



### Draft consolidated baseline methodology ACM00XX

#### “Consolidated baseline methodology for coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat and/or destruction by flaring”

#### Sources

This consolidated baseline methodology is based on elements from the following methodologies:

- NM0066 “Baseline methodology for grid-connected coalmine methane power generation at an active coal mine with existing methane extraction and partial utilization,” submitted by Hegang Coal Industry Group Limited
- NM0075 “Baseline methodology for coal mine methane (CMM) utilization and destruction at a working coal mine,” prepared by IT Power
- NM0093 “Baseline methodology for methane utilization and destruction project activities at working coal mines where both coal mine methane (drained from within the mine) and coal bed methane (drained from the surface within the coal mining concession area) is used and/or destroyed,” prepared by Westlake Associates, Ltd and Asian Development Bank
- NM0094 “Baseline methodology for coal mine methane recovery and utilization at active coal mines,” prepared by Millennium Capital Services, Co.
- NM0102 “Generalised baseline methodology for coal mine methane (CMM) power generation,” prepared by the Prototype Carbon Fund

For more information regarding the proposals and their consideration by the Executive Board please refer to <http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>. This methodology also refers to the “Consolidated baseline methodology for grid-connected electricity generation from renewable sources” (ACM0002) and the latest version of the “Tool for the demonstration and assessment of additionality”.

#### Definitions

*Coalbed methane (CBM)* - a generic term (USA) for the methane-rich gas originating in coal seams. Other terms are firedamp (UK) and coal seam methane (Australia).

*Coal mine methane (CMM)* – methane component of gases captured in a working mine by surface or underground methane drainage techniques.

*CBM to Goaf well methane* – coal bed methane extracted from surface drainage wells (vertical or vertical to in-seam) prior to mining through the wells (a special type of Pre mining CMM extraction defined for CDM purposes; becomes a Post mining CMM Extraction, “goaf well” after mining through).

*Goaf* - collapsed area of strata produced by the removal of coal and artificial supports behind a working coalface. Strata above and below the goaf is de-stressed and fractured by the mining activity. Methane released from this disturbed zone is available for Post mining CMM Extraction through either surface goaf wells or underground boreholes or drainage galleries.

*Indirect CBM to Goaf well methane* – coal bed methane extracted from surface drainage wells (vertical or vertical to in-seam) sufficiently close to the planned mining area so that the extraction of gas through



this well will contribute to reducing the future concentration of methane that would be released in the future mine.

*Ventilation air methane* – methane mixed with the ventilation air in the mine that is circulated in sufficient quantity to dilute the methane to low concentrations for safety reasons.

*Pre mining CMM Extraction* (also known as pre drainage) – methane extraction prior to the mining process from CBM, or underground inclined or horizontal boreholes in the mine (for safety reasons).

*Post mining CMM Extraction* (also known as post drainage) – methane extraction after completion of the mining process from vertical surface goaf wells, underground inclined or horizontal boreholes, gas drainage galleries or other goaf gas capture techniques, including drainage of sealed areas, in the mine (for safety reasons).

*Mining Activities* – working of an area, or panel, of coal that has been developed and equipped to facilitate coal extraction and is shown on a mining plan.

### Applicability

This methodology applies to project activities that involve the use of any of the following extraction activities:

- Surface drainage wells to capture CBM to Goaf well methane and Indirect CBM to Goaf well methane;
- Underground inclined or horizontal boreholes in the mine to capture CMM pre mining;
- Surface goaf wells, underground inclined or horizontal boreholes, gas drainage galleries or other goaf gas capture techniques, including gas from sealed areas, to capture post mining CMM;
- Ventilation CMM that would normally be vented.

This methodology applies to CMM capture, utilisation and destruction project activities at a working coal mine, where the baseline is the partial or total atmospheric release of the methane and the project activities include the following method to treat the gas captured:

- The methane is captured and destroyed through flaring; and/or
- The methane is captured and destroyed through utilisation to produce electricity, motive power and/or thermal energy; emission reductions may or may not be claimed for displacing or avoiding energy from other sources;
- The remaining share of the methane to be diluted for safety reason may still be vented;
- All the CBM or CMM captured by the project should either be used or destroyed, and cannot be vented.

The methodology applies to both new and existing mining activities.

The methodology does not apply to project activities that:

- Operate in open cast mines; or
- Capture methane from abandoned/decommissioned coalmines.
- Capture/use of virgin coal-bed methane, e.g. methane of high quality extracted from coal seams independently of any mining activities.



This baseline methodology shall be used in conjunction with the approved consolidated monitoring methodology for “Consolidated monitoring methodology for coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat and/or destruction by flaring”(ACM00XX).

### Project boundary

For the purpose of determining *project activity emissions*, project participants shall include:

- CO<sub>2</sub> emissions from the combustion of methane in a flare, engine, power plant or heat generation plant;
- CO<sub>2</sub> emissions from the combustion of non methane hydrocarbons (NMHCs), if they represent more than 1% by volume of the extracted coal mine gas;
- CO<sub>2</sub> emissions from on-site fuel consumption due to the project activity, including transport of the fuel.
- Fugitive emissions of unburned methane

For the purpose of determining *baseline emissions*, project participants shall include the following emission sources:

- CH<sub>4</sub> emissions as a result of venting and drainage;
- CO<sub>2</sub> emissions from the destruction of methane in the baseline scenario;
- CO<sub>2</sub> emissions from the production of heat and power (motive and electrical) that is replaced by the project activity.

The *spatial extent* of the project boundary comprises:

- All equipment installed and used as part of the project activity for the extraction, compression, and storage of CMM and CBM at the project site, and transport to an off-site user.
- Flaring, Captive power and heat generation facilities installed and used as part of the project activity.
- Power plants connected to the electricity grid, where the project activity exports power to the grid, as per the definition of project electricity system and connected electricity system given in ACM0002 (“Consolidated baseline methodology for grid-connected electricity generation from renewable sources”<sup>1</sup>).

Table 1 illustrates which emissions sources are included and which are excluded from the project boundary for determination of both baseline and project emissions.

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<sup>1</sup> Please refer to: <<http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>>.



Table 1: Overview on emissions sources included in or excluded from the project boundary

**Baseline**

Source	Gas		Justification / Explanation
Emissions of methane as a result of venting	CH <sub>4</sub>	Included	<ul style="list-style-type: none"> <li>Main emission source. However, certain sources of methane may not be included, as noted in the applicability conditions.</li> <li>Recovery of methane from coal seams will be taken into account only when the particular seams are mined through or disturbed by the mining activity.</li> <li>Recovery of methane from abandoned coalmines will not be included.</li> <li>The amount of methane to be released depends on the amount used (for local consumption, gas sales, etc) in the baseline.</li> </ul>
Emissions from destruction of methane in the baseline	CO <sub>2</sub>	Included	<ul style="list-style-type: none"> <li>Considers any flaring or use for heat and power in the baseline scenario.</li> </ul>
	CH <sub>4</sub>	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This is conservative.</li> </ul>
	N <sub>2</sub> O	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This is conservative.</li> </ul>
Grid electricity generation (electricity provided to the grid)	CO <sub>2</sub>	Included	<ul style="list-style-type: none"> <li>Only CO<sub>2</sub> emissions associated to the same quantity of electricity than electricity generated as a result of the use of methane included as baseline emission will be counted.</li> <li>Use of combined margin from ACM0002 is recommended.</li> </ul>
	CH <sub>4</sub>	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This is conservative.</li> </ul>
	N <sub>2</sub> O	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This is conservative.</li> </ul>
Captive power and/or heat, and vehicle fuel use	CO <sub>2</sub>	Included	<ul style="list-style-type: none"> <li>Only when the baseline scenario involves such usage.</li> </ul>
	CH <sub>4</sub>	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This is conservative.</li> </ul>
	N <sub>2</sub> O	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This is conservative.</li> </ul>

