CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM)
Version 01 - in effect as of: 1 July 2004

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SECTION A. Identification of methodology

A.1. Title of the proposed methodology:

>> Gas powered combined cycle cogeneration replacing coal based steam generation and grid electricity.

A.2. List of category(ies) of project activity to which the methodology may apply:

>> Sectoral scopes 1: Energy industries (renewable - / non-renewable sources) and sectoral scope 4: Manufacturing industries

A.3. Conditions under which the methodology is applicable to CDM project activities:

>> The methodology is applicable to:
1. Fuel switching from imported grid (dominated by coal) electricity and coal based steam generation to combined heat and power provision to an industrial plant wherever the data exists to calculate the baseline and project activity emissions.
2. Where the cogeneration plant is owned and run by the plant it provides energy to, or by a third party operator.
3. The heat and power provided by the cogeneration plant contributes part of the energy requirements for the demand of the plant it provides utility to.
4. The leakage calculation includes a component that is applied to the production of a synthetic gas equivalent in part to natural gas.
5. This methodology is to be use in conjunction with the methodology “Baseline methodology for gas powered combined cycle cogeneration replacing coal based steam generation and grid electricity”

A.4. What are the potential strengths and weaknesses of this proposed new methodology?

>> The potential strengths of the monitoring methodology are:

1. Most of the parameters being monitored in the methodology would be measured as part of normal operation. (This does not apply to the electricity baseline, but a number of projects replacing grid electricity would be undertaking the same calculations, and most likely the role of providing the data will fall on the electricity providers.)
2. Another strength in the

The potential weaknesses are:

1. The project participants do not directly monitor the electricity and gas emissions information.
2. That the potential for leakage from transport, use of natural gas in the manufacture of synthetic gas and gas transmission is high and it falls outside the project boundary. The emissions associated with these activities fall outside the project boundary and require data from third parties and the use of third party verifiers. These verifications require close attention in this methodology

SECTION B. Proposed new monitoring methodology

B.1. Brief description of the new methodology:

>> The Monitoring and Verification methodology is based on recording the amount of gas that is used in the combined heat and power plant and monitoring the quantities of both heat and power that are provided for the operations. The amount of heating and electricity provided in the project activity can then be used to estimate the emissions from the baseline electricity and heat sources.

Leakage in the form of emissions from the transportation of gas, coal and coal ash are measured in the case of gas leakage, and estimated for the various modes of transport using specific distances, consumptions, efficiencies and fuels for the various transport modes. Leakage also includes the amount of Natural Gas consumed in the production of the synthetic gas and not equivalent on mass terms to the synthetic gas dispatched to the pipeline from the supplier to the user of the gas. The gas supplier will provide data required to quantify the amount of up-stream leakage.

The project activity methodology (direct from AM0008) and coal baseline
The monitoring methodology involves monitoring of the following (for notation, refer the baseline methodology):

- For fuel switching, CO_2 emission factors EF_F_i and EF_NG—these values are fixed throughout the crediting period and are calculated or referred from a statistical document for example IPCC Good Practice Guidance on greenhouse gases (GHG) Inventory and Uncertainty Management *ex-ante* in the Project Design Document. The GHG emission factors are those per unit of caloric value (e.g., Joule, kcal, etc.) times calorific content per physical unit (e.g., ton, liter, m^3, etc.) with suitable oxidization factors specified in the IPCC Guidelines. Local statistical data are preferable to aggregated (mean) default values;
- For each element process *n*, the fuel efficiency $\eta_n\_F_i$ are measured *ex-ante* before switching the fuel as a function of load factor. On the other hand, η_n_NG (also a function of load factor) is measured at an early stage [1] after implementation of the project. By using the measured quantity $Q_n\_NG_y$ (times η_n_NG divided by $\eta_n\_F_i$), the baseline fuel consumption of each element process $Q_n\_F_{i,y}$ is calculated. $Q\_F_{i,y}$ is calculated as the sum of $Q_n\_F_{i,y}$ over *n* and operation pattern. Q_NG_y is also independently measured and confirmed as the sum of $Q_n\_NG_y$ over *n* and operation patternl;
- Applicability concerning the local regulations are checked (i.e., listed as monitoring items);
- If project participants choose to use a renewable crediting period, at each renewal the project participants should assess the additionality of the project activity (in accordance with the approved baseline methodology AM0008) and should in particular monitor the following parameters:
  a) The price differential between coal and gas in the host country. Prices are monitored, so that changes in price differentials can be seen.
  b) Ratio of imported coal to domestic coal, and the actual emission factors characteristic of coal and gas consumed in the host country.
- For non-CO_2 GHG emissions parts associated with fuel combustion and fugitive, IPCC default parameters can be used for the emission factors because such parts are minor;
- For CO_2 emission parts associated with fuel transportation, $Q\_TE_{i,y}$ is directly monitored for the project scenario and calculated with suitable assumptions for the baseline scenario. The emission factors are those of the IPCC default values.

