proponents may proceed to the following sections of this methodology, provided the baseline scenario is taken to be production of electricity by grid connected power sources and the production of steam and/or hot water is obtained from existing generating facilities. If on the other hand, it is determined that the most economically attractive scenario is a less GHG intensive alternative than the continuation of existing practice, then the methodology cannot be a applied.

Step 2.2: Common practice analysis

Demonstrate that the project activity is not common practice in the relevant country and sector by applying STEP 4 "Common Practice Analysis" as described in the latest version of the "Tool for the demonstration and assessment of additionality"

The relevant geographical area for undertaking the common practice analysis should in principle be the host country of the proposed CDM project activity. A region within the country could be the relevant geographical area if the framework conditions vary significantly within the country.

PROJECT BOUNDARY

The project boundary includes the site of the project facility(s) and the sites of the project customer(s).

CALCULATION OF EMISSION REDUCTIONS FROM THE PROJECT ACTIVITY

The emissions sources are given in table one below.

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

	Source	Gas	Included	Explanation/Justification
Baseline	Combustion of fossil fuels to produce electricity, steam and/or hot water at the project customer(s)' site, which provide steam and or hot water to the project customer site, and the power generating facilities connected to the grid.	CO_2	Yes	Main emissions source in the combustion of fossil fuel.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification.
Project activity	Combustion of natural gas to produce electricity, steam and/or hot water at the site of the project activity.	CO_2	Yes	Main emissions source in the combustion of natural gas.
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification.

PROCEDURE FOR ESTIMATING LIFETIME OF THE BOILER(S)

The following approaches shall be taken into account to estimate the remaining lifetime of the boilers that would provide steam and hot water in the absence of the project activity:

a) The typical average technical lifetime of the type of equipment may be determined taking into account common practices in the sector and country (e.g. based on industry surveys, statistics, technical literature, etc.);

b) The practices of the responsible company regarding replacement schedules may be evaluated and documented (e.g. based on historical replacement records for similar equipment).

The time to replacement of the existing equipment in the absence of the project activity should be determined in on a case-by-case basis thus taking into consideration local conditions, existing practices and possible barriers to implementation of new projects or regulatory acts relating to the continuation of existing practices regarding steam and hot water generating equipment.

If in any year of the crediting period, new steam or hot water generating equipment is installed at the project customer's installations or at the installations that supply steam and or hot water to the project customer, it shall be assumed that all steam and or hot water that is displaced by the project activity would have otherwise been produced by using equipment with such performance characteristics.

In other words, should such situations occur during the crediting period, the baseline emissions factor will be recalculated based on Option B given for steam and hot water production (equations 8, 15 and 20), to reflect the assumption that in the absence of the project activity, the steam and hot water which is produced by the project facility would have been produced by more efficient steam and hot water generation technology.

The project proponents may opt to assume though that new more efficient equipment would have been installed to generate steam and hot water. In this case they shall assume that best available fossil fuel based steam or hot water generation technology would have been used. Or if they prefer, may opt to assume that the thermal generation efficiency of the equipment that would be installed is 100%. Either option may only be applied though in cases where the project proponents can demonstrate that the use of biomass is not likely to constitute a viable alternative to produce the heat that the project activity displaces

CALCULATION OF THE BASELINE EMISSIONS

The following approach to calculate the baseline emissions is only applicable to projects in which the most plausible baseline scenario has been identified to be the continuation of the existing practice, i.e. electricity supplied by the grid and steam and/or hot water produced by a district heating plant or sourced from a district heating plant.

The baseline scenario shall indicate what the baseline fuels are. The project proponent shall assess the potential for fuel switching and energy efficiency improvements under the baseline scenario as indicated below.

For the purpose of establishing the baseline emissions the project developer shall consider any changes that may impact on the baseline alternatives CO_2e intensity of the steam and/or hot water which it displaces. In this sense attention shall be paid to:

Fuel switching

- fuel switching taking place in the centralized steam and/or hot water generating facility that provides these sources of energy to the steam and hot water grids:

    - the project proponent first determines if the fuel changes are technically feasible using existing thermal energy generating equipment. This exercise is not carried out for electricity generation. For instance the proponents shall determine if the existing equipment is capable of utilizing more that one fuel, without major capital investment. This can be verified during validation. If not, then no additional considerations need to be undertaken in the crediting period and it will be assumed that the same fuel would have been used as has been in the past. If a fuel switch constitutes a possibility given the existing equipment, the project proponent shall monitor this on a yearly basis.

    - Alternatively, the project proponents may assume that natural gas is being used as the baseline fuel, in which case no monitoring in this respect shall be required. The project proponent may apply this default approach during the entire crediting period or for any specific year of the crediting period. This shall be clearly indicated in the monitoring reports presented the verifier.

Energy efficiency improvements

Energy efficiency improvements in thermal energy generation (when the project customer is a district heating plant) and transport of thermal energy to the project customer's factory gate (when the project customer is an end user) include:

- energy efficiency measures and projects the improve the efficiency with which thermal energy is generated at the thermal energy generating facility;

- improvements to the steam transport system from the point of generation to the point of delivery to a customer connected to the grid that lead to a reduction in the amount of energy losses, and hence CO_2 emissions per unit of thermal energy delivered to the point at which the project activity steam and or hot water are delivered to the project customer. This needs to be considered in cases in which the project proponents chose to apply a GHG intensity factor which is based on measured data;

- activities that increase the amount heat returned to the central generating system boiler house in the form of hot condensate and flash steam, which therefore reduce the CO_2 intensity of the steam which is produced.

The impact of such measures on the baseline emissions are dealt with in the baseline emissions calculation and monitoring sections of this methodology. Alternatively, the project proponents may apply default factors as suggested in this methodology. In either case the DOE shall verify the appropriateness of the data/factors applied.

This methodology is only applicable to situations in which the baseline scenario is the continuation of the current practice for producing electricity and heat from fossil fuel

The baseline emissions for this particular methodology are the sum of emissions from resulting from the generation of electricity, steam and hot water.

$$BE_y = BE_{el,y} + BE_{th,y} \qquad (1)$$

Where:

$BE_{el,y}$ Baseline emissions resulting from electricity generation in the year y (in tonnes of CO_2e). Calculated below as per equation (2);

$BE_{th,y}$ Baseline emissions resulting from the production of steam and/or hot water supplied to project customer i in the year y (in tonnes of CO_2). Calculated below as per equation (3).

BASELINE EMISSIONS FROM ELECTRICITY GENERATION

Baseline emissions from electricity generation are calculated by multiplying the net electricity generated at the project plant ($EG_{P,y}$) with a baseline electricity grid CO_2 emission factor ($EGEF_{BL,CO_2,y}$) as follows:

$$BE_{el,y} = EG_{P,y} \cdot EGEF_{BL,CO_2,y} \qquad (2)$$

For construction of large new power capacity additions under the CDM, there is a considerable uncertainty relating to which type of other power generation is substituted by the power generation of the project plant. As a result of the project activity, the construction of an alternative power generation technology could be avoided, or the construction of a series of other power plants could simply be delayed. Furthermore, if the project were installed sooner than these other projects might have been constructed, its near-term impact could be largely to reduce electricity generation in existing plants. This depends on many factors and assumptions (e.g. whether there is a supply deficit) that are difficult to determine and which change over time. In order to address this uncertainty in a conservative manner, project participants shall use for ($EGEF_{BL,CO_2,y}$) the lowest emission factor among the following options:

For the first crediting period:

Option 1 The build margin, calculated according to "Tool to calculate emission factor for an electricity system"; and

Option 2 The combined margin, calculated according to "Tool to calculate emission factor for an electricity system", using a 50/50 OM/BM weight.

BASELINE EMISSIONS FROM HEAT GENERATION

The baseline emissions from heat production ($BE_{th,y}$) are the sum of emissions from steam generation and hot water generation for sale to project customers:

$$BE_{th,y} = BE_{st,y} + BE_{hw,y} \tag{3}$$

Where:

$BE_{st,y}$ Baseline emissions resulting from the production of steam supplied to project customer i in the year y (in tonnes of CO_2). Calculated below as per equation (4);

$BE_{hw,y}$ Baseline emissions resulting from the production of hot water supplied to project customer i in the year y (in tonnes of CO_2). Calculated below as per equation (11).

The maximum amount of thermal energy in the form of steam and/or hot water, which is produced by the project activity during year y and which can be used for the purpose of determining the emissions reductions upon which VERs can be claimed, is defined as the maximum annual amount of thermal energy produced in the form of steam and/or hot water that has been produced over the three most recent years for which data is available in the pre-project steam and or hot water production facilities.

I. Baseline emissions from production of steam that is supplied to project customer i in year y (in tonnes of CO_2):

$$BE_{st,y} = \sum_i \sum_j \left(SC_{BL,j,y} \cdot SEF_{BL,i,y} \right) \tag{4}$$

Where:

$SC_{BL,j,y}$	The amount of energy consumed in the form of steam by the project customer i, which is supplied by the project facility j in year y (in TJ). It is further obtained from equation (5).
$SEF_{BL,i,y}$	The baseline emission factor corresponding to the steam produced in project customer i's steam generating plant or sourced from the produced in a steam generating plant that supplies steam to a project customer i (in t CO_2/TJ), and obtained from equation (6) below.