**Project activity**

Source	Gas		Justification / Explanation
Emissions of methane as a result of continued venting	CH <sub>4</sub>	Excluded	<ul style="list-style-type: none"> <li>Only the change in CMM/CBM emissions release will be taken into account, by monitoring the methane used or destroyed by the project activity.</li> </ul>
On-site fuel consumption due to the project activity, including transport of the gas	CO <sub>2</sub>	Included	<ul style="list-style-type: none"> <li>If additional equipment such as compressors are required on top of what is required for purely drainage, energy consumption from such equipment should be accounted for.</li> </ul>
	CH <sub>4</sub>	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This emission source is assumed to be very small.</li> </ul>
	N <sub>2</sub> O	Excluded	<ul style="list-style-type: none"> <li>Excluded for simplification. This emission source is assumed to be very small.</li> </ul>
Emissions from methane destruction	CO <sub>2</sub>	Included	<ul style="list-style-type: none"> <li>From the combustion of methane in a flare, or heat/power generation.</li> </ul>
Emissions from NMHC destruction	CO <sub>2</sub>	Included	<ul style="list-style-type: none"> <li>From the combustion of NMHC in a flare, or heat/power generation, if NMHC accounts for more than 1% by volume of extracted coal mine gas.</li> </ul>



Fugitive emissions of unburned methane	CH <sub>4</sub>	Included	• Small amounts of methane will remain unburned in flares or heat/power generation.
Fugitive methane emissions from on-site equipment	CH <sub>4</sub>	Excluded	• Excluded for simplification. This emission source is assumed to be very small.
Fugitive methane emissions from gas supply pipeline or in relation to use in vehicles	CH <sub>4</sub>	Excluded	• Excluded for simplification. However taken into account among other potential leakage effects (see leakage section)
Accidental methane release	CH <sub>4</sub>	Excluded	• Excluded for simplification. This emission source is assumed to be very small.

### Identification of baseline scenario

#### Step 1. Identify technically feasible options for capturing and/or using CBM or CMM

##### *Step 1a. Options for CBM and CMM extraction*

The baseline scenario alternatives should include all possible options that are technically feasible to handle CBM and CMM to comply with safety regulations. These options could include:

- i. Ventilation air methane;
- ii. Pre mining CMM extraction including CBM to Goaf drainage and/or Indirect CBM to Goaf only;
- iii. Post mining CMM extraction;
- iv. Possible combinations of options A, B and C, with the relative shares of gas specified.

These options should include the CDM project activity not implemented as a CDM project.

##### *Step 1b. Options for extracted CBM and CMM treatment*

The baseline scenario alternatives should include all possible options that are technically feasible to use CBM and CMM. These options could include:

- i. Venting;
- ii. Using/destroying ventilation air methane rather than venting it;
- iii. Flaring of CBM/CMM;
- iv. Use for additional grid power generation;
- v. Use for additional captive power generation;
- vi. Use for additional heat generation;
- vii. Feed into gas pipeline (to be used as fuel for vehicles or heat/power generation);
- viii. Possible combinations of options i to vii with the relative shares of gas treated under each option specified.

These options should include the CDM project activity not implemented as a CDM project.

#### Step 2. Eliminate baseline options that do not comply with legal or regulatory requirements

Any options for CBM/CMM management and use that do not meet with local legal or regulatory requirements should be eliminated. The project participants shall provide evidence and supporting documents to exclude baseline options that meet the above-mentioned criteria.



### Step 3. Formulate baseline scenario alternatives

On the basis of the options that are technically feasible and comply with all legal and regulatory requirements, the project participants should construct coherent and comprehensive baseline scenario alternative(s). One of these alternative(s) shall be the CDM project activity not being registered as a CDM project.

The baseline scenario alternatives should clearly identify what share or volumes of potential CBM and CMM would be managed according to the different technology options, and what share or volumes of CBM/CMM would be used for which end-uses, where appropriate (including flaring if applicable). The baseline scenario alternatives should also identify whether the power used at the coalmine would be from the grid, from captive power, or a combination of the two.

### Step 4. Eliminate baseline scenario alternatives that face prohibitive barriers

Establish a complete list of barriers that would prevent identified baseline scenario alternatives to occur in the absence of the CDM. Such barriers may include, among others:

Investment barriers *inter alia*:

- Debt funding is not available for this type of innovative project activity.
- Neither access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented, nor sufficient ODA can be allocated to finance the considered project alternatives.

Technological barriers, *inter alia*:

- Skilled and/or properly trained labour to operate and maintain the technology is not available and no education/training institution in the host country provides the needed skill, leading to equipment disrepair and malfunctioning;
- Lack of infrastructure for implementation of the technology.

Barriers due to prevailing practice, *inter alia*:

- The project activity is the “first of its kind”: No project activity of this type is currently operational in the host country or region.

Provide transparent and documented evidence, and offer conservative interpretations of this documented evidence, as to how it demonstrates the existence and significance of the identified barriers. Anecdotal evidence can be included, but alone is not sufficient proof of barriers. The type of evidence to be provided may include:

- i. Relevant legislation, regulatory information or industry norms;
- ii. Relevant (sectoral) studies or surveys (e.g. market surveys, technology studies, etc) undertaken by universities, research institutions, industry associations, companies, bilateral/multilateral institutions, etc;
- iii. Relevant statistical data from national or international statistics;
- iv. Documentation of relevant market data (e.g. market prices, tariffs, rules);
- v. Written documentation from the company or institution developing or implementing the CDM project activity or the CDM project developer, such as minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information, etc;
- vi. Documents prepared by the project developer, contractors or project partners in the context of the proposed project activity or similar previous project implementations;



- vii. Written documentation of independent expert judgements from industry, educational institutions (e.g. universities, technical schools, training centres), industry associations and others.

The baseline scenario alternatives that face barriers that would prohibit them from being implemented should be eliminated.

If there are several potential baseline scenario candidates that do not face barriers:

- i. either choose the most conservative (results in least emissions) alternative as the baseline scenario, or
- ii. go to step 5, and choose the economically most viable scenario as the baseline scenario.

### **Step 5. Identify most economically attractive baseline scenario alternative (optional)**

Determine which of the remaining baseline scenario alternatives not prevented by any barrier is the most economically or financially attractive, and, therefore, is a possible baseline scenario.

To conduct the investment analysis, use the following sub-steps:

***If one or more baseline scenario alternatives under consideration generate financial or economic benefits, then the simple cost analysis cannot be used to select the baseline scenario. If so, go to Step 5b***

#### ***Sub-step 5a. – Option I. Apply simple cost analysis***

Document the costs associated with alternatives to the CDM project activity and demonstrate that the corresponding activities produce no financial or economic benefits.

***The least costly alternative among the baseline scenario alternatives under consideration is the baseline scenario.***

#### ***Sub-step 5b. – Option II. Apply investment comparison analysis***

Identify the financial indicator, such as IRR<sup>2</sup>, NPV, cost benefit ratio, or unit cost of service (e.g., levelized cost of electricity production in \$/kWh or levelized cost of delivered heat in \$/GJ) most suitable for the project type and decision-making context.

