



Indicative simplified baseline and monitoring methodologies  
for selected small-scale CDM project activity categories

**TYPE II - ENERGY EFFICIENCY IMPROVEMENT PROJECTS**

Project participants shall apply the general guidance to the small-scale CDM methodologies, information on additionality (attachment A to appendix B) provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> > *mutatis mutandis*.

**II.H. Energy efficiency measures through centralization of utility provisions of an industrial facility****Technology/measure**

1. This methodology comprises energy efficiency measures implemented through integration of a number of utility provisions (for power, steam/heat/hot air and cooling) of an industrial facility into one single utility. The single utility shall consist of either a Combined Heat and Power (CHP - cogeneration) or a Combined Cooling, Heat and Power (CCHP - tri-generation) installation, replacing one or more:

- (a) Existing utility provisions, and/or
- (b) Facilities that would have otherwise been built.

2. This methodology is applicable under the following conditions:

- (a) Project activity results in total energy saving of no more than 60 GWh (or 180 GWh<sub>th</sub>) per year;
- (b) Project activity does not displace existing CHP or CCHP systems; and
- (c) In case of CCHP systems, the project activity shall include the shift from vapour compression chillers using chemical refrigerants to chillers which use refrigerants that have no global warming potential (GWP) and no ozone depleting potential (ODP). This conversion must be voluntary and not mandated by laws or regulations.

3. In case the produced electricity, cooling or steam/heat/hot air are delivered to another facility within the project boundary, a contract between the supplier and consumer of the energy will have to be entered into specifying that only the facility generating the energy can claim emission reductions from the energy displaced.

4. For the purpose of this methodology, natural gas is defined as a gas which consists primarily of methane and which is generated from (i) natural gas fields (non-associated gas), (ii) associated gas found in oil fields. It may be blended up to 1% on a volume basis with gas from other sources, such as, *inter alia*, biogas generated in biodigesters, gas from coal mines, gas which is gasified from solid fossil fuels, etc.<sup>1</sup>

**Boundary**

<sup>1</sup> This limitation is included because the methodology does not provide procedures to estimate the GHG emissions associated with the production of gas from these other sources. Project activities that use gas that does not comply with this definition must apply for a revision of the methodology.



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5. The project boundary is the physical, geographical site of the industrial facility where the CHP or CCHP system is being implemented. The boundary also extends to the industrial facility consuming energy generated by the system and the processes or equipment that are affected by the project activity.

**Baseline**

6. One of the three following options for baseline emission calculations shall be used depending on the technology that would have been used to produce the heat/steam/hot air and power and where relevant cooling, in the absence of the project activity:

- (a) Electricity is imported from the grid (includes the cooling load of a vapour compression system where relevant) and/or steam/heat is produced using fossil fuel;
- (b) Electricity is produced in an onsite captive power plant (includes cooling load of a vapour compression system where relevant) and/or steam/heat/hot air is produced using fossil fuel;
- (c) A combination of (a) and (b).

7. The appropriate baseline scenario must be selected from one of the following scenarios:

- (a) Replacing existing systems: The project consists of the installation of a new system that replaces the operation of existing systems that supply electricity (grid or on-site generation) and cooling (e.g., chillers) and/or heating systems (e.g., boilers). In such cases the baseline scenario is defined as either:
  - (i) If the total annual consumption of energy (electricity, cooling and heating) by the consuming facility does not increase by more than 20% from the established baseline values during the crediting period then the baseline scenario is the continuation of the operation of the existing systems where baseline emissions are established from the characteristics of the existing systems using data from the immediately prior three years;
  - (ii) If during the crediting period, total annual consumption of energy (electricity, cooling and heating) by the consuming facility does increase by more than 20% from the established baseline values then one of two options are applicable:
    - If it can be demonstrated, using the related and relevant procedures prescribed in the SSC general guidance, that the most plausible baseline scenario for the supply of additional amounts of energy is the same as the existing systems then such systems can be continued to be used for determining baseline emissions;
    - If it cannot be demonstrated that the most plausible baseline scenario for the supply of additional amounts of energy is the



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same as the existing systems then the Baseline Reference Plant Approach, as defined below shall be used.