The amount of energy consumed in the form of steam by the project customer i which is supplied by the project facility j in year y is given by:

$$SC_{BL,j,y} = SP_{BL,j,y} \cdot SDEN_{BL,j,y} \tag{5}$$

Where:

$SP_{BL,j,y}$	Quantity of steam produced by the project facility j and supplied to the project customer i for year y, (in tonnes)
$SDEN_{BL,j,y}$	Specific enthalpy of steam leaving the project facility j (in TJ/tonne of steam supplied). This data shall be obtained from steam tables, using temperatures and pressure of the steam purchased.

The following options are provided to determine the baseline CO_2 emissions factor, $SEF_{BL,i,y}$ for the steam produced by the project customer i or by a steam generating plant that supplies a project customer i with steam (in tonnes of CO_2/TJ of steam) produced in year y.

Option I.A.

When actual data for the amount of fuel consumed and steam generated by the project customer i's steam generating plant or by the steam generating plant that supplies steam to a customer i is available, the baseline emission factor for the steam generated may be calculated as:

$$SEF_{BL,i,y} = \frac{44}{12} \cdot \frac{\sum_i \left(CEF_{FF,i,y} \cdot HEC_{BL,FF,st,i,y} \right)}{\sum_i HSC_{BL,i,y}} \qquad (6)$$

Where:

$CEF_{FF,i,y}$ Carbon emission factor in year y corresponding to fossil fuel used by project customer i to generate steam or that which is used in a given steam generating plant to produce the steam which is sourced by the project customer i (in tonnes of C/TJ), shall be determined from the technical literature, from the project customer i, or the steam generating plant which supplies steam to the project customer i.

$HEC_{BL,FF,st,i,y}$ The energy associated with the fossil fuel consumed by the project customer i or the steam generating facility that supplied steam to the project customer i, in year y (in TJ). Calculated below in equation (7).

$HSC_{BL,i,y}$ The amount of energy contained in the steam generated by the customer i or the steam generating facility that supplied steam to the project customer i by burning fossil fuel (in TJ) in year y.

The present methodology offers two options upon which to establish $HEC_{BL,FF,st,i,y}$:

Option I.A.a.

The energy associated with the fossil fuel that was consumed by the project customer i for self-generation of steam or by the steam generating facility that supplied steam to the project customer is given by:

$$HEC_{BL,FF,st,i,y} = HFC_{BL,FF,st,i,y} \cdot NCV_{FF,i,y} \qquad (7)$$

Where:

$HFC_{BL,FF,st,i,y}$ The quantity of fossil fuel consumed for steam generation by project customer i or that which was consumed by the steam generating plant that provided steam to the project customer i in year y (in tonnes)

$NCV_{FF,i,y}$ Net calorific value of the fossil fuel used by the project customer i in the scenario of self-generation or used by the steam generating plant that supplied steam to the project customer i in year y. Specific data may be provided by the project customer or from the technical literature (TJ/tonne)

Option I.A.b.

Alternatively, $HEC_{BL,FF,st,i,y}$ may be calculated from records of steam produced and the temperature and pressure conditions at which boiler feed water is supplied to and the steam generated from the boilers, as follows:

$$HEC_{BL,FF,st,i,y} = \frac{(HSC_{BL,i,y} - HSP_{BL,i,y} \cdot HSEN_{w,y}) \cdot 100}{\eta_{BL,st,i}} \tag{8}$$

Where:

$HSC_{BL,i,y}$ The amount of energy contained in the steam which was generated by the customer i or that which was generated by the steam generating facility that provided steam to the project customer i, and which was obtained by burning fossil fuel (in TJ) in year y.

$HSEN_{w,y}$ The specific enthalpy of water entering the boiler at project customer i's steam generating facilities or the water entering the boiler at the steam generating facilities which supplied steam to the project customer i in year y.

$HSP_{BL,i,y}$ The quantity of steam produced by the project customer i or that which was produced by the generating facility that supplied the steam to the project customer i in year y (in tonnes of steam produced).

$\eta_{BL,st,i}$ The efficiency of project customer i's boiler or the efficiency of the boiler that supplied steam to the project customer i based on NCV (in %). This parameter shall be one of the following:

i) the highest measured value of boiler efficiency recorded over full range boiler test;

ii) the boiler's peak thermal efficiency as per manufacturer's information;

iii) efficiencies of boilers of similar design;

iv) a default boiler efficiency of 100%;

Note: heat losses associated with the transmissions and distribution of steam are assumed to be zero

Energy content (in TJ) of the steam generated by customer i or by the facility that supplied steam to the project customer i is given by:

$$HSC_{BL,i,y} = HSP_{BL,i,y} \cdot HSEN_{BL,i,y} \qquad (9)$$

Where:

$HSP_{BL,i,y}$	The quantity of steam produced by the project customer i or produced by the steam generating facility that supplied steam to the project customer i in year y (in tonnes of steam produced)
$HSEN_{BL,i,y}$	The specific enthalpy of the steam produced by project customer i or by the steam generating facilities that supplied steam to the project customer i in year y (in TJ/ tonne of steam produced).

Note for monitoring during the crediting period.

Option 1.A

Changes may be made to certain elements of the project customer's steam system (e.g. the condensate recovery system) that could result in a lower baseline emissions factor during the years of the crediting period. Additionally, changes in the type of fuel used may occur in any year y during the crediting period, which are likely to have occurred also in the absence of the project activity.

For the purpose of establishing the steam baseline emission factor in any given year y during the crediting period, the project proponent shall therefore:

a) establish the lowest specific heat consumption per unit of steam energy given by $\min(HEC_{BL,FF,st,i,y} / HSC_{BL,i,y})$ up till year y

b) multiply this value with the value of $\left(\frac{44}{12} \cdot CEF_{FF,i,y}\right)$ of the fuel used in year y

The baseline emissions factor for year y shall be the lowest between the value so calculated and that obtained from equation (6) above.

The purpose of this approach is to identify which year is the least energy intensive one, and assume that the improved performance would have not been lost over time. That is, in any year y it is always assumed that steam will be produced with the minimum amount of fossil fuel derived energy. It also aims to reflect the fact that changes in the fuel type being used in any year y may change to what has been previously the case, and that furthermore such changes would have also occurred in the absence of the project activity. If however in any year y, there is no fossil fuel consumption at the project customer's steam generating facility because all is displaced by the project activity, then the project proponent shall apply the lowest baseline emissions factor amongst the historical value for the three most recent years prior to the implementation of the project for which data is available and the values obtained during the years of the crediting period leading up to year y.

Note for cases in which a project customer uses steam produced by another steam generating plant:

Where the project customer is one that imports steam from generating facility, heat losses in transmission and distribution of that steam shall be considered nil. In other words, enthalpy data applied into the equations above shall be that which corresponds to the temperature and pressure conditions of the steam produced at the steam generating facility and not those existing of the steam at the point of off-take by the project customer. In this case, the steam baseline emissions factor shall be monitored as per the preceding note.

Option I.B.

The baseline CO_2 emissions factor per TJ of steam energy generated by customer i or by the steam generating facility that supplied steam to the project customer i, in the absence of the project activity can also be determined from boiler manufacturer's design data for customer i, and the fraction of heat recovered in the form of condensate, assuming no heat losses occur along the steam transmission and distribution lines, as follows:

$$SEF_{BL,i,y} = \frac{44}{12} \cdot \frac{CEF_{FF,i,y} \cdot (1 - X_{c,y}).100}{\eta_{BL,st,i}} \qquad (10)$$

Where:

$CEF_{FF,i,y}$ Carbon emission factor (in tonnes of C/TJ), corresponding to the fossil fuel consumption by customer i or the facility that provided steam to the project customer i in year y;

$\eta_{BL,st,i}$ Project customer i's boiler efficiency or the boiler efficiency of the steam generating plant that supplied steam to a project customer, based on NCV (in %).In the absence of boiler performance data, $\eta_{BL,st,i}$ can be determined by one of the following:

i) the highest measured value of boiler efficiency recorded over full range boiler test;

ii) the boiler's peak thermal efficiency as per manufacturer's information;

iii) efficiencies of boilers of similar design;

iv) a default boiler efficiency of 100%.

$X_{c,y}$ The fraction of the total energy contained in the steam which is produced by the steam generating facilities which is returned as hot condensate and flash steam where applicable, to the boiler house in year y. The values of $X_{c,y}$ can be obtained as follows:

Option 1. Based on historical/actual measured data

- from historical data:

Option 1a. When the mass of condensate and temperature and pressure conditions at which the condensate is returned to the boiler house condensate tank are known:

If this option is to be applied, then this calculation must be performed yearly during the crediting period to ensure that no improvements have been made that might lead to a further increase in the amount of energy recovered from the condensate. Should the value of the fraction so obtained in any year y be less than the historical maximum value (spanning the first year of the historical data used to establish the initial value of $X_{c,y}$ till year y-1 in the crediting period), the maximum value of $X_{c,y}$ during this period shall be taken. Energy returned to the boiler house in the form of hot condensate as well as from any flash steam recovered and thereafter used in a deaerator shall be accounted for.