Calculate the suitable financial indicator for each of the project alternatives that have not been eliminated in step 4 and include all relevant costs (including, for example, the investment cost, the operations and maintenance costs, financial costs, etc.), and revenues (including subsidies/fiscal incentives<sup>3</sup>, ODA, etc. where applicable), and, as appropriate, non-market cost and benefits in the case of public investors.

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<sup>2</sup> For the investment comparison analysis, IRRs can be calculated either as project IRRs or as equity IRRs. Project IRRs calculate a return based on project cash outflows and cash inflows only, irrespective of the source of financing. Equity IRRs calculate a return to equity investors and therefore also consider amount and costs of available debt financing. The decision to proceed with an investment is based on returns to the investors, so equity IRR will be more appropriate in many cases. However, there will also be cases where a project IRR may be appropriate.

<sup>3</sup> This provision may be further elaborated depending on deliberations by the Board on national and sectoral policies.



Present the investment analysis in a transparent manner and provide all the relevant assumptions in the CDM-PDD, so that a reader can reproduce the analysis and obtain the same results. Clearly present critical techno-economic parameters and assumptions (such as capital costs, fuel prices, lifetimes, and discount rate or cost of capital). Justify and/or cite assumptions in a manner that can be validated by the DOE. In calculating the financial indicator, the project's risks can be included through the cash flow pattern, subject to project-specific expectations and assumptions (e.g. insurance premiums can be used in the calculation to reflect specific risk equivalents).

Assumptions and input data for the investment analysis shall not differ across the project activity and its alternatives, unless differences can be well substantiated.

Present in the CDM-PDD submitted for validation a clear comparison of the financial indicator for the proposed project alternatives.

The alternative that has the best indicator (e.g. highest IRR) can be identified as the baseline scenario candidate. Perform Step 5.c to confirm the results of this step. Step 5.c shall be performed for all baseline scenario alternatives that have not been eliminated in step 4.

***Sub-step 5c. Sensitivity analysis:***

Include a sensitivity analysis that shows whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. The investment analysis provides a valid argument in selecting the baseline only if it consistently supports (for a realistic range of assumptions) the conclusion that the identified baseline scenario is likely to remain the most financially and/or economically attractive.

*In case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with least emissions among the baseline scenario alternatives that are the most financially and/or economically attractive according to both steps 5.b and the sensitivity analysis in this step 5.c.*

Once the baseline scenario has been determined, it has to be detailed and quantified consistently with the baseline data requirement in the methodology calculations of baseline emissions and emissions reductions.

This includes detailed projected values for baseline variables used in equation 10, and 12, among which:

$CBM_{BL,i,y}$	CBM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in the year $y$ (expressed in $tCH_4$ ), if any,
$CMM_{BL,i,y}$	Pre-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year $y$ (expressed in $tCH_4$ ), if any,
$PMM_{BL,i,y}$	post-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year $y$ ( $tCH_4$ ), if any,

for each use  $i$  of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses) in the baseline, if any, and,  
for projects where some portion of extracted CMM/CBM is already used to produce thermal energy in the baseline, variables used in equation 11:

$TH_y$	Mean baseline CMM / CBM demand for thermal uses for year $y$ ( $tCH_4$ )
$TH_{b,k}$	Mean daily baseline CMM and CBM demand for existing thermal energy uses in the baseline such as heating and cooking for day $k$ ( $tCH_4$ ),
$d_k$	scalar adjustment factor for day $k$ , based on the seasonal load shape ( $\sum d_k = 365$ )





## Additionality

*The additionality of the project activity shall be demonstrated and assessed using the latest version of the “Tool for the demonstration and assessment of additionality” agreed by the Executive Board<sup>4</sup>.*

This section elaborates on the use of the tool, and in particular how it relates to the selection of the baseline scenario. Because of the similarity of both approaches used to determine the baseline scenario and the additionality tool, step 1 of the tool for the demonstration and assessment of additionality can be ignored.

Consistency shall be ensured between baseline scenario determination and additionality demonstration.

The baseline scenario alternative selected in the previous section shall be used when applying steps 2 (or 3) to 5 of the tool for the demonstration and assessment of additionality.

The investment analysis approach, if used, should identify whether the baseline scenario selected above is economically and/or financially attractive than the CDM project activity if not registered as a CDM project.

## Project Emissions

Project emissions are defined by the following equation

$$PE_y = PE_{ME} + PE_{MD} + PE_{UM} \quad (1)$$

where:

$PE_y$	Project emissions in year y (tCO <sub>2</sub> e)
$PE_{ME}$	Project emissions from energy use to capture and use methane (tCO <sub>2</sub> e)
$PE_{MD}$	Project emissions from methane destroyed (tCO <sub>2</sub> e)
$PE_{UM}$	Project emissions from un-combusted methane (tCO <sub>2</sub> e)

### 1.1 Combustion emissions from additional energy required for CBM/CMM capture and use

Additional energy may be used for the capture, transport, compression and use for CBM/CMM. Emissions from this energy use should be included as project emissions.

$$PE_{ME} = \text{CONS}_{\text{ELEC,PJ}} \times \text{CEF}_{\text{ELEC}} + \text{CONS}_{\text{HEAT,PJ}} \times \text{CEF}_{\text{HEAT}} + \text{CONS}_{\text{Foss Fuel,PJ}} \times \text{CEF}_{\text{Foss Fuel}} \quad (2)$$

$PE_{ME}$	Project emissions from energy use to capture and use methane (tCO <sub>2</sub> e)
$\text{CONS}_{\text{ELEC,PJ}}$	Additional electricity consumption for capture and use of methane, if any (MWh)
$\text{CEF}_{\text{ELEC}}$	Carbon emissions factor of electricity used by coal mine (tCO <sub>2</sub> e/MWh)
$\text{CONS}_{\text{HEAT,PJ}}$	Additional heat consumption for capture and use of methane, if any (GJ)
$\text{CEF}_{\text{HEAT}}$	Carbon emissions factor of heat used by coal mine (tCO <sub>2</sub> e/GJ)
$\text{CONS}_{\text{FossFuel,PJ}}$	Additional fossil fuel consumption for capture and use of methane, if any (GJ)
$\text{CEF}_{\text{FossFuel}}$	Carbon emissions factor of fossil fuel used by coal mine (tCO <sub>2</sub> e/GJ)

For electricity emissions factor, the same formulae are used as in the calculations of baseline emissions. In other words, if the source of power for the coalmine is the grid, then the formulae from ACM0002 for calculating the combined margin emissions factor are used. If the source of power for the coalmine

<sup>4</sup> Please refer to: <<http://cdm.unfccc.int/EB/Meetings/016/eb16repan1.pdf>>



is captive power generation, then the emissions factor is calculated based on the emission factor for the fuel used and the efficiency of the captive power plant.

For the heat generation emission factor, the same formulae are used as in the calculations of baseline emissions. In other words, the boiler efficiency and the emission factor for the fuel used are the basis of the emissions factor.