[Note] If the project participant can demonstrate that some segment of emission reductions ER_y *(*such as a term in the leakage, e.g., CO_2 emissions from fuel transportation) is negligibly small (e.g., such a part is demonstrated to be much smaller ($<10^{-1}$) than the uncertainty level of the most contributing part in ER_y), the parameters associated with the segment do not need to be monitored.

[1] [1] The measurement should be repeated for each process *n* with several load factors in order to get the curve of η_n with statistical significance.

If the project participant can demonstrate that some element process consumes less energy than 5% of total consumption and its time variance is negligible small, fixed values (monitoring is once) or less frequent monitoring can be applied, or such effects can be neglected as a conservative estimation.

Baseline monitoring methodology
The emissions from electricity imported and from coal are monitored separately. The coal baseline is dealt with as in the project activity monitoring methodology.

Electricity baseline
The methodology requires monitoring of the following:

- Electricity generation from the proposed project activity;
- Data needed to recalculate the operating margin emission factor, if needed, based on the choice of the method to determine the operating margin (OM), consistent with consolidated baseline methodology for grid-connected electricity generation from renewable sources. (ACM0002);
- Data needed to recalculate the build margin emission factor, if needed, consistent with "Consolidated baseline methodology for grid-connected electricity generation from renewable sources". (ACM0002);
- For geothermal power projects, data needed to calculate fugitive carbon dioxide and methane emissions and carbon dioxide emissions from combustion of fossil fuels required to operate the geothermal power plant.

Leakage
Leakage in the change of transport modes is dealt with in the project activity monitoring methodology above. Leakage will also include the emissions produced during the production of incremental synthetic gas and the direct leaks from the pipeline transporting the gas to the end point of use.

B.2. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario: The monitoring components are drawn from AM0008.

B.2.1. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table B.7)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. Q_NGy	Quantity of natural gas used by project activity	Measured and converted from metered volumes	joules	M	Continuous	100%	Electronic	Converted from physical quantity (e.g., m^3), if needed, using conversion factor (e.g., kcal/m^3) provided by local supplier. Confirmed by natural gas purchase record. Confirmed to be equal to $\sum n$, operation pattern *Qn*_NG*y*
1-n. Qn_NGy	Quantity of natural gas used at the process n	Measured and converted from metered volumes	joules	M	Monthly	100%	Electronic	Converted from physical quantity, if needed, using conversion factor provided by local supplier (see above). This value is monitored by operation pattern (e.g., normal, start-up, holiday, etc.) at the process *n* (e.g., boiler).
2-n. η_n_NG	Fuel efficiency of natural gas used at the process n	Process n energy balance	%	measured; estimate ex ante to calculate total ER	Once at the early stage of the project	100%	Electronic	Not a single value but a pattern (function) of "load factor" at the process *n*. Preferable to draw a graph as a function of load factor. The measurement should be repeated for each process *n* with several load factors in order to get the curve of η_n with statistical significance.
3. L_Factor $_n$	Load factor of operation pattern at the process n	Process n	%	M	Once before fuel switch	100%	Electronic	Plural values of load factor are measured for "pre-set" operation patterns (such as normal operation, start-up, shut-down, holiday operation, etc.)
4. MCEO	Amount of electricity supplied to plant		MWh/year	M	Monthly	100%	Electronic and paper PI	
5. MCHO	Cogeneration heat supplied to plant		GJ/Year	M	Monthly	100%	Electronic and paper PI	

B.2.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>> The project emissions PE_y (measured in ton of CO_2 equivalents (tCO_2e/yr)) during a year (y) is expressed as:

$$PE_y = (\sum_i Q_i\_NG_y) * (EF\_NG + FC\_NG\_CH_4 * GWP\_CH_4 + FC\_NG\_N_2O * GWP\_N_2O) \quad \text{(Equation 1)}$$

where:

$Q_i\_NG_y$	Quantity of natural gas used in the project scenario for replacing $Q\_F_{i,y}$ quantity of fuel i used in the baseline scenario, measured in energy units (e.g., Joule).
Q_NG_y	Total quantity of natural gas in the project scenario used for replacing all the quantity of fuel i used in some element processes in the baseline ($\sum_i Q_i\_NG_y$) scenario.
EF_NG	IPCC default CO_2 emission factor per unit of natural gas associated with fuel combustion (e.g., tCO_2/Joule).
$FC\_NG\_CH_4$	IPCC default CH_4 emission factor of natural gas associated with fuel combustion, measured in tCH_4/Joule.
$FC\_F_i\_N_2O$	IPCC default N_2O emission factor of natural gas associated with fuel combustion, measured in tN_2O/Joule.