Option 1.b When the mass of condensate recovered unknown, but temperature at which the condensate is returned to the condensate tank is known:

Calculate the heat recovered from the condensate entering the condensate tank by assuming that all the steam that condensed throughout the steam system is routed back to the boiler house condensate recovery tank, based upon the maximum temperature observed from historical records. In other words, assume that:

- no steam is used directly in a process
- all the steam that is condensed in heat exchangers is returned, i.e. no losses due to leaks (neither condensate nor live steam). Flash losses that occur across the steam traps are calculated by carrying out an enthalpy balance around

the condensate recovery tank at the tank's operating conditions

If this option is to be applied, then this calculation must be performed yearly to ensure that no improvements have been made that might lead to a further increase in the amount of energy recovered in the form of condensate that was present in the heat exchangers (e.g. if a condensate flash steam recovery project were to be implemented). Select the maximum condensate recovery temperature (at the condensate recovery tank) in the period spanning the first year of the historical data used to establish the initial value of $X_{c,y}$ till year y-1 in the crediting period, and use this value to establish the heat recovered from the condensate which is returned to the boiler in the form of condensate.

Option 2. Based on Default values

The following options assume that there are neither losses of condensate along the condensate piping nor losses to direct heating processes. The above assumptions overestimate the amount energy which can be recovered from this part of a steam system.

Option 2a If the existing condensate system is of the atmospherically vented condensate system type:

If the quantity and temperature at which the condensate is returned to the boiler house are not known, apply option 1b above but assume that the condensate which is obtained from the bottom of the condensate flash tank is pumped to the deaerator at 100°C to calculate the heat returned to the boiler in the form of hot condensate.

The proponents shall confirm annually if any changes to the design of the condensate system have been made that enable it to operate at a higher pressure, and thus recover more energy from the condensate routed to the condensate tank. Should this be the case, this default can no longer be applied.

Note: For such system condensate cannot exceed 100°C otherwise pump impeller cavitation /capitation would occur. Hence there is a practical limit to the amount of heat that can be recovered; in fact it would probably be somewhat lower than 100°C.

Option 2b. The project proponent may chose to calculate $X_{c,y}$ assuming that all the heat contained in the condensate in the heat transfer equipment is returned to the boiler. The calculation shall be performed based on enthalpy values of water, h_f, corresponding to the conditions at which the steam is generated according to the boiler manufacturer's design or the actual conditions.

II. Baseline emissions from production of hot water

The baseline emissions from the production of hot water in project customer i's installation or produced in the installation that supplied hot water to the project customer i are given by:

$$BE_{hw,y} = \sum_i \sum_j \left(HWC_{BL,j,y} \cdot HWEF_{BL,i,y} \right) \qquad (11)$$

Where:

$HWC_{BL,j,y}$ The energy content in the hot water produced by the project facility j, which is purchased by project customer i in year y (in TJ);

$HWEF_{BL,i,y}$ The CO_2 baseline emissions factor corresponding to the hot water produced by the project customer i or produced by the hot water production plant that produces hot water which the project customer i uses in year y (in t CO_2/TJ)

The energy content in the hot water produced by the project facility j, which is purchased by project customer i in year y is obtained by the following equation:

$$HWC_{BL,j,y} = HWP_{BL,j,y} \cdot HWEN_{BL,j,y} \qquad (12)$$

Where:

$HWP_{BL,j,y}$ The amount of hot water produced by project facility j and supplied to project customer i in year y (in tonnes);

$HWEN_{BL,j,y}$ The specific enthalpy of hot water produced by the project facility j in the year y (in TJ/tonne of water).

This part of the methodology considers situations in which a project customer i would have produced or obtained hot water from a hot water production plant. This hot water in the absence of the project activity would have been derived from either of the following sources of energy:

- fossil fuel, in directly fired hot water boilers, hwb (Option II.A.)

- steam, in steam to water heat exchangers, sthx (Option II.B.)

Option II.A. Hot water produced in boilers firing fossil fuels

The following alternatives are provided to determine the baseline CO_2 emissions factor associated to the production hot water in tonnes of CO_2/TJ where historical data is available.

Option II.A.a.

The baseline CO_2 emission factor associated with hot water production in boilers running on fossil fuel can be calculated as:

$$HWEF_{BL,i,y} = \frac{44}{12} \cdot \frac{\sum_i (CEF_{FF,i,y} \cdot HEC_{BL,FF,hwb,i,y})}{\sum_i HHWC_{BL,hwb,i,y}} \tag{13}$$

$CEF_{FF,i,y}$ Carbon emission factor corresponding to the fossil fuel used by the project customer i to produce hot water or used by the plant which supplied hot water to a project customer i in year y (in tonnes of C/TJ). Obtained from the relevant hot water generating plant or from the technical literature.

$HEC_{BL,FF,hwb,i,y}$ The energy associated with the fossil fuel consumed by customer i to self-generate hot water in a hot water boiler or that consumed by a hot water production plant that provides the hot water to the project customer i (in TJ) in year y.

$HHWC_{BL,hwb,i,y}$ The energy contained in the hot water, which was generated by the customer i from burning natural gas (in TJ) or which was produced by the facility that provided hot water to the project customer i in year y.

The present methodology offers two options upon which to determine $HEC_{BL,FF,hwb,i,y}$:

Option II.A.a.i

The energy associated with the fossil fuel consumed by a customer i to self-generate hot water in a hot water boiler or that which is used to generate hot water in a facility that supplied hot water to a project customer i given by:

$$HEC_{BL,FF,hwb,i,y} = HFC_{BL,FF,hwb,i,y} \cdot NCV_{FF,i,y} \tag{14}$$

Where:

$HFC_{BL,FF,hwb,i,y}$ The quantity of fossil fuel consumed for hot water generation in hot water boilers by the project customer i or by the plant that generated the hot water which customer i used for year y. This can be reported as mass units of the baseline fuel or in units of volume if data is provided on the mass density of the fossil fuel used (in tonnes)

$NCV_{FF,i,y}$ Net calorific value of the fossil fuel used in the hot water generating plant, whether this is the project customer i's facility or the plant that generated the hot water which the project customer i used, whichever is applicable,or specific data to be provided by the project customer for year y

Option II.A.a.ii

Alternatively, in the absence of suitable historical data for fossil fuel consumption or if preferred, $HEC_{BL,FF,hwb,i,y}$ may be calculated as follows:

$$HEC_{BL,FF,hwb,i,y} = \frac{(HHWC_{BL,hwb,i,y} - HHWP_{BL,hwb,i,y} \cdot HSEN_{w,y}) \cdot 100}{\eta_{BL,hwb,i}} \quad (15)$$

Where:

$HHWC_{BL,hwb,i,y}$ The energy contained in the hot water, which was generated by the customer i or by the plant that provided the hot water to the project customer i, from burning fossil fuel (in TJ) in year y

$HSEN_{w,y}$ The specific enthalpy of water entering the hot water boiler in year y

$\eta_{BL,hwb,i}$ Customer i's hot water boiler's efficiency or that of the hot water generating plant that supplied hot water to the project customer i, based on NCV. The value of this parameter shall be one of the following:

a. the highest measured value of boiler efficiency recorded over full range boiler test;

b. the boiler's peak thermal efficiency as per manufacturer's information;

c. efficiencies of boilers of similar design;

d. a default boiler efficiency of 100%

The energy content of the hot water self-generated by project customer i, or by the hot water generating facility that supplies hot water to customer i, is given by:

$$HHWC_{BL,hwb,i,y} = HHWP_{BL,hwb,i,y} \cdot HHWEN_{BL,hwb,i,y} \quad (16)$$

Where:

$HHWP_{BL,hwb,i,y}$ The mass of hot water self-generated in hot water boilers by the project customer i or by the hot water generating plant that supplies hot water to customer i, in year y (in tonnes)

$HHWEN_{BL,hwb,i,y}$ The specific enthalpy of the hot water leaving project customer i's installation or that of the hot water leaving the facility that supplies hot water to the project customer i, in year y (in TJ/tonne of water)

Note for monitoring during the crediting period.

Option II Aa is based on actual performance data. However changes may be made to certain elements of the project customer's hot water system (e.g. the improved insulation) could result in a lower hot water baseline emissions factor during the years of the crediting period. Additionally, changes in the type of fuel used may occur in any year y during the crediting period, which are likely to have occurred also in the absence of the project activity.

The project proponents shall therefore:

a) establish the lowest specific heat consumption per unit of thermal energy given by $\min\left(HEC_{BL,FF,st,i,y} / HHWC_{BL,hwb,i,y}\right)$ up till year y

b) multiply the above value with $\left(\frac{44}{12} \cdot CEF_{FF,i,y}\right)$ of the fuel used in year y

The baseline hot water emissions factor for year y shall be the lowest between the value so calculated and that obtained from equation (13).