### 1.2 Combustion emissions from use of captured methane

When the captured methane is burned in a flare, heat or power plant, combustion emissions are released. In addition, if NMHC account for more than 1% by volume of the extracted coal mine gas, combustion emission from these gases should also be included.

$$PE_{MD} = (MD_{FL} + MD_{ELEC} + MD_{HEAT} + MD_{GAS}) \times (CEF_{CH_4} + r \times CEF_{NMHC}) \quad (3)$$

with :

$$r = PC_{NMHC} / PC_{CH_4} \quad (3 \text{ bis})$$

where:<sup>5</sup>

$PE_{MD}$	Project emissions from CMM/CBM destroyed (tCO <sub>2</sub> e)
$MD_{FL}$	Methane destroyed through flaring (tCH <sub>4</sub> )
$MD_{ELEC}$	Methane destroyed through power generation (tCH <sub>4</sub> )
$MD_{HEAT}$	Methane destroyed through heat generation (tCH <sub>4</sub> )
$MD_{GAS}$	Methane destroyed after being supplied to gas grid or for vehicle use (tCH <sub>4</sub> )
$CEF_{CH_4}$	Carbon emission factor for combusted methane (2.75 tCO <sub>2</sub> e/tCH <sub>4</sub> )
$CEF_{NMHC}$	Carbon emission factor for combusted non methane hydrocarbons (the factor varies and, therefore, to be obtained through periodical analysis of captured methane) (tCO <sub>2</sub> eq/tNMHC)
$r$	Relative proportion of NMHC compared to methane
$PC_{CH_4}$	Concentration (in mass) of methane in extracted gas (%)
$PC_{NMHC}$	NMHC concentration (in mass) in extracted gas (%)

In each end-use, the amount of gas destroyed depends on the efficiency of combustion of each end use.

$$MD_{FL} = MM_{FL} \times Eff_{FL} \quad (4)$$

where:

$MD_{FL}$	Methane destroyed through flaring (tCH <sub>4</sub> )
$MM_{FL}$	Methane measured sent to flare (tCH <sub>4</sub> )
$Eff_{FL}$	Efficiency of flare (taken as 98% for conservativeness)

The flare efficiency ( $Eff_{FL}$ ) shall be measured as :

- the fraction of time in which the gas is combusted in the flare
- multiplied by the efficiency of the flaring process. For this purpose, the methane content of the flare emissions should be measured at least quarterly. This procedure requires the use of enclosed flares. In case open flares are used, since flare efficiency cannot be measured in a reliable manner (external air will be mixed and lower the concentration of methane) a conservative destruction

<sup>5</sup> Note that throughout this baseline methodology, it is assumed that measured quantities of coal mine gas are converted to tonnes of methane using the measured methane concentration of the coal mine gas and the density of methane.



efficiency factor should be provided and documented. If it cannot be done, a default value of 50% should be used.

$$MD_{ELEC} = MM_{ELEC} \times Eff_{ELEC} \quad (5)$$

where:

MD<sub>ELEC</sub> Methane destroyed through power generation (tCH<sub>4</sub>)  
 MM<sub>ELEC</sub> Methane measured sent to power plant (tCH<sub>4</sub>)  
 Eff<sub>ELEC</sub> Efficiency of methane destruction/oxidation in power plant (taken as 99.5% from IPCC)

$$MD_{HEAT} = MM_{HEAT} \times Eff_{HEAT} \quad (6)$$

where:

MD<sub>HEAT</sub> Methane destroyed through heat generation (tCH<sub>4</sub>)  
 MM<sub>HEAT</sub> Methane measured sent to heat plant (tCH<sub>4</sub>)  
 Eff<sub>HEAT</sub> Efficiency of methane destruction/oxidation in heat plant (taken as 99.5% from IPCC)

$$MD_{GAS} = MM_{GAS} \times Eff_{GAS} \quad (7)$$

where:

MD<sub>GAS</sub> Methane destroyed after being supplied to gas grid (tCH<sub>4</sub>)  
 MM<sub>GAS</sub> - Methane measured supplied to gas grid for vehicle use or heat/power generation off-site (tCH<sub>4</sub>)  
 Eff<sub>GAS</sub> Overall efficiency of methane destruction/oxidation through gas grid to various combustion end uses, combining fugitive emissions from the gas grid and combustion efficiency at end user (taken as 98.5% from IPCC)<sup>6</sup>

### 1.3 Un-combusted methane from flaring and end uses

Not all of the methane sent to the flare or used to generate power and heat will be combusted, so a small amount will escape to the atmosphere. These emissions are calculated using the following:

$$PE_{UM} = GWP_{CH_4} \times \sum_i MM_i \times (1 - Eff_i) \quad (8)$$

where:

PE<sub>UM</sub> Project emissions from un-combusted methane (tCO<sub>2</sub>e)  
 GWP<sub>CH<sub>4</sub></sub> Global warming potential of methane (21 tCO<sub>2</sub>e/tCH<sub>4</sub>)  
 i Use of methane (flaring, power generation, heat generation, supply to gas grid to various

<sup>6</sup>The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories gives a standard value for the fraction of carbon oxidised for gas combustion of 99.5% (Reference Manual, Table 1.6, page 1.29). It also gives a value for emissions from processing, transmission and distribution of gas which would be a very conservative estimate for losses in the grid and for leakage at the end user (Reference Manual, Table 1.58, page 1.121). These emissions are given as 118,000kgCH<sub>4</sub>/PJ on the basis of gas consumption, which is 0.6%. Leakage in the residential and commercial sectors is given as 0 to 87,000kgCH<sub>4</sub>/PJ, which is 0.4%, or in industrial plants and power station the losses are 0 to 175,000kg/CH<sub>4</sub>/PJ, which is 0.8%. These leakage estimates are additive. Eff<sub>GAS</sub> can now be calculated as the product of these three efficiency factors, giving a total efficiency of (99.5% \* 99.4% \* 99.6%) 98.5% for residential and commercial sector users, and (99.5% \* 99.4% \* 99.2%) 98.1% for industrial plants and power stations.



	combustion end uses)
MM <sub>i</sub>	Methane measured sent to use i (tCH <sub>4</sub> )
Eff <sub>i</sub>	Efficiency of methane destruction in use i (%)

### Baseline Emissions

Baseline emissions are given by the following equation:

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y} \quad (9)$$

BE <sub>y</sub>	Baseline emissions in year y (tCO <sub>2</sub> e)
BE <sub>MD,y</sub>	Baseline emissions from destruction of methane in the baseline scenario in year y (tCO <sub>2</sub> e)
BE <sub>MR,y</sub>	Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity (tCO <sub>2</sub> e)
BE <sub>Use,y</sub>	Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year y (tCO <sub>2</sub> e)

#### 1.4 Methane destruction in the baseline

Depending on the nature of the activities in the baseline scenario, CBM/CMM can be removed at three different stages – (1) as coal bed methane from a CBM to goaf wells prior to mining, or from underground pre-mining CMM drainage; (2) during the mining process using surface or underground post mining CMM drainage techniques, or (3) after the mining process by drainage from sealed goafs but before the mine is closed.