The variables in the baseline emissions ($Q_n\_F_{i,y}$) and the project emissions ($Q_n\_NG_y$) are linked with the constraint relation:

$$Q_n\_F_{i,y} * \eta_n\_F_i = Q_n\_NG_y * \eta_n\_NG \quad \text{(Equation 2)}$$

For each element process n that use the fuel i in the baseline scenario. Here $\eta_n\_F_i$ and η_n_NG are fuel efficiency for use of fuel i (baseline scenario) and natural gas (project scenario) respectively, measured either in unit of output per unit of energy (e.g., ton of output/Joule) or ratio of the output energy to the input energy, or the percentage, as appropriate $\eta_n\_F_i$ and η_n_NG are regarded as functions of the load factor measured *ex-ante* before fuel switching3 (for $\eta_n\_F_i$) and at the early stage of each crediting period[2] (for η_n_NG). This relation should be kept at each operating pattern,[3] in which a single load factor can be presented.

[2] The measurement should be repeated for each process n with several load factors in order to get the curve of η_n with statistical significance.
[3] The operating pattern may include normal operation, start-up, shut-down, holiday operation, etc. during which the load factor can be represented by a certain fixed value.

B.2.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of greenhouse gases (GHG) within the project boundary and how such data will be collected and archived:

For electricity baseline (derived from ACM 0002)

ID number	*Data type*	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	*For which baseline method(s) must this element be included*	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
6. EG_y (EG_h if dipatch data OM is used)	*Electricity quantity*	Electricity exported from the Grid	MWh	Directly measured	*Simple OM* *Simple adjusted OM* *Dispatch data OM* *Average OM* *BM*	yearly	100%	electronic	During the crediting period and two years after	
7. EFy	*Emission factor*	CO^2 emission factor of the grid	tCO_2 / MWh	C	*Simple OM* *Simple adjusted OM* *Dispatch data OM* *Average OM* *BM*	yearly	100%	electronic	During the crediting period and two years after	Calculated as a weighted sum of the OM and BM emission factors
8. EFOM,y	*Emission factor*	CO^2 Operating Margin emission factor of the grid	tCO^2 / MWh	C	*Simple OM* *Simple adjusted OM* *Dispatch data OM* *Average OM* *BM*	yearly	100%	electronic	During the crediting period and two years after	Calculated as indicated in the relevant OM baseline method above
9. EFBM,y	*Emission factor*	CO^2 Build Margin emission factor of the grid	tCO^2 / MWh	C	*BM*	yearly	100%	electronic	During the crediting period and two years after	Calculated as [∑i Fi,y*COEFi] / [∑m GENm,y] over recently built power plants defined in the baseline methodology
10. Fi,y	*Fuel quantity*	Amount of each fossil fuel consumed by each power source / plant	Mass or volume	M	*Simple OM* *BM*	yearly	100%	electronic	During the crediting period and two years after	Obtained from the power producers, dispatch centers or latest local statistics.
11. COEFi	*Emission factor coefficient*	CO^2 emission coefficient of each fuel type i	tCO^2 / mass or volume unit	M	*Simple OM* *BM*	yearly	100%	electronic	During the crediting period and two years after	Plant or country-specific values to calculate COEF are preferred to IPCC default values.

12. GENj/k/n,,y	Electricity quantity	Electricity generation of each power source / plant j, k or n	MWh/a	M	Simple OM BM	yearly	100%	Electronic	During the crediting period and two years after	Obtained from the power producers, dispatch centers or latest local statistics.
13.	Plant name	Identification of power source/plant for OM	Text	E	Simple OM Simple adjusted OM Dispatch data OM Average OM BM	yearly	100%	Electronic	During the crediting period and two years after	Identification of plants (j, k or n) to calculate operating margin emission factor
14.	Plant name	Identification of power source/plant for BM	Text	E	BM	yearly	100%	Electronic	During the crediting period and two years after	Identification of plants (j, k or n) to calculate operating margin emission factor
15. λ_y	parameter	Fraction of time during which low cost/must run-sources are on the margin	number	C+	Simple adjusted OM	yearly	100%	Electronic	During the crediting period and two years after	Factor accounting for number of hours per year during which lowcost/ must-run sources are on the margin
16.	Merit Order	The merit order in which power plants are dispatched by documented evidence	Text	M	Dispatch Data OM	yearly	100%	Paper for original documents, else electronic	During the crediting period and two years after	Required to stack the plants in the dispatch data analysis.
17. T&D	Transmission and distribution losses	The proportion of electricity lost compared to the electricity dispatched as a result of technical losses in transmission and distribution	%	M	All	yearly	100%	Electronic	During the crediting period and two years after	Technical losses of electricity from the transmission and distribution of electricity across the entire selected electricity grid.