The purpose of this approach is to identify which year is the least energy intensive one, and assume that the improved performance would have not been lost over time. That is, in any year y it is always assumed that hot water will be produced with the minimum amount of fossil fuel derived energy. It also aims to reflect the fact that changes in the fuel type being used in any year y may change to what has previously been the case, and that furthermore such changes would have also occurred in the absence of the project activity. If however in any year y, there is no fossil fuel consumption at the project customer's hot water generating facility because all is displaced by the project activity, then the project proponent shall apply the lowest hot water baseline emissions factor amongst the one for the three most recent years prior to the implementation of the project for which data is available and the values obtained during the years of the crediting period leading up to year y.

Note for cases in which a project customer uses hot water produced by another hot water generating plant:

Where the project customer is one that imports hot water from a generating facility, heat losses in transmission and distribution of that hot water shall be considered nil. In other words, enthalpy data applied into the equations above shall be that which corresponds to the temperature of the water produced at the hot water generating facility and not those existing at the point of off-take by the project customer. In this case, the hot water emissions factor shall be monitored during the crediting period as per the preceding note.

Option II.A.b.

The baseline specific CO_2 emissions factor for a project customer "i" of the hot water generating facility that supplies hot water to a project customer i, can be determined from the hot water boiler manufacturer's design data and monitoring the difference between the boiler hot water outlet and inlet return temperatures as follows:

$$HWEF_{BL,i,y} = \frac{44}{12} \cdot \frac{CEF_{BL,i,y} \cdot 100}{\eta_{BL,hwb,i}} \cdot \frac{\Delta T_{P,i,y}}{\Delta T_{BL,i}} \qquad (17)$$

Where:

$CEF_{BL,i,y}$ Carbon emissions factor in tonnes CO_2/TJ corresponding to the fossil fuel used by customer i to produce the hot water, or by the hot water production plant that supplies the hot water which the project customer uses in year y

$\eta_{BL,hwb,i}$ Customer i's hot water boiler's efficiency or the efficiency of the facility that produces the hot water which project customer i uses, based on the NCV. The value of this parameter shall be one of the following:

a. the highest measured value of boiler efficiency recorded over full range boiler test;

b. the boiler's peak thermal efficiency as per manufacturer's information;

c. efficiencies of boilers of similar design;

d. a default boiler efficiency of 100%.

$\Delta T_{BL,i}$ Temperature difference between the water exiting the boiler and the water returning to it. The value applied shall be the lowest mean annual temperature difference over the three most recent years for which historical data is available. Alternatively, the design annual mean temperature difference may be considered as a default;

$\Delta T_{P,i,y}$ Temperature difference between the water exiting boiler and water returning in year y. The applied value shall be the lowest value during the historical period considered and the current year. Alternatively, the design annual mean temperature difference may be considered as a default.

Option II.B. Hot water produced from steam using heat exchangers

The following alternatives are provided to determine the baseline CO_2 emissions factor associated to the production hot water in tonnes of CO_2/TJ when this is produced from steam.

Option II.B.a.

The CO_2 baseline emission factor associated with hot water production in steam heat exchangers can be calculated based upon historical data as:

$$HWEF_{BL,i,y} = \frac{44}{12} \cdot \frac{\sum_i (SEF_{BL,i,y} \cdot HEC_{BL,st,sthx,i})}{\sum_i HHWC_{BL,sthx,i}} \quad (18)$$

$SEF_{BL,i,y}$ The baseline emission factor for the production of steam which is used to produce the hot water (in tonnes CO_2/TJ), and obtained from equation (4).

$HHWC_{BL,sthx,i,y}$ The energy contained in hot water self generated by project customer i from steam or by the supplier of the hot water to a project customer i in a steam-to-water heat exchanger (in TJ) in year y

$HEC_{BL,st,sthx,i,y}$ The energy associated with the steam consumed by customer i to self-generate hot water or that which is consumed by the hot water production plant which produces the hot water that a project customer i uses, in a steam-to-water heat exchanger (in TJ) in year y

The energy contained in hot water self generated by project customer i from steam or obtained from the hot water generating plant that supplied this hot water to a project customer i, by means of a steam-to-water heat exchanger can be obtained by:

$$HHWC_{BL,sthx,i,y} = HHWP_{BL,sthx,i,y} \cdot HHWEN_{BL,hw,sthx,i,y} \quad (19)$$

$HHWP_{BL,sthx,i,y}$ The mass of hot water self-generated by the project customer i or by the hot water production plant that produced the hot water that a project customer i uses, by means of a steam-to-water heat exchanger during year y (in tonnes)

$HHWEN_{BL,hw,sthx,i,y}$ Specific enthalpy of water leaving the steam-to-water heat exchanger or exchangers of the project customer i, during year y.

The amount of energy consumed in the form of steam to produce hot water in the absence of the project activity (in TJ), $HEC_{BL,st,sthx,i,y}$, is given by:

Option II.B.a.i.

$$HEC_{BL,st,sthx,i,y} = HFC_{BL,NG,hwb,i,y} \cdot HHWEN_{BL,st,sthx,i,y} \quad (20)$$

$HFC_{BL,st,stbx,i,y}$ Quantity of steam consumed by the project customer i or the facility that generates the hot water which a project customer i used in year y (in tonnes)

$HHWEN_{BL,st,sthx,i,y}$ Difference of the specific enthalpy of steam entering and condensate leaving the heat exchanger in year y (in TJ/tonne of water)

Option II.B.a.ii.

Alternatively, in the absence of suitable actual steam consumption data, or if preferred, $HEC_{BL,st,sthx,i,y}$ may be calculated as follows:

$$HEC_{BL,st,sthx,i,y} = \frac{(HHWC_{BL,sthx,i,y} - HHWP_{BL,sthx,i,y} \cdot HSEN_{w,y}) \cdot 100}{\eta_{BL,sthx,i}} \quad (21)$$

Where

$HSEN_{w,y}$ The specific enthalpy of water entering the steam to water heat exchanger in year y

$\eta_{BL,sthx,i}$ The steam-to-water exchanger efficiency (%) of customer i's hot water generating plant or that of the hot water generating plant that provides hot water to customer i, based on one of the following:

a. the highest measured annual value of heat exchanger efficiency;

b. the design heat exchanger efficiency;

c. efficiencies of steam-to-water heat exchangers of similar design;

d. a default heat exchanger efficiency of 100%.

Note for monitoring during the crediting period.

Changes may be made during the crediting period to elements of the hot water distribution system (e.g. improved insulation) that may reduce the amount of steam required to meet the thermal loads), which in turn will lead to changes in the baseline emissions factor of the hot water produced.

Changes may also occur to elements of the steam system from which the heat exchangers are fed, which may also lead to changes in the baseline emissions factor of the steam, and hence impact the baseline emissions factor for the hot water.

In establishing the value of the hot water baseline emissions factor to be applied in year y the project proponents shall therefore:

c) establish the lowest specific heat consumption per unit of thermal energy given by $\min(HEC_{BL,st,sthx,i,y} / HHWC_{BL,sthx,i,y})$ up till year y

d) multiply the above value with $SEF_{BL,i,y}$ corresponding to the year y

The baseline hot water emissions factor for year y shall be the lowest between the value so calculated and that obtained from equation (18).

The purpose of this approach is to identify which year is the least energy intensive one, and assume that the improved performance achieved in the hot water system would have not been lost over time. That is, in any year y it is always assumed that hot water will be produced with the minimum amount of steam energy.. If however in any year y, there is no steam consumption in the steam – hot water heat exchanger at the project customer's hot water generating facility because all of it is displaced by the project activity, then the project proponent shall apply the lowest hot water baseline emissions factor amongst the one obtained from the average of the three most recent years prior to the implementation of the project for which data is available and the values obtained during the years of the crediting period leading up to year y.

The project proponent shall ensure the steam baseline emissions factor is monitored annually and updated accordingly when applied to the above equations. The value for the baseline emissions factor of the steam to be applied in any year y shall be that obtained as per Section I above.

Option II.B.b.

The baseline CO_2 emissions factor for a customer i can be determined without having to resort to historical data of steam and/or hot water production from the steam-to-water heat exchanger manufacturer design data as follows:

$$HWEF_{BL,i,y} = \frac{44}{12} \cdot \frac{SEF_{BL,i,y} \cdot 100}{\eta_{BL,sthx,i}} \qquad (22)$$

Where:

$SEF_{BL,i,y}$ — The baseline emission factor corresponding to the steam that is utilized either by the project customer i or the hot water production plant that supplies hot water to customer i in year y, whichever is the case (in tonnes CO_2/TJ). Obtained from equation 4.

$\eta_{BL,sthx,i}$ — The efficiency of steam-to-water exchanger efficiency at customer i's installations or at the facility which supplies hot water to customer i, based on one of the following:

a. the highest measured annual value of heat exchanger efficiency;

b. the design heat exchanger efficiency;

c. efficiencies of heat exchangers of similar design;

d. a default heat exchanger efficiency of 100%.

Note for monitoring during the crediting period

Changes may be made during the crediting period to elements of the steam system from which the heat exchangers are fed may lead to changes in the baseline emissions factor of the steam used, and hence impact the baseline emissions factor for the hot water which is produced.