- (iii) If, irrespective of total annual energy consumption of baseline or project scenarios, it is determined that new and more efficient systems (as compared to the existing systems) would have been installed in the absence of the project activity (for example, due to the baseline equipment reaching the end of its useful life at any point during the crediting period) then the Baseline Reference Plant Approach, as defined below, shall be used.
- (b) Replacing systems that would have been built: The project consists of the installation of a new system that replaces the operation of electricity and cooling and/or heating systems that would have been built and utilized. In such cases the Baseline Reference Plant Approach, as defined below, shall be used to define the baseline scenario.

**Baseline Reference Plant Approach**

In cases where the baseline scenario consists of the installation of new cooling and/or heating systems and/or the utilization of new electricity sources, a Reference Plant shall be defined as the baseline scenario. The Reference Plant shall be based on common practice for similar capacity, new heating and cooling systems and sources of electricity in the same industrial sector and in the same country or region as the project. The identification of the Reference Plant should exclude plants implemented as CDM project activities. In cases where no such plant exists within the region, the economically most attractive technology and fuel type should be identified among those which provide the same service (i.e., the same or similar power, heat and/or cooling capacity), that are technologically available, and that are in compliance with relevant regulations. The efficiency of the technology should be selected in a conservative manner, i.e., where several technologies could be used and are similarly economically attractive, the most efficient technology should be defined as the baseline scenario. In addition, the least carbon intensive fuel type should be chosen in case of multiple fuels being possible choices.

8. For each identified equipment that is/would be displaced by the project activity an assessment shall be carried out to determine:

- (a) Historical relative contribution of the equipment to the total annual output of energy type concerned (power, steam/heat/hot air or cooling) based on the measured relative contribution over the last 3 years<sup>2</sup>.

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<sup>2</sup> In case more than one captive system is generating a specific energy type (power, steam/heat or cooling) and one or more systems are being replaced in the project activity the relative contribution of these systems to the total output shall be taken into account in the formulas for baseline and project emissions. For example, if a project activity replaces two boilers, the first boiler delivers 2TJ and the second boiler 8TJ, the ratio of contribution by the individual boilers is 2/10 and 8/10 respectively. The formulas for baseline and project emission calculations shall be adjusted accordingly.



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- (b) In case the project activity displaces captive equipment(s), the baseline determined is only applicable up to the point in time when the concerned equipment needs to be replaced or is no longer fit for service ( $DATE_{ServiceEnd}$ ). Beyond this time, it is assumed that the equipment will be replaced by an equipment analogous to the equipment installed in the project activity and thus from that point onwards the baseline emissions from this source are considered zero<sup>3</sup>.
- (c) The remaining/expected service lifetime of the equipment as outlined in paragraph 9 below.

9. The point in time at which the baseline systems would have been replaced in the absence of the project activity, and thus triggering the requirement for a new baseline scenario, shall be estimated in a conservative manner using the “Tool to determine the remaining lifetime of the equipment”. The project activity shall be considered as one possible baseline scenario at the end of the useful life of existing equipment.

10. In the case of a project activity displacing a captive electricity generation plant and or grid electricity the baseline emissions are determined as follows:

- (a) If the project activity generates electricity that displaces electricity previously obtained from the grid, the baseline emissions are the CO<sub>2</sub> emissions of the power plants connected to the grid. The baseline emissions ( $BE_{elec,y}$ ) are then calculated based on the amount of grid electricity displaced by the project activity ( $E_{grid,y}$  in MWh) times the emission factor of the grid ( $EF_{grid,y}$ ) calculated in accordance with methodology AMS-I.D.

$$BE_{elec,y} = E_{grid,y} * EF_{grid,y} \quad (1)$$

Where:

$BE_{elec,y}$  Baseline emissions for the grid electricity displaced by the project in year  $y$  (t CO<sub>2</sub>e/year)

$E_{grid,y}$  Amount of grid electricity displaced by the project in year  $y$  (MWh)