$FC\_NG\_CH_4$, $FC\_F_i\_CH_4$, $FC\_NG\_N_2O$, $FC\_F_i\_N_2O$, $FE\_NG\_CH_4$, $FE\_F_i\_CH_4$, and $EF\_TF_{(j \text{ or } k)}$ are obtained as the default values specified in the IPCC Guidelines on GHG Inventories or Good Practice Guidance Report.

For heat baseline (derived from AM 0008)

ID number	Data type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	For which baseline method(s) must this element be included	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
18. Q_Fi	Energy	The quantity of fuel i used in the baseline scenario,	Joules/year	C	Simple OM BM	yearly	100%	electronic	During the crediting period and two years after	Calculated as a weighted sum of the OM and BM emission factors

B.2.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

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Formulae used in the calculation of emissions from electricity in the baseline scenario

The first part entails electricity that would have otherwise been generated by the operation of grid-connected power plants and/or by the addition of new generation sources.

Choice of the grid

For determination of an accurate baseline and for its validation it is important to select a realistic grid representing the factual scenario associated with the project activity. An isolated grid normally identified as a state, regional, national or sometimes transnational grid. The following points need to be considered while selecting the grid:

1. Size of the project activity: If the size of the project activity is too small to have significant impact on the grid (=<1% of the grid to which it is connected), in terms of changes in the generation and dispatch system, then the lowest grid such as state or regional grid are to be selected. If the project size is big enough to alter the distribution pattern, then the next level of grid e.g. state/regional/national grid can be selected.
2. Connectivity of grid: If the inter-grid transmission of electricity is poor or restricted due to some reasons (e.g. policy, infrastructure) and the same can be verified then rather than choosing the larger grid (say national), an isolated grid should be selected.

It should be noted by the CDM project participants that, the bigger the size of the grid the more it is prone to errors in data assimilation and more costly for baseline determination and verification.

For project activities that modify or retrofit (but not expand the output of) an existing electricity generation facility, the guidance provided by EB08 shall be taken into account.[4]

A baseline emission factor (*EF_y*) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (*OM*) and build margin (*BM*) factors according to the following three steps. Calculations for this combined margin must be based on data from an official source (where available)[5] and made publicly available.

STEP 1. Calculate the Operating Margin emission factor(s) ($EF_{OM,y}$) based on one of the four following methods:

(a) Simple OM, or

(b) Simple adjusted OM, or

(c) Dispatch Data Analysis OM, or

(d) Average OM.

Each method is described below.

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[4] "If a proposed CDM project activity seeks to retrofit or otherwise modify an existing facility, the baseline may refer to the characteristics (i.e. emissions) of the existing facility only to the extent that the project activity does not increase the output or lifetime of the existing facility. For any increase of output or lifetime of the facility which is due to the project activity, a different baseline shall apply." (EB08, Annex 1, http://cdm.unfccc.int/EB/Meetings/).

[5] Plant emission factors used for the calculation of operating and build margin emission factors should be obtained in the following priority:

1. *Acquired directly* from the dispatch center or power producers, if available; or
2. *Calculated*, if data on fuel type, fuel emission factor, fuel input and power output can be obtained for each plant; if confidential data available from the relevant host Party authority are used the calculation carried out by the project participants shall be verified by the DOE and the CDM-PDD may only show the resultant carbon emission factor and the corresponding list of plants.
3. *Calculated*, as above, but using estimates such as
    - Default IPCC values from the *IPCC 1996 Revised Guidelines* and the *IPCC Good Practice Guidance* for net calorific values and carbon emission factors for fuels instead of plant-specific values (note that the *IPCC Good Practice Guidance* includes some updates from the *IPCC 1996 Revised Guidelines*);
    - Technology provider's name plate power plant efficiency or the anticipated energy efficiency documented in official sources (instead of calculating it from fuel consumption and power output). This is likely to be a conservative estimate, because under actual operating conditions plants usually have lower efficiencies and higher emissions than name plate performance would imply;
    - Conservative estimates of power plant efficiencies, based on expert judgments on the basis of the plant's technology, size and commissioning date; or
4. *Calculated,* for the simple OM and the average OM, using aggregated generation and fuel consumption data, in cases where more disaggregated data is not available.

Dispatch data analysis should be the first methodological choice. Where this option is not selected project participants shall justify why and may use the simple OM, the simple adjusted OM or the average emission rate method taking into account the provisions outlined hereafter.

The Simple OM method (a) can only be used where low-cost/must run resources[6] constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term normals for hydroelectricity production.