Therefore, the project proponent shall ensure the steam baseline emissions factor is monitored annually and updated accordingly when applied to the above equations. The value for the baseline emissions factor of the steam to be applied in year y shall be that obtained as per Section I above.

CALCULATION OF THE PROJECT EMISSIONS

Project emissions within the project boundary result from the combustion of natural gas within the project boundary:

$$PE_y = PE_{NG,P,y} \tag{23}$$

Where:

$PE_{NG,P,y}$	Project emissions resulting from combustion of natural gas within the project boundary (in t CO_2e) for the year y.

Those project emissions are respectively calculated as follows:

$$PE_{NG,P,y} = FC_{NG,P,y} \cdot NCV_{NG} \cdot EF_{NG,CO2,p} \tag{24}$$

Where:

$FC_{NG,P,y}$	Natural gas consumed within the project facility “j” (in tonnes/ normal m^3) in the year y.
NCV_{NG}	Lower heating value of the natural gas combusted (in TJ/t or TJ/normal m^3). As per certificates from the natural gas supplier or from IPCC figures.
$EF_{NG,CO2,p}$	CO_2 emission factor for the combustion of natural gas (in t CO2/TJ). As per certificates from the natural gas supplier or from IPCC figures.

When calculating the term $FC_{NG,P,y}$, the project proponent may resort to using the formula below:

$$FC_{NG,P,y} = FC_{NG,P,C,y} + FC_{NG,P,H,y} \tag{25}$$

Where:

$FC_{NG,P,C,y}$	Natural gas consumed by the main equipment within the boundaries of the project facility j in year y (in tonnes/ normal m^3)
$FC_{NG,P,H,y}$	Natural gas consumed for supplementary firing within the boundaries of the project facility j in year y (in tonnes/ normal m^3).

CALCULATION OF THE LEAKAGE EMISSIONS

The project proponent should estimate the size of leakage emission from electricity consumption and assess if those leakages are higher than 1% of the calculated emission reductions from that project activity, in the event that the project activity were to draw electricity from the grid. If that is the case, those leakage emissions should be included in the leakage calculations.

Upstream emissions from fuel extraction, processing, liquefaction, transportation and regasification of Natural Gas (to be considered only when the project fuel is Natural Gas)

In this methodology, the following leakage emission sources shall be considered:

- Fugitive CH_4 emissions associated with fuel extraction, processing, liquefaction, transportation, regasification and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity ($LE_{CH_4,y}$).
- In the case LNG is used in the project plant: CO_2 emissions from fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system ($LE_{LNG,CO_2,y}$).

$$LE_{US,y} = LE_{CH_4,y} + LE_{LNG,CO_2,y} \qquad (26)$$

Where:

$LE_{CH_4,y}$	Leakage emissions due to fugitive upstream CH4 emissions in the year y in t CO2e
$LE_{LNG,CO_2,y}$	Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in t CO2e

Fugitive methane emissions

For the purpose of determining fugitive methane emissions associated with the production – and in case of natural gas, the transportation and distribution of the fuels – project participants should multiply the quantity of natural gas consumed in all element processes i with a methane emission factor for these upstream emissions ($EF_{NG,upstream,CH_4}$), and subtract for all fuel types k which would be used in the absence of the project activity the fuel quantities multiplied with respective methane emission factors ($EF_{NG,upstream,CH_4}$), as follows:

$$LE_{CH_4,y} = \left[FF_{\Pr oject,y} \cdot NCV_{NG,y} \cdot EF_{NG,upstream,CH_4} - \sum_k FF_{Baseline,k,y} \cdot NCV_{NG,k} \cdot EF_{NG,upstream,CH_4} \right] \cdot GWP_{CH_4} \quad (27)$$

Where:

$LE_{CH_4,y}$	Leakage emissions due to upstream fugitive CH4 emissions in the year y in t CO2e
$FF_{\Pr oject,y}$	Quantity of natural gas combusted in all element processes during the year y in m³
$NCV_{NG,y}$	Average net calorific value of the natural gas combusted during the year *y* in /m³
$EF_{NG,upstream,CH_4}$	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas in t CH4 per TJ fuel supplied to final consumers
$FF_{Baseline,k,y}$	Quantity of fuel type *k* (a coal or oil) that would be combusted in the absence of the project activity in all element processes during the year *y* in a volume or mass unit
$EF_{NG,upstream,CH_4}$	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas in t CH4 per TJ fuel supplied to final consumers
GWP_{CH_4}	Global warming potential of methane valid for the relevant commitment period

Where reliable and accurate national data on fugitive CH4 emissions associated with the production, and in case of natural gas, the transportation and distribution of the fuels is available, project participants should use this data to determine average emission factors by dividing the total quantity of CH4 emissions by the quantity of fuel produced or supplied respectively. Where such data is not available, project participants may use the default values provided in Table 2 below. In this case, the natural gas emission factor for the location of the project should be used, except in cases where it can be shown that the relevant system element (gas production and/or processing/transmission/distribution) is predominantly of recent vintage and built and operated to international standards, in which case the US/Canada values may be used.

Note that the emission factor for fugitive upstream emissions for natural gas ($EF_{NG,upstream,CH_4}$) should include fugitive emissions from production, processing, transport and distribution of natural gas, as indicated in the Table 2 below. Note further that in case of coal the emission factor is provided based on a mass unit and needs to be converted in an energy unit, taking into account the net calorific value of the coal.

Table 2: Default emission factors for fugitive CH_4 upstream emissions

Activity	Unit	Default emission factor	Reference for the underlying emission factor range in Volume 3 of the *1996 Revised IPCC Guidelines*
Coal			
Underground mining	t CH4 / kt coal	13.4	Equations 1 and 4, p. 1.105 and 1.110
Surface mining	t CH4 / kt coal	0.8	Equations 2 and 4, p.1.108 and 1.110
Oil			
Production	t CH4 / PJ	2.5	Tables 1-60 to 1-64, p. 1.129 - 1.131
Transport, refining and storage	t CH4 / PJ	1.6	Tables 1-60 to 1-64, p. 1.129 - 1.131
Total	t CH4 / PJ	4.1	
Natural gas			
USA and Canada			
Production	t CH4 / PJ	72	Table 1-60, p. 1.129
Processing, transport and distribution	t CH4 / PJ	88	Table 1-60, p. 1.129
Total	t CH4 / PJ	160	
Eastern Europe and former USSR			
Production	t CH4 / PJ	393	Table 1-61, p. 1.129
Processing, transport and distribution	t CH4 / PJ	528	Table 1-61, p. 1.129
Total	t CH4 / PJ	921	
Western Europe			
Production	t CH4 / PJ	21	Table 1-62, p. 1.130
Processing, transport and distribution	t CH4 / PJ	85	Table 1-62, p. 1.130
Total	t CH4 / PJ	105	
Other oil exporting countries / Rest of world			
Production	t CH4 / PJ	68	Table 1-63 and 1-64, p. 1.130 and 1.131
Processing, transport and distribution	t CH4 / PJ	228	Table 1-63 and 1-64, p. 1.130 and 1.131
Total	t CH4 / PJ	296	

Note: The emission factors in this table have been derived from IPCC default Tier 1 emission factors provided in Volume 3 of the 1996 Revised IPCC Guidelines, by calculating the average of the provided default emission factor range.

CO_2 emissions from LNG

Where applicable, CO2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($LE_{LNG,CO_2,y}$) should be estimated by multiplying the quantity of natural gas combusted in the project with an appropriate emission factor, as follows:

$$LE_{LNG,CO_2,y} = FF_{Project,y} \cdot EF_{CO_2,upstream,LNG} \quad (28)$$

Where:

$LE_{LNG,CO_2,y}$ Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or

	distribution system during the year y in t CO2e
$FF_{Project,y}$	Quantity of natural gas combusted in all element processes during the year *y* in m³
$EF_{CO_2,upstream,LNG}$	Emission factor for upstream CO2 emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, regasification and compression of LNG into a natural gas transmission or distribution system

CALCULATION OF THE EMISSION REDUCTIONS

The GHG emission reductions resulting from the project activity in the year y (ER_y) are calculated as in the equation below:

$$ER_y = BE_y - PE_y - LE_y \quad (29)$$

Where:

BE_y	Emissions in the baseline scenario for the year y. Calculated as in the equation given above.
PE_y	Emissions resulting from the project activity in the year y. Calculated as in the equation given above.
LE_y	Net leakage emissions resulting from the implementation and operation of the project activity. Calculated as in the equation given above.

The project proponent, who applies the new VCS methodology, should provide evidences for the figures applied and used in the excel work sheets in order to be able to fully retrace the assumptions and calculations made to determine the emissions reductions.

Data and parameters not monitored:

Data/parameter:	$SC_{BL,j,y}$
Data unit:	TJ
Description:	The amount of energy consumed in the form of steam by the project customer i, which is supplied by the project facility “j” in year y.
Source of data:	Calculated on the basis of the steam generation and the data for the steam enthalpy.