Depending on the baseline scenario, part of this methane may be destroyed in the baseline scenario through flaring, power generation, heat generation, supply to gas grid to various combustion end uses. Baseline emissions should account for the CO<sub>2</sub> emissions resulting from the destruction of that methane.

$$BE_{MRy} = (CEF_{CH_4} + r \times CEF_{NMHC}) \times \sum_i (CBM_{BLi,y} + CMM_{BLi,y} + PMM_{BLi,y}) \quad (10)$$

where:

$BE_{MD,y}$	Baseline emissions from destruction of methane in the baseline scenario in year y (tCO <sub>2</sub> e)
$i$	Use of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses)
$CBM_{BLi,y}$	CBM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in the year y (expressed in tCH <sub>4</sub> )
$CMM_{BLi,y}$	Pre-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year y (expressed in tCH <sub>4</sub> )
$PMM_{BLi,y}$	post-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year y (tCH <sub>4</sub> )
$CEF_{CH_4}$	Carbon emission factor for combusted methane (2.75 tCO <sub>2</sub> e/tCH <sub>4</sub> )
$CEF_{NMHC}$	Carbon emission factor for combusted non methane hydrocarbons (various. To be obtained through periodical analysis of captured methane) (tCO <sub>2</sub> eq/tNMHC)
$r$	Relative proportion of NMHC compared to methane

with :

$$r = P_{C_{NMHC}} / P_{C_{CH_4}}$$

$P_{C_{CH_4}}$	Concentration (in mass) of methane in extracted gas (%)
$P_{C_{NMHC}}$	NMHC concentration (in mass) in extracted gas (%)

##### 1.4.1 Special case for calculation of baseline emissions resulting from methane destroyed to serve thermal demand in the baseline scenario

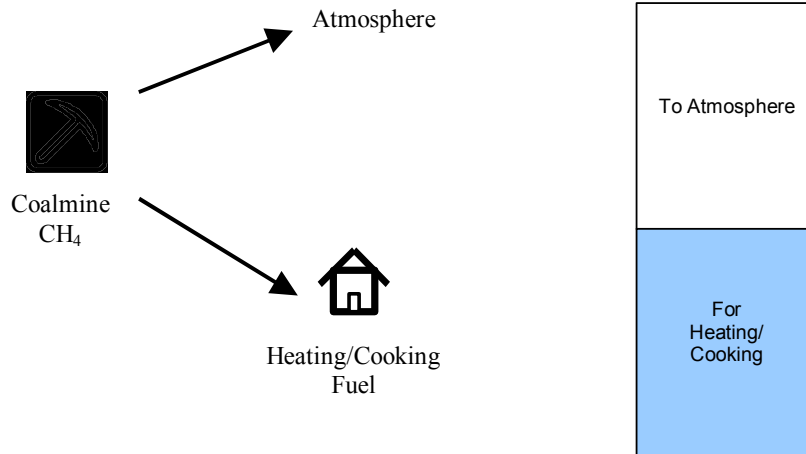
To estimate conservatively methane destruction in the baseline over time, it is important to understand the characteristics of the *ex ante* thermal demand for methane in the baseline scenario.

***This section applies only to projects that use CMM/CBM to produce electricity or other uses at a mine where CMM/CBM is already extracted, and where some portion of this extracted CMM/CBM is already used to produce thermal energy (e.g., for heating or cooking).***

As a result, a specific additional applicability condition applies for that section, that is, only above described projects (see paragraph above) that can provide the adequate ex ante data required by this section can use the whole methodology. If this is not the case, project participants have to submit a new methodology.

This section presumes that such power generation (or other uses) projects are designed to primarily (or exclusively) use extracted CMM that would *not* be used for baseline thermal energy and would otherwise be emitted to the atmosphere. Figures 1 and 2 indicate the disposition of methane under the baseline and project scenarios for this type of project.

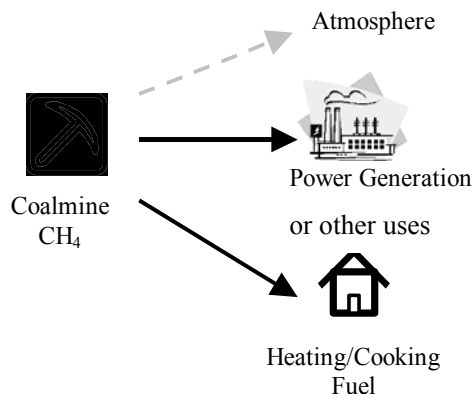
**Figure 1. Baseline Disposition of CMM/CBM**



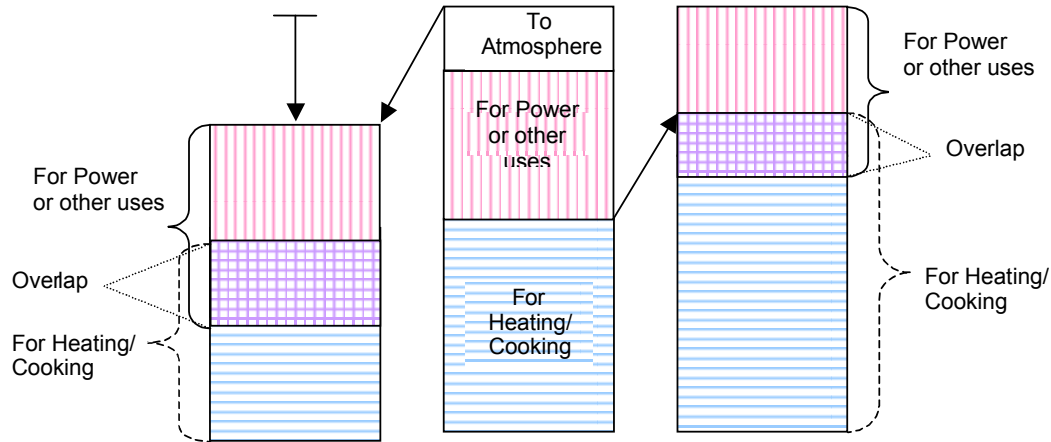
For applicable projects, some or all of the CMM used to generate electricity would be emitted to the atmosphere under the baseline (Figure 1). Appropriate CMM flow and concentration meters should directly measure the amount of methane delivered to the project electric generator.

Under some circumstances, some portion of the CMM used by a project for power generation might otherwise have gone to produce thermal energy under the baseline. This situation is shown in Figure 2, indicating an “overlap” between CMM used for power and baseline use of CMM for heating/cooking. This overlap may occur if CMM flows fall below expected levels (left column at bottom of Figure 2), or if baseline thermal energy demand exceeds expected levels (right column at bottom of Figure 2). Such overlaps may occur even where total annual CMM volumes are more than enough to cover annual thermal energy and power requirements (as in Figure 2). This methodology provides for conservatively estimating what amount of methane – if any – used for power production would have been used for thermal energy in the baseline. Emissions from the project are reduced only to the extent that the power generation uses methane that would have been *emitted* in the baseline (i.e., “emitted to atmosphere” in Figure 1). Reductions are calculated by converting methane that would have been

emitted into metric tones of CO<sub>2</sub> equivalent, and subtracting CO<sub>2</sub> produced by the combustion of the methane.



**Figure 2. Project Case CMM/CBM for Power (or other uses) Overlaps with Baseline Thermal CMM**



As a result, in equation (10) when, and only when  $i =$  thermal use in the baseline, the following sum

$$\sum_i (CBM_{BLi,y} + CMM_{BLi,y} + PMM_{BLi,y})$$

should be substituted, for each year  $y$ , by the following sum

$$\sum_{k=1}^{365} (TH_{b,k})$$

where:

$TH_{b,k}$  daily baseline CMM and CBM demand for existing thermal energy uses in the baseline such as heating and cooking for day  $k$  (tCH<sub>4</sub>), (see 7.1.2)

#### 1.4.2 Daily baseline thermal energy demand for CMM and CBM

The quantity  $TH_{b,k}$  should be determined for each day  $k$  of the annual reporting period. For each day  $k$ , in a standard year the formula is:

$$TH_{b,k} = (TH_y / 365) \times d_k \quad (11)$$

where:

$TH_{b,k}$  Daily baseline CMM / CBM demand for thermal energy uses in the baseline for day  $k$  (tCH<sub>4</sub>)

$TH_y$  Mean baseline CMM / CBM demand for year  $y$  (tCH<sub>4</sub>)

$d_k$  scalar adjustment factor for day  $k$

#### Calculation of the mean annual demand ( $TH_y$ ) for each year of the crediting period

The source of data for mean annual baseline thermal energy demand should be provided on an *ex ante projection* basis by local CMM / CBM distribution system operators, supported by a detailed description of the drivers of, and constraints on, future CMM / CBM thermal energy demand. The project participants will use the methods below to project thermal energy demand. . If using approach (b) project proponents must document why (a) cannot be used. If using approach (c) project proponents must document why neither (a) or (b) can be used.