The average emission rate method (d) can only be used in cases where the:

- low-cost/must run resources constitute more than 50% of total grid generation and detailed data to apply option (b) are unavailable, and
- data to apply option (c) above are unavailable.

(a) *Simple OM.* The Simple OM emission factor ($EF_{OM,simple,y}$) is calculated as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the system, not including low-operating cost and must-run power plants:

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}} \qquad \text{(Equation 3)}$$

where:

$F_{i,j,y}$ is the amount of fuel *i* (in a mass or volume unit) consumed by relevant power sources *j* in year(s) *y*,

j refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports[7] to the grid,

$COEF_{i,j\,y}$ is the CO_2 emission coefficient of fuel *i* (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and

$GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j*.

The CO_2 emission coefficient $COEF_i$ is obtained as

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \qquad \text{(Equation 4)}$$

[6] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

[7] As described above, an import from a connected electricity system should be considered as one power source *j*.

where:
NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel *i*,
$OXID_i$ is the oxidation factor of the fuel (see page 1.29 in the 1996 Revised IPCC Guidelines for default values),
$EF_{CO2,i}$ is the CO_2 emission factor per unit of energy of the fuel *i*.
Where available, local values of NCV_i and $EF_{CO2,i}$ should be used. If no such values are available, country-specific values (see e.g. IPCC Good Practice Guidance) are preferable to IPCC worldwide default values.

The Simple OM emission factor can be calculated using either of the two following data vintages for years(s) *y*:

- A 3-year average, based on the most recent statistics available at the time of PDD submission, or
- The year in which project generation occurs, if $EF_{OM,y}$ is updated based on ex post monitoring.

(b) *Simple Adjusted OM.* This emission factor ($EF_{OM,simple\ adjusted,y}$) is a variation on the previous method, where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*):

$$EF_{OM,simple\ adjusted,y} = (1-\lambda_y)\cdot\frac{\sum_{i,j} F_{i,j,y}\cdot COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y\cdot\frac{\sum_{i,k} F_{i,k,y}\cdot COEF_{i,k}}{\sum_k GEN_{k,y}} \quad \text{(Equation 5)}$$

where $F_{i,k,y}$, $COEF_{i,k}$ and GEN_k are analogous to the variables described for the simple OM method above for plants *k*; the years(s) *y* can reflect either of the two vintages noted for simple OM above, and

$$\lambda_y(\%) = \frac{\text{Number of hours per year for which low-cost/must-run sources are on the margin}}{\text{8760 hours per year}} \quad \text{(Equation 6)}$$

where lambda (λ_y) should be calculated as follows (see figure below):

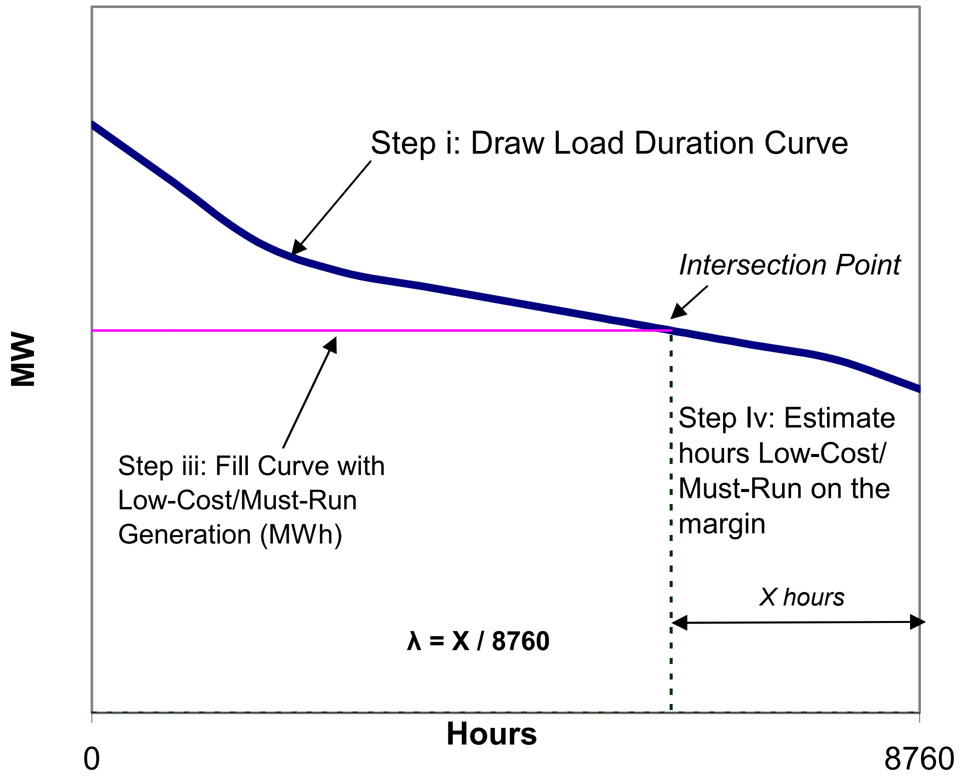
Step i) Plot a Load Duration Curve. Collect chronological load data (typically in MW) for each hour of a year, and sort load data from highest to lowest MW level. Plot MW against 8760 hours in the year, in descending order.