Measurement procedures (if any):	If applicable, energy content of steam can be directly measured.
QA/QC procedures	
Any comment:	-
Uncertainty level	Low: this parameter is calculated from variables which are monitored and subject to their own QA/QC procedures ($SP_{BL,j,y}$ and $SDEN_{BL,j,y}$). Alternatively, this could be measured by a heat meter, calibrated also following the QA/QC procedures applied in the data and parameters to be monitored section, which is similar also to that applied in other CDM approved methodologies such as AM0048.

Data/parameter:	$SEF_{BL,i,y}$
Data unit:	t CO_2/TJ
Description:	The baseline emission factor for the production of steam in project customer i for year y.
Source of data:	Actual performance data that is publicly available will be used for purpose. Otherwise, the project proponent may resort to historical data for the three most recent years for which data is available.
Measurement procedures (if any):	-
QA/QC procedures	-
Any comment:	
Uncertainty level	Low: two options are given in the meth to determine SEF: Option I.A., based on publicly available energy performance data on the amount of energy produced in the form of steam and energy consumed to produce it. The uncertainty level is in theory dependent mostly upon the how the amount of fossil fuel energy consumed is determined, namely $HEC_{BL,FF,st,i,y}$. The uncertainty level of this parameter is in turn considered to be low per se, and two options are given in turn to determine it as discussed in the table for $HEC_{BL,FF,st,i,y}$ Option I.B, based on default values and varying degrees of condensate recovery percentages with respect to the total amount of steam generated. Hence, the uncertainty level in this option is dependent primarily on how the fraction of heat recovered in the form of condensate is determined. This option relies on the use of efficiency values which are taken conservatively as those of the steam generating facilities of the project customers. It assumes that there are no transmission losses

	of heat. Such assumptions lead to a highly conservative estimate for the specific emissions because it assumes that once steam is generated from the boilers, there is no further loss of energy until the point of use. In practice, heat losses due to transmission tend to be of the order of 10%. The fossil fuel that needs to be burned to make up for these losses is ignored in our calculations, and this we feel is more than sufficient to compensate for even uncertainties, which as discussed we feel are low anyhow. Furthermore, all the options used to estimate the amount of energy recovered from the condensate that is formed assume that there are no condensate, nor heat losses between the point of condensate formation and entrance to the condensate recovery tank. This of course is highly conservative per se. There are two options given to determine Xc depending upon the availability of historical and actual data for quantity of condensate recovered and sent to the boiler house and condensate conditions of temperature and pressure. Where actual data is used, the maximum historical values are assumed, thereby assuming maximum energy recovery. The second option involves the use of default factors and requires annual verification to be carried out that the no changes have occurred that warrant a change in the applied default value.

Data/parameter:	$HEC_{BL,FF,st,i,y}$
Data unit:	TJ
Description:	The energy associated with the fossil fuel that was consumed by the project customer "i" during year y
Source of data:	Calculated on the basis of actual fuel consumption data that is publicly available.
Measurement procedures (if any):	-
QA/QC procedures	Ensure suitable standards for determining efficiency are applied if parameter is not determined from public sources. Check consistency with previously derived values and equipment design efficiency values
Any comment:	
Uncertainty level	There are two options given to determine $SEF_{BL,i,y}$, one based on a publicly reported data (Option 1 A) and the other based on default values (Option 1 B). Option 1A. The uncertainty level is considered to be low for this option if the central heating plant has to publicly report it heat production and fuel consumption figures to energy regulators. However if the central generating facility has only to report publicly its heat production figures and not its fossil fuel consumption ones, then in this case the uncertainty is potentially

	higher and additional measures need to be in place to ensure a low level of uncertainty. The methodology offers two alternatives to determine what the fossil energy consumption may be: Option I.A.a, which is based on publicly reported fuel consumption figures and fuel properties, which can be obtained from fuel suppliers, and which therefore is considered to be of low uncertainty Option I.A.b is based on the actual heat or steam production figures and conditions of boiler feedwater and steam, and the efficiency of the steam generating system. The efficiency of the steam generating equipment enables the project proponent to apply four options, each of which are more conservative than the other. Three of those options are: the manufacturer's quoted peak boiler efficiency, efficiencies of boilers of similar design, or a default value of 100% efficiency. The uncertainty level of these is low. The forth option is based on peak measured efficiencies, but this must be carried out by applying the standard procedures for boiler efficiency determinations. The use of a standard method, which relies on calibrated equipment and involves applying the highest value obtained over a full load range text in our opinion lead to a low level of uncertainty in the determination of the boiler efficiency in the event this option were to be applied. Option I B, which does not rely on reported energy production and consumption data but rather relies on similar boiler efficiency options given above. It offers an even lower uncertainty level In both cases above heat losses throughout the transmission system are ignored. Heat losses in steam transmission alone can amount to 5 – 10 % , and sometime even more in old systems, of energy produced by the generating facility. The calculations in the meth assume zero losses, and thus fuel to steam efficiency is significantly higher than what is in typical. Hence, the extra fossil fuel that needs to be burned to make up for these losses is not considered for the purpose of determining the amount of fossil fuel energy supplied to the steam generating facilities. This leads to a lower CO_2 emissions factor per unit energy of steam produced that will be the case in reality.

Data/parameter:	$HSC_{BL,i,y}$
Data unit:	TJ
Description:	The amount of energy contained in the steam which was generated by the customer i by burning fossil fuel during year y

Source of data:	Actual data that is publicly available will be used for purpose, or calculated using measured data (quantity of stem produced by customer i or the facility that supplies steam to customer i.
Measurement procedures (if any):	-
QA/QC procedures	Check for consistency with historical values if option involving the use of measured data is applied.
Any comment:	
Uncertainty level	Low: this data is publicly available and presented to energy authorities and the result of heat supplied to customers, or optional derived from monitored parameters subject to common QA/QC applied to measure similar parameters

Data/parameter:	$HFC_{BL,FF,st,i,y}$
Data unit:	tonnes
Description:	The quantity of fossil fuel consumed for steam generation by project customer i during year y.
Source of data:	Actual data that is publicly available will be used for this purpose.
Measurement procedures (if any):	-
QA/QC procedures	
Any comment:	
Uncertainty level	Low: if this is provided by the supplier of the steam as part of its duty to report this consumption to outside stakeholders. Data can also be crosschecked against historical data and compared to the amount of heat produced in the form of steam and supplied to the customers.

Data/parameter:	$\eta_{BL,st,i}$
Data unit:	**%**
Description:	Project customer i's boiler efficiency based on NCV (in %).
Source of data:	The highest measured value of boiler efficiency recorded over full range boiler test; the boiler's peak thermal efficiency as per manufacturer's information or a default boiler efficiency of 100%;
Measurement procedures (if any):	Full range boiler test if applicable
QA/QC procedures	Ensure suitable standards for determining efficiency are applied if relevant to the option chosen. Check consistency with similarly derived historical values and equipment design efficiency values
Any comment:	
Uncertainty level	Low: even in the case in which boiler efficiency is determined based measurements, these have to be done according to acceptable standards. It also involves taking the highest value of a full boiler efficiency load test which leads to a conservative determination of efficiency under this option. The remaining

	options involve an even higher degree of efficiency and to do not rely on any measured data, but rather on published data or very high conservative assumptions for boiler efficiency.

Data/parameter:	$HWC_{BL,j,y}$
Data unit:	TJ
Description:	The energy content in the hot water produced by the project facility j, which is purchased by project customer i in year y
Source of data:	If applicable, energy content of hot water can be directly measured.
Measurement procedures (if any):	-
QA/QC procedures	Where applicable meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data. Crosscheck with invoices at project facility site
Any comment:	
Uncertainty level	Low: determined using QA/QC procedures commonly used in the CDM to temperature measurements.

Data/parameter:	$HWEF_{BL,i,y}$
Data unit:	t CO_2/TJ
Description:	The CO_2 emissions factor for the hot water produced in year y.
Source of data:	Actual data that is publicly available will be used for purpose.
Measurement procedures (if any):	-
QA/QC procedures	-
Any comment:	
Uncertainty level	Low: based partly on publicly reported data for heat production and fossil fuel consumption required to comply with energy legislation, or if applicable based on conservative and low level of uncertainty values of efficiency and publicly reported heat production figures, or in the absence of these on default values of low uncertainty level.

Data/parameter:	$HEC_{BL,FF,hwb,i,y}$
Data unit:	TJ
Description:	The energy associated with the fossil fuel consumed by customer i to self-generate hot water in a hot water boiler during year y.
Source of data:	Actual data that is publicly available will be used for purpose.
Measurement procedures (if any):	-
QA/QC procedures	-
Any comment:	

Uncertainty level	Low: same as for $HEC_{BL,FF,st,i,y}$ given above.