- a) *Engineering/economic study of thermal energy demand.* Ideally, projections should be based on a detailed description of the existing CMM / CBM distribution system for thermal energy, how and why it was constructed, and what the primary drivers are behind thermal energy demand on the system. Based on this description, project proponents should describe how thermal energy demand is expected to change in the future in the absence of the project. Key points to address include:
- Who the users of CMM for thermal energy are, by quantity and type (e.g., residential, commercial, industrial);
  - What service agreements are in place with these end users;
  - Average CMM/thermal energy consumption rates for each type of end user;
  - The number of end users serviced by the distribution system relative to the total pool of possible end users, given infrastructure constraints;
  - How quickly the total pool of possible end users is expected to grow, if at all;
  - Whether official plans exist to expand the CMM / CBM thermal energy system;
  - The cost/benefits of expanding the CMM / CBM delivery system to additional end users;
  - The type and cost of alternative fuels for potential or existing CMM / CBM thermal energy customers, compared to the cost of delivering CMM / CBM;
  - Any other variables relevant to the particular thermal energy CMM / CBM distribution system associated with the project.

Project proponents should explain how any assumptions used in this analysis are conservative.

- b) *Statistical projection.* If detailed information on thermal energy demand or the existing CMM distribution system is not available, project proponents may use a statistical projection based on CMM / CBM availability and thermal energy CMM / CBM usage rates over at least the past five years. If the latter approach is used, proponents must explain why such a statistical projection is reasonable, and should supplement any projection with as much engineering/economic information as possible.
- c) *Maximum throughput on the distribution system.* Failing sufficient data for an engineering/economic assessment or a statistical projection (e.g., if less than five years of data are available), prospective thermal energy demand in the absence of the project may be estimated from the maximum amount of CMM / CBM that could be delivered to end users through existing pipelines. To be conservative, this approach should assume that thermal energy demand for CMM / CBM in all future years will be equal to the maximum amount of CMM / CBM that can be delivered. Maximum throughput estimates should be based on a detailed engineering description of the existing pipeline infrastructure. This analysis may also inform the analysis for (a) and (b), above.

Under the project, CMM / CBM used for thermal energy should also be measured directly *post hoc* on a daily and cumulative basis, using an appropriate flow meter (accounting for temperature, pressure, and methane concentration) installed at the front of the CMM / CBM distribution system. (MM<sub>HEAT</sub>).

#### **1.4.3 Adjustment to account for volatility in baseline thermal energy demand**

Even when a project's average annual CMM/CBM use for electricity generation or other uses is significantly below baseline CMM/CBM emissions, there may be times – due to daily fluctuations in thermal energy demand or in CMM/CBM extraction rates – that the project will use CMM that would have been used for thermal energy under baseline conditions. This methodology prescribes a conservative approach to account for how daily fluctuations in CMM/CBM extraction and thermal energy demand will affect actual emission reductions relative to the baseline.



The likely fluctuation around daily estimates of baseline thermal energy demand for CMM results from both:

- The expected year-to-year volatility in thermal energy demand relative to baseline projections of average demand.
- The expected day-to-day volatility in thermal energy demand, relative to average quantity required on each day.

These sources of volatility should be combined into a single distribution around daily estimates of thermal energy demand. This distribution is generated by equation 11 above, in which the mean daily baseline  $TH_{b,k}$  is multiplied by the daily scalar adjustment factor  $d_k$ .

The scalar adjustment factor for the day  $k$  of the year  $y$  is the ratio between the demand for that day  $k$  and the mean daily demand for year  $y$ . For the past 5 years before the starting date of the proposed project activity,  $d_k$  is calculated using real measured data. For each year  $y$  of the crediting period,  $d_k$  takes the highest value observed during the 5 years before the starting date of the proposed project activity.

### 1.5 Methane released into the atmosphere

Depending on the nature of the project activity, CBM/CMM can be removed at three different stages – (1) as coal bed methane from a CBM to goaf wells prior to mining, or from underground pre-mining CMM drainage; (2) during the mining process using surface or underground post mining CMM drainage techniques, or (3) after the mining process by drainage from sealed goafs but before the mine is closed.

This methane would have been emitted to the atmosphere in the baseline scenario, unless some capture and use activities form part of the baseline.

$$BE_{MR,y} = GWP_{CH_4} \times \left[ \sum_i (CBMe_{i,y} - CBM_{BLi,y}) + \sum_i (CMM_{PJi,y} - CMM_{BLi,y}) + \sum_i (PMM_{PJi,y} - PMM_{BLi,y}) \right] \quad (12)$$

where:

$BE_{MR,y}$	Baseline emissions from release of methane into the atmosphere in year $y$ that is avoided by the project activity (tCO <sub>2</sub> e)
$i$	Use of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses)
$CBMe_{i,y}$	Eligible CBM captured, sent to and destroyed by use $i$ in the project for year $y$ (expressed in tCH <sub>4</sub> )
$CBM_{BLi,y}$	CBM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in the year $y$ (expressed in tCH <sub>4</sub> )
$CMM_{PJi,y}$	Pre-mining CMM captured, sent to and destroyed by use $i$ in the project activity in year $y$ (expressed in tCH <sub>4</sub> )
$CMM_{BLi,y}$	Pre-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year $y$ (expressed in tCH <sub>4</sub> )
$PMM_{PJi,y}$	post-mining CMM captured, sent to and destroyed by use $i$ in the project activity in year $y$ (tCH <sub>4</sub> )
$PMM_{BLi,y}$	post-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year $y$ (tCH <sub>4</sub> )
$GWP_{CH_4}$	Global warming potential of methane (21 tCO <sub>2</sub> e/tCH <sub>4</sub> )
$CEF_{CH_4}$	Carbon emission factor for combusted methane (2.75 tCO <sub>2</sub> e/tCH <sub>4</sub> )
$CEF_{NMHC}$	Carbon emission factor for combusted non methane hydrocarbons (various. To be obtained through periodical analysis of captured methane) (tCO <sub>2</sub> eq/tNMHC)
$r$	Relative proportion of NMHC compared to methane



with :

$$r = P_{\text{NMHC}} / P_{\text{CH}_4}$$

$P_{\text{CH}_4}$  Concentration (in mass) of methane in extracted gas (%)

$P_{\text{NMHC}}$  NMHC concentration (in mass) in extracted gas (%)

The methane which still vented in the project is not accounted for neither in the project emissions nor in the baseline emissions, since it is vented in both scenarios.

For CBM captured, the avoided emissions should only be credited in the year in which the seam is mined through the CBM well influence zone, as explained in the next section.

### 1.5.1 Eligible CBM

The approach to quantify the eligible CBM is to identify the zone of influence of CBM to goaf wells and indirect CDM to goaf wells, and when these are impacted by mining activities.