Step ii) Organize data by Generating Sources. Collect data for, and calculate total annual generation (in MWh) from low-cost/must-run resources (i.e. $\sum_k GEN_{k,y}$).

Step iii) Fill Load Duration Curve. Plot a horizontal line across load duration curve such that the area under the curve (MW times hours) equals the total generation (in MWh) from low-cost/must-run resources (i.e. $\sum_k GEN_{k,y}$).

Step iv) Determine the "Number of hours per year for which low-cost/must-run sources are on the margin". First, locate the intersection of the horizontal line plotted in step (iii) and the load duration curve plotted in step (i). The number of hours (out of the total of 8760 hours) to the right of the intersection is the number of hours for which low-cost/must-run sources are on the margin. If the lines do not intersect, then one may conclude that low-cost/must-run sources do not appear on the margin and λ_y is equal to zero. Lambda (λ_y) is the calculated number of hours divided by 8760.

Figure 1: Illustration of Lambda Calculation for Simple Adjusted OM Method



Note: Step (ii) is not shown in the figure, it deals with organizing data by source.

(c) *Dispatch Data Analysis OM*. The Dispatch Data OM emission factor ($EF_{OM,Dispatch\ Data,y}$) is summarized as follows:

$$EF_{OM,Dispatch\ Data,y} = \frac{E_{OM,y}}{EG_y} \qquad \text{(Equation7)}$$

where EG_y is the generation of the project (in MWh) in year y, and $E_{OM,y}$ are the emissions (tCO_2) associated with the operating margin calculated as

$$E_{OM,y} = \sum_h EG_h \cdot EF_{DD,h} \qquad \text{(Equation 8)}$$

where EG_h is the generation of the project (in MWh) in each hour h and $EF_{DD,h}$ is the hourly generation-weighted average emissions per electricity unit (tCO_2/MWh) of the set of power plants (n) in the top 10% of grid system dispatch order during hour h:

$$EF_{DD,h} = \frac{\sum_{i,n} F_{i,n,h} \cdot COEF_{i,n}}{\sum_n GEN_{n,h}} \qquad \text{(Equation 9)}$$

where F, $COEF$ and GEN are analogous to the variables described for the simple OM method above, but calculated on an hourly basis for the set of plants (n) falling within the top 10% of the system dispatch. To determine the set of plants (n), obtain from a national dispatch center: a) the grid system dispatch order of operation for each power plant of the system; and b) the amount of power (MWh) that is dispatched from all plants in the system during each hour that the project activity is operating (GEN_h). At each hour h, stack each plant's generation (GEN_h) using the merit order. The set of plants (n) consists of those plants at the top of the stack (i.e., having the least merit), whose combined generation ($\sum GEN_h$) comprises 10% of total generation from all plants during that hour (including imports to the extent they are dispatched).

(d) *Average OM*. The average Operating Margin (OM) emission factor ($EF_{OM,average,y}$) is calculated as the average emission rate of all power plants, using equation (1) above, but including low-operating cost and must-run power plants. Either of the two data vintages described for the simple OM (a) may be used.

STEP 2. Calculate the Build Margin emission factor ($EF_{BM,y}$) as the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants m, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}} \quad \text{(Equation 10)}$$

where $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the simple OM method above for plants *m*.

Project participants shall choose between one of the following two options:

Option 1. Calculate the Build Margin emission factor $EF_{BM,y}$ *ex ante* based on the most recent information available on plants already built for sample group *m* at the time of PDD submission. The sample group *m* consists of either

- the five power plants that have been built most recently, or
- the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation.

Option 2. For the first crediting period, the Build Margin emission factor $EF_{BM,y}$ must be updated annually *ex post* for the year in which actual project generation and associated emissions reductions occur. For subsequent crediting periods, $EF_{BM,y}$ should be calculated *ex-ante*, as described in option 1 above. The sample group *m* consists of either the:

- five power plants that have been built most recently, or
- power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation.

Power plant capacity additions registered as CDM project activities should be excluded from the sample group *m*.