$EF_{grid,y}$  Emission factor of the grid (calculated in accordance with methodology AMS-I.D. (tCO<sub>2</sub>/MWh)

- (b) If the project activity generates electricity that displaces electricity previously obtained from the operation of a captive power plant, the baseline emissions in

<sup>3</sup> For example, if a project activity displaces boiler “A” with service lifetime up to 2020, and an electrical chiller “B” with service lifetime up to 2015, then the baseline determined for the displacement of the boiler “A” is applicable up to 2020, whereas the determined baseline for displacing the electrical chiller “B” is applicable up to 2015. The baseline emissions for boiler “A” and chiller “B” beyond 2020 and 2015 respectively are considered zero.



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year  $y$  ( $BE_{elec,y}$ ) are calculated as the amount of electricity displaced  $E_{grid,y}$  (in MWh) times the emission factor of the captive power plant.

$$BE_{elec,y} = E_{capt,y} * EF_{capt} \quad (2)$$

Where:

$BE_{elec,y}$  Baseline emissions for the amount of electricity displaced by the captive power plant in year  $y$  (t CO<sub>2</sub>e/year)

$E_{capt,y}$  Amount of electricity displaced by the project activity in year  $y$  (MWh)

$EF_{capt}$  Emission factor of the captive power plant (tCO<sub>2</sub>/MWh)

The baseline emissions of the captive power plant are calculated up to ( $DATE_{ServiceEnd}$ ).

- (c) In case the project activity displaces electricity from a captive power plant as well as from the grid, then the emission factor for the displacement of electricity should reflect the emissions intensity of the captive power plant and the grid. The emission factor for the electricity displaced ( $EF_{electricity}$ ) shall be calculated as the weighted average of captive electricity generation and the grid electricity<sup>4</sup>. For new facilities, the most conservative (lowest) emission factor of the two power sources should be used.
- (d) The emission factor of the captive power plant ( $EF_{capt}$ ) is calculated based on the specific fuel consumption<sup>5</sup> (quantity of fuel in thermal, mass or volume unit per unit electrical output) of the captive power plant ( $SFC_{cap}$ ) determined as follows:
  - (i) For project activities displacing electricity previously obtained from the operation of existing captive power plants, the specific fuel consumption should be established based on historical measurement from the last 3 years;
  - (ii) For project activities displacing electricity from a captive power plant that otherwise would have been built, the specific fuel consumption ( $SFC_{cap}$ ) is obtained from at least two manufacturers of equipment of similar specifications and a conservative value shall be used;

<sup>4</sup> For example if in the baseline 80% of annual electricity requirement was met by grid import and the remaining by captive generation, the weighted average emission factor ( $EF_{electricity}$ ) would be  $0.8 EF_{grid} + 0.2 EF_{captive}$ .

<sup>5</sup> In case in the baseline situation more than one type of fossil fuel is used in the captive power plant, the relative contribution to the total output of each fossil fuel shall be considered and the formulas for baseline emissions shall be adjusted accordingly.



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- (iii) The emission factor for the captive power plant ( $EF_{capt}$ ) is calculated as the product of the emission factor of fuel “i” used by the captive power plant ( $COEF_i$ ) times  $SFC_{cap}$ ; Equations 2, 3, or 4 contained in the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” shall be used for this purpose.

$$EF_{capt} = COEF_i * SFC_{cap} \quad (3)$$

Where:

$SFC_{cap}$  Specific fuel consumption of the captive power plant (quantity of fuel in thermal, mass or volume unit/MWh)

$COEF_i$  CO<sub>2</sub> emission coefficient of fuel type  $i$  (tCO<sub>2</sub> / quantity of fuel in thermal, mass or volume unit)