#### Step 1: Classification of wells

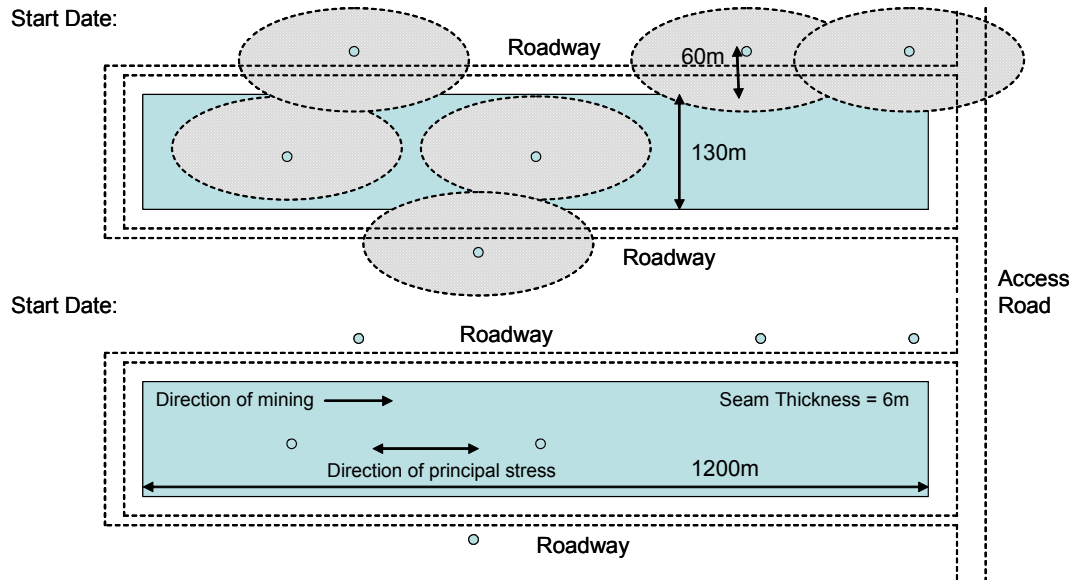
The first step is to identify the drilling plan and classification of the wells as follows:

Their location in relation to the mine concession area and mining plan during the initial crediting period is estimated using the latest mine plan information, and a map should be included in the Project Design Document. An indicative mining map showing Type 1 and Type 2 wells and their zone of influence is shown in Figure 3.

Well Type	Name	Definition
1	CBM to Goaf Well	These are wells that intersect the area to be mined and so will be completely drilled through during mining.
2	Indirect CBM to Goaf well drilled with a zone of influence	These are wells that, while they do not intersect the mining pathway, extract methane from an area that will influence the amount of methane released into the mine in the future.

*Note: Wells that extract virgin coal bed methane, i.e. from areas that would not be mined and would not influence eventual CMM emissions in mined areas, are out of the boundary of both the baseline and the project. Any activity intending to extract and use such virgin coal bed methane should refer to another methodology.*

**Figure 3.** Indicative Figure Showing Mining Plan and Type 1 and Type 2 wells and their zone of influence



**Step 2. Estimation of the Zone of Influence of a Surface Drainage Well and ratio of eligible Indirect CBM to Goaf well methane**

This methodology estimates the overlap between the gas drainage zone around a production well with the zone of disturbance around a longwall panel, from which gas is emitted into the mine.

A generalised zone or radius of influence,  $R$ , for a particular well can be estimated at any time during the pre drainage process based on either (i) the cumulative flow measured at the well  $V_w$  or (ii) on the total cumulative gas drained from all the wells measured at the centralised monitoring station  $V_c$ . Idealised uniform degassing is assumed within a cylindrical zone centred on the borehole and a constant production flow.

(i) Using cumulative flow at the well:

$$R = ((V_c)/(\pi \times T \times \rho_{\text{coal}} \times g_{\text{coal}}))^{0.5} \quad (13)$$

where:

$R$	Cumulative radius of zone of influence per year (m/year)
$V_c$	Cumulative flow measured at the well ( $\text{m}^3$ )
$T$	Total thickness of coal in section accessed by well (m)
$\rho_{\text{coal}}$	Density of locally mined coal ( $\text{t}/\text{m}^3$ )– default value $1.4 \text{ t}/\text{m}^3$
$g_{\text{coal}}$	Gas content of the coal ( $\text{m}^3 \text{ CH}_4/\text{tonne coal}$ )

(ii) using cumulative flow from a number of wells

$$R = ((n \times V_a)/(\pi \times T \times \rho_{\text{coal}} \times g_{\text{coal}}))^{0.5} \quad (14)$$

where:



R	Cumulative radius of zone of influence (m)
n	Number of days the selected well is operational
$V_a$	Average flow per day ( $m^3/d$ )
T	Total thickness of coal in section accessed by well (m)
$\rho_{coal}$	Density of locally mined coal – default value $1.4 t/m^3$
$g_{coal}$	Gas content of the coal ( $tCH_4/tonne$ coal)

and

$$V_a = V_{tc} / N \quad (15)$$

where:

$V_a$	Average flow per day ( $m^3$ )
$V_{tc}$	Total cumulative gas drained from all the wells measured at the centralised monitoring station
N	Sum of days that all wells have been operational

As an example, taking the density of coal as  $1.4$  tonne per  $m^3$ , the gas in coal to be  $12 m^3$  per tonne, the thickness of the section to be  $40$  metres and the flow rate to be  $2400 m^3/day$  then the radius of zone of influence will increase by  $20$  m per year. Therefore, if the number pre-drainage years are '3' the corresponds radius of zone of influence will be '60' m. The Project Design Document should elaborate the project specific values for the zone of influence.

#### *Area of Overlap*

Once the zone of influence for a well in a given year overlaps the longwall panel to be mined, then the gas from the well is considered to be eligible CBM. To estimate portion of CBM that would have been released from mining activities, a geometric approach in the horizontal plane and the vertical plane is used where the area of overlap between the defined zones of influence for each well and the longwall panel to be mined ("*Area of Overlap*") is used as well as the de-stressing zone above and below the seam to be mined.

*Horizontal plane:* The ratio of the Area of Overlap to the total area of the zones of influence of the wells considered is calculated and used to identify the appropriate share of gas counted as eligible CBM. The equations for this are:

$$ES_h = \frac{\sum_w AO_w}{\sum_w AT_w} \quad (16)$$

where:

$ES_h$	eligible share of CBM based on the horizontal plane overlap (%)
$AO_w$	area of overlap of well w with the longwall mining panel ( $m^2$ )
$AT_w$	total zone of influence of well w ( $m^2$ )
w	wells classified as Type 2 wells

Note that for type 1 wells,  $ES_h$  is unity by definition. In other words, all of the CBM drained from a type 1 well is eligible, unless there is gas coming from seams beyond the de-stressing zone.



Vertical plane: The de-stressing zone typically extends upwards 140 m and downwards 40 metres. If cased boreholes are used and the seams are fraced within the de-stressing zone, then all the gas entering the CBM well is gas that would have appeared as methane in ventilation air and CMM during and after mining. If other seams outside of the destressed zone are fraced, then this gas must be excluded from the eligible CBM. The eligible share is defined as follows:

$$ES_v = \frac{t}{T} \quad (17)$$

where:

ES<sub>v</sub>            eligible share of CBM based on the vertical plane overlap (%)  
t                thickness of coal which lies within the longwall emission zone (m)  
T                total thickness of coal that is producing gas in the production well (m)

The value for ES<sub>v</sub> would be 1 for cased boreholes where fracing is only done in the seams of relevance. A mine cross section should be included in the PDD together and supporting documentation on the well drilling process should be supplied to the Validator to justify the ratio of t/T.