Data/parameter:	$HHWC_{BL,hwb,i,y}$
Data unit:	TJ
Description:	The energy contained in the hot water, which was generated by the customer i from burning fossil fuel during year y.
Source of data:	Actual data that is publicly available will be used for purpose.
Measurement procedures (if any):	-
QA/QC procedures	-
Any comment:	
Uncertainty level	Low: this data is publicly available and presented to energy authorities and the result of heat supplied to customers

Data/parameter:	$HFC_{BL,FF,hwb,i,y}$
Data unit:	tonnes
Description:	The quantity of fossil fuel consumed for hot water generation in hot water boilers by project customer i during year y. This can be reported as mass units of the baseline fuel or in units of volume if data is provided on the mass density of the natural gas used (in tonnes)
Source of data:	Actual data that is publicly available will be used for purpose.
Measurement procedures (if any):	-
QA/QC procedures	- .
Any comment:	
Uncertainty level	Low: if this is provided by the supplier of the hot water as part of its duty to report this consumption to outside stakeholders. Data can also be crosschecked against historical data and compared to the amount of heat produced in the form of steam and supplied to the customers.

Data/parameter:	$\eta_{BL,hwb,i}$
Data unit:	
Description:	Project customer i's hot water boiler's efficiency based on NCV.
Source of data:	The highest measured value of boiler efficiency recorded over full range boiler test; the boiler's peak thermal efficiency as per manufacturer's information or a default boiler efficiency of 100%
Measurement procedures (if any):	A full range boiler test if applicable.
QA/QC procedures	Ensure suitable standards for determining efficiency are applied if relevant to the option chosen. Check consistency with similarly derived historical values and equipment design efficiency values
Any comment:	

Uncertainty level	Low: even in the case in which boiler efficiency is determined based measurements, these have to be done according to acceptable standards. It also involves taking the highest value of a full boiler efficiency load test which leads to a conservative determination of efficiency under this option. The remaining options involve an even higher degree of efficiency and to do not rely on any measured data, but rather on published data or very high conservative assumptions for boiler efficiency.

Data/parameter:	$HHWC_{BL,sthx,i,y}$
Data unit:	TJ
Description:	The energy contained in hot water self generated by project customer i from steam, in a steam-to-water heat exchanger (in TJ) during year y.
Source of data:	Actual data that is publicly available will be used for purpose.
Measurement procedures (if any):	-
QA/QC procedures	-
Any comment:	
Uncertainty level	Low: if this data is publicly available and presented to energy authorities and the result of heat supplied to customers.

Data/parameter:	$HHWP_{BL,sthx,i,y}$
Data unit:	tonnes
Description:	The mass of hot water self-generated by the project customer i by steam-to-water heat exchanger during year y.
Source of data:	Actual data that is publicly available will be used for purpose.
Measurement procedures (if any):	-
QA/QC procedures	-
Any comment:	
Uncertainty level	Low: this data is publicly available and presented to energy authorities and quantifies the result of heat supplied to customers.

Data/parameter:	$HFC_{BL,st,stbx,i,y}$
Data unit:	tonnes
Description:	Quantity of steam consumed by the project customer for hot water production during year y.
Source of data:	Actual data that is publicly available will be used for this purpose.
Measurement procedures (if any):	-
QA/QC procedures	-
Any comment:	
Uncertainty level	Low: this data is publicly available and presented to energy

	authorities and quantifies the result of heat supplied to customers.

Data/parameter:	$\eta_{BL,sthx,i}$
Data unit:	
Description:	customer i's (in %) steam-to-water exchanger efficiency based on one of the following
Source of data:	The highest measured annual value of heat exchanger efficiency; the design heat exchanger efficiency or a default heat exchanger efficiency of 100%.
Measurement procedures (if any):	-
QA/QC procedures	Ensure suitable standards for determining efficiency are applied if relevant to the option chosen. Check consistency with similarly derived historical values and equipment design efficiency values if applicable.
Any comment:	
Uncertainty level	Low: provided suitable tests are conducted. Low: if any default value is chosen.

MONITORING METHODOLOGY

Monitoring procedures

Data for carbon content of fuel sources may be taken from IPCC. In the event that more recent or accurate scientific studies are produced and approved by the UNFCCC these data shall be used.

Official electricity generation and transmission company statistics is used to determine the grid electricity coefficient. This data is gathered from the utilities, whether on the national, regional or local level, as appropriate.

It is assumed that the data provided for the electricity grid and from individual facilities are available and transparent, in order to calculate the carbon coefficient of the electricity and steam and or hot water being displaced from project customers by the project activity.

Vintage and spatial level of data: the data is gathered on a national or regional power grid level to determine the combined margin.

As for the vintage of the data, the project developer should try and get three years of data prior to project implementation where to required in the baseline methodology. If three years of data is not available, then the project developer must use at least one complete year (two when it exists) and must demonstrate using evidence from credible sources to the DOE that additional data does not exist. Non-representative data is included unless there is a major outlying event. Should the project developer wish to exclude non-representative data they must be able to document why this is removed and this should be approved during validation.

When IPCC data is available, project proponents shall take into consideration that the Board agreed that the IPCC default values should be used only when country or project specific data are not available or difficult to obtain.

The project developer will have to ensure the completeness and accuracy of the data set during the baseline measurement year by installing, repairing, and calibrating meters as appropriate. Completeness/accuracy of data should be relatively easy to verify, and emissions reductions will not be included if the evidence does not demonstrate this point clearly. The project developer should obtain data on metering in the project and try and ascertain that the meter accuracy is 95% or greater – and that quality control procedures are in place to deal with defective meters and/or recalibrate them on a regular basis.

The project proponent shall also provided simplified diagrams illustrating the location of the monitoring points.

Data and parameters monitored

Data/parameter:	$EG_{P,y}$
Data unit:	MWh
Description:	Net electricity supplied to the power grid by the proposed project facility ‘j’ in year ‘y’(MWh/yr).
Source of data:	Electricity meter at the project facility ‘j’
Measurement procedures (if any):	Read electricity meter and store information until 2 years after the end of the crediting period.
Monitoring frequency	Monthly
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data. Crosscheck with invoices and electricity supply data at project facility site.
Any comment:	
Uncertainty level	Low, it follows QA/QC procedures and monitoring frequencies which are common to other CDM Monitoring methodologies such as AM0048

Data/parameter:	$CEF_{BL/P,FF,y}$
Data unit:	t C/TJ
Description:	Carbon emission factor corresponding to the fossil fuel used to produce steam or hot water as applicable. Carbon emission factor in year y corresponding to fossil fuel used by project customer i to generate steam/hot water or that which is used in a given steam/hot water generating plant to produce the steam/hot water which is sourced by the project customer i (in tonnes of C/TJ), shall be determined from the technical literature, from the project customer i, or the steam/hot water generating plant which supplies steam/hot water to the project customer i.
Source of data:	Obtained from the project customer ‘i’ / project facility ‘j’ or technical literature.
Measurement procedures (if any):	When IPCC data is available, project proponents shall take into consideration that the Board agreed that the IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Monitoring frequency	-
QA/QC procedures	-
Any comment:	-

Uncertainty level	Low, given external sources that provide it (fuel suppliers/government bodies, IPCC)

Data/parameter:	$EF_{BL,CO_2,y}$
Data unit:	t CO_2/MWh
Description:	Emission factor of the electricity grid to which the project facility “j” supplies the electricity generated. Determination of the emission factor will be made once at the validation stage based on an ex ante assessment, and once again at the start of each subsequent crediting period (if applicable). Regardless of whether option 1 (BM) or option 2 (CM) is chosen, the emission factor is also calculated ex-post as described in the “Tool to calculate emission factor for an electricity system”.
Source of data:	Publicly available data on electricity generation within the respective power grid.
Measurement procedures (if any):	
Monitoring frequency	Calculated ex-post each year.
QA/QC procedures	As per “Tool to calculate emission factor for an electricity system”
Any comment:	-
Uncertainty level	Low, the data upon which the parameter is determined is obtained for official electricity sector statistics whilst the treatment of the data to the determine the parameter uses an approved CDM tool

Data/parameter:	$EF_{NG,upstream,CH_4}$
Data unit:	t CH_4/TJ
Description:	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas.
Source of data:	Obtained from the project facility ‘j’ or table in the leakage section.
Measurement procedures (if any):	When IPCC data is available, project proponents shall take into consideration that the Board agreed that the IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Monitoring frequency	-
QA/QC procedures	-
Any comment:	-
Uncertainty level	Low, the source is an official third party (IPCC) or a host country official source

Data/parameter:	$EF_{CO_2,upstream,LNG}$
Data unit:	tCO_2/TJ

Description:	Emission factor for upstream CO_2 emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, regasification and compression of LNG into a natural gas transmission or distribution system
Source of data:	Where reliable and accurate data on upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system is available, project participants should use this data to determine an average emission factor. Where such data is not available, project participants may assume a default value of 6 tCO_2/TJ as a rough approximation
Measurement procedures (if any):	When IPCC data is available, project proponents shall take into consideration that the Board agreed that the IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Monitoring frequency	-
QA/QC procedures	-
Any comment:	-
Uncertainty level	Low, the source is an official third party (IPCC) or a host country official source

Data/parameter:	$SDEN_{BL,j,y}$
Data unit:	TJ/tonne
Description:	Specific enthalpy of steam leaving the project facility 'j' (in TJ/tonne of steam supplied).
Source of data:	This data shall be obtained from steam tables, using temperatures and pressure of the steam purchased.
Measurement procedures (if any):	Use monitored pressure and temperature of the steam to obtain specific enthalpy from steam tables.
Monitoring frequency	Monthly
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data.
Any comment:	-
Uncertainty level	Low, parameter is obtained from temperature and pressure data that is monitored and subject to QA/QC procedures applied in CDM monitoring methodologies such as AM0048 and AM0029, and publicly available steam tables

Data/parameter:	Steam temperature
Data unit:	°C
Description:	Temperature of steam purchased by project customer 'i'.