STEP 3. Calculate the baseline emission factor EF_y as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y} \quad \text{(Equation 11)}$$

where the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in tCO_2/MWh. Alternative weights can be used, as long as $w_{OM} + w_{BM} = 1$, and appropriate evidence justifying the alternative weights is presented. These justifying elements are to be assessed by the Executive Board.[8]

Distribution and transmission losses
Transmission and distribution losses may be included for electricity imported and used within the project boundary.

$$EFy_{T\&D} = \left[\frac{EFy \times 100}{100 - T\&D}\right] - EFy \qquad \text{(Equation 12)}$$

Where,

- $EFy_{T\&D}$ - Baseline emission factor of transmission and distribution losses for imported electricity to plant. The units are in tCO_2e/MWh
- T&D – Transmission & Distribution loss % (These losses include technical electrical energy losses that incur during transmission & distribution). [The value used should be supported by documentary evidence]

Formulae used in the estimation of emissions from heat in the baseline scenario
The second part of the baseline includes the emissions from the fossil fuels used to produce the steam that provides process heat to the operation.

The baseline scenario for the project activity, which is eligible to use in this methodology, is that the current fuels (coal and/or petroleum fuels; denoted by *i* in the formula below) are continued to be used in the existing facility at least up to the end of the crediting period without any retrofit, which extends its capacity or lifetime, or improves its fuel efficiency.

The fuels that are replaced by the project activity *i* are identified using operating protocols of the plant concerned and correct by monitoring operating records.

The baseline emissions BE_y (measured in ton of CO_2 equivalents (tCO_2e/yr)) during a year (y)[9] is expressed as:

$$BE_y = \sum_i Q\_F_{i,y} * (EF\_F_{i,}\_CO_{2y} + FC\_F_i\_CH_4 * GWP\_CH_4 + FC\_F_i\_N_2O * GWP\_N_2O) \qquad \text{(Equation 13)}$$

[8] More analysis on other possible weightings may be necessary and this methodology could be revised based on this analysis. There might be a need to propose different weightings for different situations.

[9] Throughout this document, suffix "*y*" denotes that such a variable parameter is the annual amount during a given year (*y*).

where:

*Q*_F$_{i,}$ Are quantity of fuel *i* used in the baseline scenario, measured in energy units (e.g., Joule).

*EF*_F$_i$ Are CO_2 equivalent emission factor per unit of energy of fuel *i* (e.g., tCO_2e/Joule).

*FC*_F$_i$ CH_4 Are the IPCC default CH_4 emission factor of fuel *i* associated with fuel combustion, measured in tCH_4/Joule.

*FC*_F$_i$ N_2O Are the IPCC default N_2O emission factor of fuel *i* associated with fuel combustion, measured in tN_2O/Joule.

*GWP*_CH_4 Is the global warming potential of CH_4 set as 21 tCO_2e/tCH_4 for the 1st commitment period.

*GWP*_N_2O Is the global warming potential of N_2O set as 310 tCO_2e/tN_2O for the 1st commitment period.

The parameters (variable) *Q*_F$_{i,y}$ in the baseline emissions formula are calculated as specified in the "project scenario" section by using monitored parameters and default values.

B.3. Option 2: Direct monitoring of emission reductions from the project activity:

>> not applicable

B.3.1. Data to be collected or used in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to table B.7)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

B.3.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

Not applicable

B.4. Treatment of leakage in the monitoring plan:

>> Emissions from the use of the incremental Natural Gas at synthetic fuel plant, fugitive CH_4 emissions from gas transmission and CO_2, CH_4, and N_2O emissions from coal and ash transportation are categorized as leakage.

B.4.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity:

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
20. MEC GS	*Quantity of synthetic gas dispatched down pipeline*	*From gas supplier*	*GJ/year*	*M*	*Yyearly*	*All data*	*Electronic and paper*	
21. Q_TF*j,y*	*Quantity of transport energy for mode "j" in yea r"y" for project activity*	*From transport records*	*GJ/year*	*M*	*Yearly*	*All data*	*Electronic and paper*	
22. Q_TF*k,y*	*Quantity of transport energy for mode "k" in year "y" for the baseline scenario*	*From transport records*	*GJ/year*	*M*	*Historic data*	*All data*	*Electronic and paper*	
23 GWP SG	*Global warming potential of synthetic gas*	*From analysis of contents*	*tCO2e/GJ*	*M*	*Yearly*	*Sample*	*Electronic and paper*	
24. MCi	*Gas supplier mass and energy balance*	*From gas supplier*	*tC/GJ*	*m*	*Yearly*	*All data*	*Electroinic and paper*	

$FE\_NG\_CH_4$, $FE\_F_i\_CH_4$, and $EF\_TF_{(j \text{ or } k)}$ are obtained as the default values specified in the IPCC Guidelines on GHG Inventories or Good Practice Guidance Report.