11. In the case of a project activity displacing a captive steam generation plant:

- (a) The baseline emissions are calculated based on the equivalent amount of fuel that would have been used in the absence of the project activity. The baseline emissions of the captive steam generation plant can only be calculated up to ( $DATE_{ServiceEnd}$ ).
- (b) The equivalent amount of fuel (in thermal unit) that would have been consumed by the captive steam generation plant in year  $y$  ( $FC_y$ ) is calculated using the efficiency of the displaced equipment ( $\eta_{cs}$ ) and the project thermal energy delivery ( $S_{p,y}$ ) using the following relationship:

$$FC_y = \frac{S_{p,y}}{\eta_{cs}} \quad (4)$$

Where:

$FC_y$  Equivalent amount of fuel that would have been consumed by the captive steam generation plant in year  $y$  (TJ)

$\eta_{cs}$  Efficiency of the displaced captive steam generation plant in year  $y$

$S_{p,y}$  Thermal energy delivery of the project activity (TJ)

- (c) The efficiency of the captive steam generation plant ( $\eta_{cs}$ ) is determined as follow:
- (i) If the displaced captive steam generation plant is an existing plant, the efficiency should be based on historical measurement of specific fuel consumption (for example, steam output per fuel input) using the data from the last three years;



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- (ii) If the displaced captive steam generation plant is a plant that would otherwise have been built in the absence of the project activity, the efficiency should be determined using one of the following options:
  1. Highest measured efficiency of a unit with similar specifications;
  2. Highest efficiency values provided by two or more manufacturers of equipment with similar specification;
  3. Maximum efficiency of 100%.
- (d) The baseline emissions associated with the combustion of fossil fuels, shall be calculated following the provisions specified in the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion”.

12. In the specific case of project activities replacing a compression system chiller in the baseline by an absorption system chiller using engine exhaust gas, which does not need to generate intermediate steam as heat carrier before chilling can be generated, the baseline emissions are determined as follows:

- (a) The baseline emissions are calculated up to ( $DATE_{ServiceEnd}$ ). Baseline emissions are:
  - (i) Emissions from the electricity consumed to operate the baseline chiller, whether it is captive power or power from the grid; and
  - (ii) Emission associated with the physical leakage of refrigerants if the electrical chillers would have continued to be in service. This is only applicable if:
    1. The displaced refrigerant is a greenhouse gas listed in Annex A of the Kyoto Protocol and;
    2. The displaced chiller is an existing unit, and not an equipment that would otherwise been built.

The leakage rate shall be chosen in a conservative way.

- (b) The amount of electricity consumed to operate the baseline chiller in year  $y$  ( $E_{BC,y}$ ) is calculated based on the displaced chiller’s Coefficient of Performance ( $COP_c$ ). The Coefficient of Performance is defined as ‘chilling output per electrical input’.

$$E_{BC,y} = \frac{C_{P,y}}{COP_c} \quad (5)$$

Where:

$E_{BC,y}$  Amount of electricity consumed to operate the baseline chiller in year  $y$



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- (MWh/year)
- $COP_c$  The Coefficient of Performance of the displaced chiller (MWh<sub>th</sub>/MWh)
- $C_{p,y}$  Cooling output of the baseline chiller in year y (MWh<sub>th</sub>/year)
- (c) The coefficient of performance is determined as follow:
- (i) If the displaced unit is an existing chiller, then the electricity consumed should be calculated based on the COP of the displaced chiller based on data from the last three years.
  - (ii) If the displaced unit is equipment that would otherwise have been built, the Coefficient of Performance shall be determined as follows:
    1. The highest measured COP of a unit with similar specifications; or
    2. The highest COP values provided by two or more manufacturer of equipment with similar specifications.

Manufacturers often do not directly specify the COP values but quote the chillers performance in tonnage of refrigerant (TR) per kW of electrical input. 1 TR is equivalent to the amount of heat absorbed by the melting of 1 ton of ice within 24 hours and is equivalent to 3.513 kW.