Source of data:	Temperature meters at project facility 'j'
Measurement procedures (if any):	Read temperature meter daily and calculate monthly average. Store information until 2 years after the end of the crediting period.
Monitoring frequency	Daily measurements and monthly average.
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data.
Any comment:	-
Uncertainty level	Low, parameter is monitored and subject to QA/QC procedures applied in CDM monitoring methodologies such as AM0048

Data/parameter:	Steam pressure
Data unit:	MPa
Description:	Pressure of steam purchased by project customer 'i'.
Source of data:	Pressure meters at project facility 'j'
Measurement procedures (if any):	Read pressure meter daily and calculate monthly average. Store information until 2 years after the end of the crediting period.
Monitoring frequency	Daily measurements and monthly average.
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data.
Any comment:	-
Uncertainty level	Low, parameter is monitored and subject to QA/QC procedures applied in CDM monitoring methodologies such as AM0048

Data/parameter:	$FC_{NG,P,y}$
Data unit:	Tonnes or m^3
Description:	Natural gas consumed within the boundary of the project facility (in tonnes/normal m^3) in the year y.
Source of data:	Purchase records and fuel data logs.
Measurement procedures (if any):	Store information until 2 years after the end of the crediting period.
Monitoring frequency	Daily measurement and monthly recorded.
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data. Crosscheck with purchase records.
Any comment:	-
Uncertainty level	Low, parameter is monitored and subject to QA/QC procedures applied in CDM monitoring methodologies such as AM0029

Data/parameter:	GWP_{CH_4}
Data unit:	tCO_2/tCH_4
Description:	Global warming potential of CH_4 valid for the commitment period. Obtained from IPCC.
Source of data:	-
Measurement procedures (if any):	-
Monitoring frequency	-
QA/QC procedures	-
Any comment:	-
Uncertainty level	Low, given external source that provides it (IPCC)

Data/parameter:	NCV_{NG} / $NCV_{FF,i,y}$
Data unit:	TJ/t
Description:	Lower heating value of the natural gas/fossil fuel combusted (in TJ/t or TJ/10^3 normal m^3).
Source of data:	As per purchase certificates or IPCC default data.
Measurement procedures (if any):	-
Monitoring frequency	-
QA/QC procedures	-
Any comment:	-
Uncertainty level	Low, the source is a credible host country source such as the fuel supplier of an third part source such as the IPCC.

Data/parameter:	$HWEN_{BL,j,y}$
Data unit:	TJ/tonne
Description:	The specific enthalpy of hot water produced by the project facility j in the year y (TJ/ tonne).
Source of data:	This data shall be obtained using temperature of the hot water purchased measured at the project facility ‘j’ using data from the steam tables.
Measurement procedures (if any):	Use monitored temperature of the hot water produced by the project facility ‘j’ to obtain specific enthalpy.
Monitoring frequency	Monthly
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data.
Any comment:	If heat meter is available, separate temperature readings are not

	required.
Uncertainty level	Low, provided the given QA/QC procedures and monitoring frequencies are adhered to. Where the parameter is determined based on measured temperature the enthalpy is determined from steam tables. Hence uncertainty is also low.

Data/parameter:	Hot water temperature
Data unit:	°C
Description:	Temperature of hot water purchased by project customer 'i'.
Source of data:	Temperature meters at project facility 'j'.
Measurement procedures (if any):	Read temperature meter daily and calculate monthly average. Store information until 2 years after the end of the crediting period.
Monitoring frequency	Daily measurements and monthly average.
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data.
Any comment:	-
Uncertainty level	Low, parameter is monitored and subject to QA/QC procedures and monitoring frequency applied in CDM monitoring methodologies such as AM0048 to similar variables

Data/parameter:	Water return temperature
Data unit:	°C
Description:	Temperature of warm water returned to hot water generating facility.
Source of data:	Temperature meters at project facility 'j'.
Measurement procedures (if any):	Read temperature meter daily and calculate monthly average. Store information until 2 years after the end of the crediting period.
Monitoring frequency	Daily measurements and monthly average.
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data.
Any comment:	To be applied when using Option II.A.b.
Uncertainty level	Low, parameter is monitored and subject to QA/QC procedures and monitoring frequency applied in CDM monitoring methodologies such as AM0048 to similar variables

Data/parameter:	Steam condensate temperature
Data unit:	°C
Description:	Temperature of condensate from existing heat exchanger used by customer 'i ' to produce hot water or by the supplier of hot water

	to customer i
Source of data:	Temperature meters
Measurement procedures (if any):	Store information until 2 years after the end of the crediting period.
Monitoring frequency	Daily measurements and monthly average.
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data.
Any comment:	To be used when applying Option II.B.a.i
Uncertainty level	Low, parameter is monitored and subject to QA/QC procedures and monitoring frequency applied in CDM monitoring methodologies such as AM0048 to similar variables. Where defaults are used, the validity of these defaults is verified annually to determine if significant changes have been made to operating conditions (pressure) of the condensate system or if flash steam recovery system is added or it operating pressure increased.

Data/parameter:	$HWP_{BL,j,y}$
Data unit:	tonnes/yr
Description:	The amount of hot water produced by project facility ‘j’ and supplied to project customer ‘i’ in the year y (in tonnes)
Source of data:	Measured at the project facility ‘j’.
Measurement procedures (if any):	Read hot water meter and store information until 2 years after the end of the crediting period.
Monitoring frequency	Monthly
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data. Crosscheck with purchase receipts and hot water supply data at project site.
Any comment:	-
Uncertainty level	Low, the parameter is monitored and subject to QA/QC procedures which are common to those demanded in other CDM methodologies such as AM0029 and AM0048. It can be cross checked with billing information

Data/parameter:	$SP_{BL,j,y}$
Data unit:	tonnes/yr
Description:	Quantity of steam produced by the project facility ‘j’ and supplied to the project customer ‘i’ in the year y, (in tonnes)
Source of data:	Measured at the project facility ‘j’.
Measurement procedures (if any):	Read steam meter and store information until 2 years after the end of the crediting period.

Monitoring frequency	Monthly
QA/QC procedures	Meters shall be calibrated as per their data book. Measuring conditions shall be as per meters data book. Check consistency with historical monitored data. Crosscheck with invoices and steam supply data at project site.
Any comment:	-
Uncertainty level	Low, the parameter is monitored and subject to QA/QC procedures which are common to those demanded in other CDM methodologies such as AM0029 and AM0048. It can be cross checked with billing information

GUIDANCE TO THE APPLICATION OF THE METHODOLOGY AND THE PREPARATION OF THE VCS PROJECT DESCRIPTION

1. Project location including geographic and physical information allowing the unique identification and delineation of the specific extent of the project should be provided in the PDD.

2. In line with the requirements of the VCS PD format, the project proponent, who applies the new VCS methodology, should provide a detailed description of:

   (a)The scenario existing prior to the start of the implementation of the project activity, with a list of the equipment(s) and systems in operation at that time;

   (b) The scope of activities/measures that are being implemented within the project activity, with a list of the equipment(s) and systems that will be installed and/or modified within the project activity/activities.

   The project implementation schedule (precise schedule of works) should be described in detail with indication of the current status. Project proponents should indicate the source for the technical data provided in the PDD.

3. The technical specifications of the equipment installed at the site of the project activity should be disclosed together with the consumption of fuel, electricity, net calorific value of the fuel used together with detailed information on quality and quantity of heat and power generated.

4. When designing the monitoring plan in the VCS PD the project proponent should provide where possible an organigram illustrating the monitoring and reporting system organizational structure. Where possible, names of the staff with monitoring and reporting functions should be included in the PD.

5. The project proponent who applies the VCS methodology should describe how staff responsible for monitoring, recording and maintenance and calibration of monitoring equipment shall be trained.

6. Project emissions which are not addressed in the new methodology shall be calculated and compared with 1% of the overall average annual emissions reductions. They can only be excluded from further analysis they represent less than 1% of the total expected emission reductions."

7. In cases where the project activity results in the decommissioning of a steam and/or hot water generating facility at the project customer's site, the project proponent shall describe if there is any possibility that this may result in leakage. If it is deemed that leakage may occur, then the project proponent shall describe a means of estimating in a conservative manner what such leakage may be.

If however it is argued that the project activity results in the replacement of equipment and that the leakage due to the use of the replaced equipment in another activity can be neglected because the replaced equipment is scrapped, then an independent monitoring of the scrapping of the replaced equipment shall be implemented. The monitoring should include a check to ensure that the name plate of the equipment scrapped corresponds to that which has been replaced. For this purpose, scrapped equipment should be stored until such correspondence has been checked. The scrapping of replaced equipment should be documented and independently verified.