B.4.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

LE_y = [MEC $GS_{j,y}$ * $FE\_NG\_CH_4$ – MEC $GS_{k,y}$ * $FE\_NG\_CH_4$)] * GWP_CH_4
+ [$\sum_j (Q\_TF_{j,y} * EF\_TF_j) - \sum_k (Q\_TF_{k,y} * EF\_TF_k)$] + (MEC GS - Q_NGy *10^9) * GWP SG - (Natural gas used by the suppler to produce to produce synthetic gas)

Where $FE\_NG\_CH_4$ and $FE\_F_i\_CH_4$ are the IPCC default CH_4 emission factor of natural gas and fuel *i* associated with fugitive emissions (tonnes CH_4/joules/year). In case the effect of methane leaked from pipeline cannot be neglected, it should be included in this term (although it is not a function of Q_NG_y in the IPCC Guidelines).

For the transportation related part, $Q\_TE_{j,y}$ and EF_TE_j are transportation energy quantity used and its CO_{2e} emission factor concerning the transportation mode *j* for project scenario and for mode *k* for baseline scenario (such as marine, railroad or truck). In case those information and data are not available due to uncertainties and diversities in energy market, the IPCC default value could apply. Otherwise, it could be estimated qualitatively in view of it being a relatively small part of the total emissions.

The natural gas used in the incremental synthetic gas production is considered upstream leakage. This source of leakage can be calculated using mass balances around the synthetic gas producer's plant.

B.5. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>> Emissions reductions from the project activity = Total baseline emissions – Total project activity emissions – Total project leakage emissions (Equation 14)

Total baseline emissions
Total baseline emissions per year = emissions intensity of baseline electricity * quantity of electricity produced by project activity (MCEO MWh/year) + emissions intensity of baseline heat * quantity of process heat produced by the project activity (MCHO GJ/year)

Total baseline emissions = MCEO *(MWh/year)* * $EF_{y\ T\&D}$ *(tonnes CO_2e/MWh) + MCHO GJ/year * BEy/Y* (tonnes CO_2e/GJ) (Equation 15)

Total project activity emissions
Total project emissions per year = emissions intensity of natural gas * quantity of natural gas used in the production of heat and electricity = emissions intensity of project electricity * quantity of electricity produced by project activity (MCEO MWh/year) + emissions intensity of project activity heat * quantity of process heat produced by the project activity (MCHO GJ/year)

Total project activity emissions (tonnes CO_2 per year) = (MCEO MWh/year * 3600 Joules/MWh + MCHO GJ heat * 10 E9) * *EF*_NG Tonnes CO_{2e}/Joule Natural Gas (Equation 16)

Emissions reductions from the project activity
Emissions reductions from the project activity = MCEO *(MWh/year)* * $EF_{y\ T\&D}$ *(tonnes CO_2e/MWh) + MCHO GJ/year * BEy/MCHO* (tonnes CO_2e/GJ) - (MCEO MWh/year * 3600 Joules/MWh + MCHO GJ heat * 10^9) * *EF*_NG Tonnes CO_2/Joule Natural Gas – Le_y (Equation 17)

B.6. Assumptions used in elaborating the new methodology:

>> For emission factors, IPCC 1996 Guidelines on GHG Inventory (The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, IPCC) and Good Practice Guidance Report (Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, IPCC) are to be referred not only for their default values but also for their monitoring methodology as well as uncertainty management to ensure data credibility. These documents are downloadable from http://www.ipcc-nggip.iges.or.jp/. The latter document is a new supplementary document of the former.
1996 Guidelines:
Vol. 2, Module 1 (Energy) for methodology,
Vol. 3, Module 1 (Energy) for application (including default values)
2000 Good Practice Guidance
Chapter 2: Energy
Chapter 6: Uncertainty

B.7. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored:

Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1-5	*Low*	*These data are used to calculate the project activity emissions. Data capture in PI system subject to routine checking and recalibration of monitoring dices where necessary.*
6-18	*Medium*	*These data are used to calculate the electricity baseline emissions. Data capture in PI system subject to routine checking and recalibration of monitoring dices where necessary.*
19	*Low*	*These data are used to calculate the heat baseline emissions. Data capture in PI system subject to routine checking and recalibration of monitoring dices where necessary.*
20-2119	*Medium*	*These data used to calculate the leakage. Leakage data capturing will be the responsibility of third party. Mass balance around synthetic fuel plant must be subject to independent verification.*

B.8. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?

>> The methodology borrows from ACM0002, AM0014 and AM0008. These methodologies have been used elsewhere. The upstream leakage in the production of synthetic gas is new as is the method to calculate fugitive emissions from the gas pipeline and neither have been applied before. The methodology as it stands has not been applied elsewhere.