- (d) The baseline emissions associated with electricity consumed to operate the baseline chiller is calculated using similar approach as per paragraph 10 of this methodology.
- (e) The emissions associated with the leakage of refrigerant from the baseline chiller in year y ( $BE_{LR,y}$ ) are calculated as a function of the historical specific leakage rate of the displaced chiller ( $SLR_C$ ) times the global warming potential of the refrigerant concerned ( $GWP_j$ ) using the following relationship:

$$BE_{LR,y} = SLR_C * GWP_j \quad (6)$$

Where:

$BE_{LR,y}$  The baseline emissions associated with the leakage of refrigerant from chiller in year y (t CO<sub>2</sub>e/year)

$SLR_C$  The historical specific leakage rate of the displaced chiller (tonnes/year)

$GWP_j$  Global Warming Potential for refrigerant “j” in the baseline chiller

- (f) The historical specific leakage rate of the displaced chiller ( $SLR_C$ ) shall be based on historical charging records from at least the last 3 years. This value shall be compared to the default values provided in 2006 IPCC guidelines for national GHG inventories, volume 3, chapter 7, table 7.9. The lower of the two values i.e.,





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IPCC default values and the leakage rates as determined from historical charging records shall be used.

- (g) The total cooling output of the project activity per year in MJ ( $C_{p,y}$ ) is calculated by measurement of the total chilled water mass flow-rate ( $m$ ), differential temperature of incoming and outgoing water ( $\Delta T$ ) and the heat capacity of water ( $C_{pw}$ )

$$C_{p,y} = m * C_{pw} * \Delta T \quad (7)$$

Where:

- $m$  The chilled water mass flow-rate in year  $y$  (tonnes/year)
- $C_{pw}$  The specific heat capacity of water (MJ/tonnes °C) (liquid water 4.2 MJ/t °C)
- $\Delta T$  Differential temperature of incoming and outgoing water (°C)

**Project activity emissions**

13. The use of fossil fuels by the CHP or CCHP unit(s), including those to run auxiliary equipments, shall be monitored and accounted for as project emission in accordance with the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion”. Electricity consumption of project including any electricity used to run auxiliary equipment are calculated using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.

**Leakage**

14. Leakage is to be considered if the displaced energy generating equipment is transferred from another activity or the existing equipment is transferred to another activity.

15. In case of introduction of a CCHP system, if the displaced refrigerant is a greenhouse gas as defined in Annex A of the Kyoto Protocol or in paragraph 1 of the Convention and is not destroyed, leakage emission from its storage or usage in another equipment must be considered<sup>6</sup> and deducted from the emission reductions. As the measures covered in this methodology is limited to shift from chemical refrigerant to a refrigerant with no global warming potential and no ozone depleting potential, leakage due to production of refrigerant is not included.

**Emission Reductions**

16. The emission reduction achieved by the project activity shall be calculated as the difference between the baseline emissions and the sum of the project emissions and leakage.

<sup>6</sup> The global warming potentials used to calculate the carbon dioxide equivalence of anthropogenic emissions by sources of greenhouse gases not listed in Annex A of the Kyoto Protocol, shall be those accepted by the Intergovernmental Panel on Climate Change in its third assessment report.



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**Monitoring**

17. Monitoring shall consists of:

- (a) Documenting of the technical specification of the captive equipment displaced or equipment which would otherwise have been built.
- (b) The metering of all the relevant parameters should be as per the Table.1.



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**Table 1: The following parameters shall be monitored and recorded during the crediting period.**

No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
1	$E_{grid,y}$	Amount of grid electricity displaced in year $y$	MWh/ $y$	Continuous monitoring, hourly measurement and at least monthly recording	Measurements are undertaken using energy meters and calibration shall be as per the related and relevant paragraph of General guidelines to SSC methodologies  If applicable, measurement results shall be cross checked with records for sold/purchased electricity (e.g., invoices/receipts)
2	$E_{capt,y}$	Amount of captive electricity displaced in year $y$	MWh/ $y$	Continuous monitoring, hourly measurement and at least monthly recording	Measurements are undertaken using energy meters and calibration shall be as per the related and relevant paragraph of General guidelines to SSC methodologies  If applicable, measurement results shall be cross checked with records for sold/purchased electricity (e.g., invoices/receipts)
3	$EF_{grid,y}$	CO <sub>2</sub> emission factor for the grid electricity in year $y$	t CO <sub>2</sub> e/ kWh	Annually	Grid emission factor shall be determined following the provisions in AMS-I.D
4	$SLR_C$	The historical specific leakage rate of the chiller displaced as a result of the installation of cogeneration or trigeneration plant $i$	tonnes/ year	Annually	Values taken from chiller maintenance record or purchase records of refrigerant. The value shall be cross-checked with the default values provided in 2006 IPCC guidelines for national GHG inventories, vol.3, chapter 7, table 7.9



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No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
5	$m$	The chilled water mass flow-rate for chiller $i$ produced by project in hour $h$ of year $y$	tonnes/hour	Continuous, integrated hourly, at least monthly recording	Measured using calibrated meters  Calibration shall be as per the related and relevant paragraph of General guidelines to SSC methodologies
6	$\Delta T$	Differential temperature for chiller $i$ in hour $h$ of year $y$ of incoming and outgoing water from project	°C	Continuous, integrated hourly, at least monthly recording	Measured using calibrated meters  Calibration shall be as per the related and relevant paragraph of General guidelines to SSC methodologies



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No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
7	$S_{p,y}$	Thermal energy delivered by the project activity in year y	TJ/y	Continuous, integrated hourly, at least monthly recording	<p>Measured using calibrated meters</p> <p>Calibration shall be as per the related and relevant paragraph of General guidelines to SSC methodologies</p> <p>Thermal energy production is determined as the difference of the enthalpy of the steam/heat generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and any condensate returns. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure</p> <p>In case of equipment that produces hot air this is expressed as difference in the enthalpy between the hot air supplied and the total enthalpy of feed input (e.g., air ) entering the project equipment</p> <p>In case the project activity is exporting heat to other facilities, the metering shall be carried out at the recipient's end</p>



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No.	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
8	$T$	Temperature	°C	Continuous monitoring, hourly measurement and at least monthly recording	<p>Measured using calibrated meters</p> <p>Calibration shall be as per the related and relevant paragraph of General guidelines to SSC methodologies</p> <p>In the cases (e.g., hot air output) where it is justified that the continuous measurement of flow and temperature can not be done, its enthalpy can be determined through sampling with a 90% confidence level and a 10% precision following a procedure provided in “General Guidelines For Sampling And Surveys For Small-Scale CDM Project Activities”</p>
9	$P$	Pressure	kg/cm <sup>2</sup>	Continuous monitoring, hourly measurement and at least monthly recording	<p>Measured using calibrated meters.</p> <p>Calibration shall be as per the related and relevant paragraph of General guidelines to SSC methodologies</p> <p>In the cases (e.g., hot air output) where it is justified that the continuous measurement of flow and temperature can not be done, its enthalpy can be determined through sampling with a 90% confidence level and a 10% precision following a procedure provided in “General Guidelines For Sampling And Surveys For Small-Scale CDM Project Activities”</p>
10		Quantity of fossil fuel type $j$ combusted in year $y$	Mass or volume unit	As per the “Tool to calculate project or leakage CO <sub>2</sub> emissions from fossil fuel combustion”	As per the “Tool to calculate project or leakage CO <sub>2</sub> emissions from fossil fuel combustion.”



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No .	Parameter	Description	Unit	Monitoring/recording Frequency	Measurement Methods and Procedures
11		Quantity of grid electricity consumed in year y	MWh/y	As per “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”	As per “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”

**Project activity under a programme of activities**

18. Leakage emissions resulting from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary shall be considered, as per the guidance provided in the leakage section of ACM0009. In case leakage emissions in the baseline situation are higher than leakage emissions in the project situation, leakage emissions will be set to zero.

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**History of the document**

Version	Date	Nature of revision
02	EB 54, Annex 12 28 May 2010	To include Greenfield project activities and provide options for sample based monitoring of thermal energy output.
01	EB 38, Annex 8, 14 March 2008	Initial adoption.
<b>Decision Class:</b> Regulatory <b>Document Type:</b> Standard <b>Business Function:</b> Methodology		