Eligible CBM: Summarising the eligible contribution of CBM in the horizontal and vertical planes gives the final ratio of eligible CBM:

$$ES_t = ES_h \times ES_v \quad (18)$$

where:

ES<sub>t</sub>            total eligible share of CBM (%)  
ES<sub>h</sub>            eligible share of CBM based on the horizontal plane overlap (%)  
ES<sub>v</sub>            eligible share of CBM based on the vertical plane overlap (%)

*CO<sub>2</sub> emissions from use or destruction of CBM:*

Note that while only the eligible CBM should be accounted to calculate the volume of methane emissions avoided by the project, the totality of the CO<sub>2</sub> resulting from the use or the destruction of all the CBM extracted should be accounted as project emissions.

Note that once a Type 1 Well (CBM to Goaf Well) has been mined through, then the well acts in the same manner as conventional underground post mining CMM drainage and therefore all of the methane that is drained through this type of well is eligible, irrespective of whether the well is drilled off-centre to the longwall panel and some of the area of influence is outside the area of the longwall panel.

The Project Design Document should contain the relevant project specific data in order to calculate an ex-ante estimate of the above. Furthermore this will be updated ex-post using mining plans and accurate measurements of the locations of the actually drilled wells, as the final location of the type 1 and 2 CBM wells will be determined after proper risk assessments and taking into account local conditions for drilling.

If any wells that were planned to be Type 1 or 2 wells are not reached by the mining activities, then corresponding methane extracted should not be taken into account in the emission reduction calculation.



However fossil fuel emissions reduction achieved by substituting fossil fuels by this methane in other activities (power generation, heat generation, etc.) can be accounted.

### *Step 3 Temporal adjustments for baseline emissions within a defined crediting period*

No emission reductions from CBM utilization and or destruction can be claimed until the mining activity enters the zone of influence of the well. At that time the emission reductions from the share of eligible pre-drainage and subsequent post-drainage methane can be claimed. This is calculated as follows:

$$CBM_{e,y} = ES_t \times \sum_w \sum_{i=0}^{y-b} V_{w,y-i} \quad (19)$$

where:

$CBM_{e,y}$	Eligible CBM captured by the project for year $y$ (tCH <sub>4</sub> )
$ES_t$	total eligible share of CBM (%)
$V_{w,y-i}$	Volume of methane captured from well $w$ in year $y-i$ (tCH <sub>4</sub> )
$w$	number of wells where mining has reached the zone of influence
$b$	initial year of crediting period

Note that  $CBM_{BL,y}$  may be defined as a fixed share of  $CBM_{e,y}$ . This share of CBM that would have been captured in the baseline must be justified by the project participants.

### *1.5.2 Pre-mining and post-mining CMM extraction*

Both  $CMM_{PJ,y}$  and  $PMM_{PJ,y}$  are directly monitored as part of the project activity. In both cases, the avoided methane equals the amount captured, less any that would have been captured in the baseline. The amount captured in the baseline may be defined as an absolute amount, or as a share of the amount captured in the project activity. In either case, these assumptions must be justified by the project participants.

### *1.6 Emissions from power/heat generation and vehicle fuel replaced by project*

$$BE_{Use,y} = GEN_y \times EF_{ELEC} + HEAT_y \times EF_{HEAT} + VFUEL_y \times EF_V \quad (20)$$

$BE_{Use,y}$	Baseline emissions from the production of power or heat replaced by the project activity in year $y$ (tCO <sub>2</sub> e)
$GEN_y$	Electricity generated by project activity in year $y$ (MWh), including through the use of CBM
$EF_{ELEC}$	Emissions factor of electricity (grid, captive or a combination) replaced by project (tCO <sub>2</sub> /MWh)
$HEAT_y$	Heat generation by project activity in year $y$ (GJ), including through the use of CBM
$EF_{HEAT}$	Emissions factor for heat production replaced by project activity (tCO <sub>2</sub> /GJ)
$VFUEL_y$	Vehicle fuel provided by the project activity in year $y$ (GJ), including through the use of CBM
$EF_V$	Emissions factor for vehicle operation replaced by project activity (tCO <sub>2</sub> /GJ)

### 1.6.1 Grid power emission factor

If the baseline scenario includes grid power supply that would be replaced by the project activity, the Emissions Factor for displaced electricity is calculated as in ACM0002.

### 1.6.2 Captive power emissions factor

If the baseline scenario includes captive power generation (either existing or new) that would be replaced by the project activity, the Emissions Factor for displaced electricity is calculated as follows:

$$EF_{captive,y} = \frac{EF_{CO_2,i}}{Eff_{captive}} \times \frac{44}{12} \times \frac{3.6TJ}{1000MWh} \quad (21)$$

where:

$EF_{captive,y}$	Emissions factor for captive power generation (tCO <sub>2</sub> /MWh)
$EF_{CO_2,i}$	CO <sub>2</sub> emissions factor of fuel used in captive power generation (tC/TJ)
$Eff_{captive}$	Efficiency of the captive power generation (%)
44/12	Carbon to Carbon Dioxide conversion factor
3.6/1000	TJ to MWh conversion factor

### 1.6.3 Combination of grid power and captive power emissions factor

If the baseline scenario selection determines that both captive and grid power would be used, then the emissions factor for the baseline is the weighted average of the emissions factor for grid power and captive power.

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

$EF_{ELEC,y}$	CO <sub>2</sub> baseline emission factor for the electricity displaced due to the project activity during the year $y$ (tCO <sub>2</sub> /MWh).
$EF_{grid,y}$	CO <sub>2</sub> baseline emission factor for the grid electricity displaced due to the project activity during the year $y$ (tCO <sub>2</sub> /MWh).
$EF_{captive,y}$	CO <sub>2</sub> baseline emission factor for the captive electricity displaced due to the project activity during the year $y$ (tCO <sub>2</sub> /MWh).
$S_{grid}$	Share of facility electricity demand supplied by grid imports over the last 3 years (%) <sup>7</sup>
$S_{captive}$	Share of facility electricity demand supplied by captive power over the last 3 years (%) <sup>2</sup>

<sup>7</sup> If the facility is a new facility, then the share of grid versus import power determined to be the most likely baseline scenario should be used.



### 1.6.4 Heat generation emissions factor

If the baseline scenario includes heat generation (either existing or new) that is replaced by the project activity, the Emissions Factor for displaced heat generation is calculated as follows:

$$EF_{heat,y} = \frac{EF_{CO_2,i}}{Eff_{heat}} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \quad (23)$$

where:

$EF_{heat,y}$	Emissions factor for heat generation (tCO <sub>2</sub> /GJ)
$EF_{CO_2,i}$	CO <sub>2</sub> emissions factor of fuel used in heat generation (tC/TJ)
$Eff_{heat}$	Boiler efficiency of the heat generation (%)
44/12	Carbon to Carbon Dioxide conversion factor
1/1000	TJ to GJ conversion factor

To estimate boiler efficiency, project participants may choose between the following two options:

#### Option A

Use the highest value among the following three values as a conservative approach:

- Measured efficiency prior to project implementation;
- Measured efficiency during monitoring;
- Manufacturer nameplate data for efficiency of the existing boilers.

#### Option B

Assume a boiler efficiency of 100% based on the net calorific values as a conservative approach.

### 1.6.5 Vehicle fuel use emissions factor

If the baseline scenario includes vehicle operation that will be fuelled by gas produced by the project activity, the Emissions Factor for displaced vehicle fuel use is calculated as follows:

$$EF_V = \frac{EF_{CO_2,i}}{Eff_V} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \quad (24)$$

where:

$EF_V$	Emissions factor for vehicle operation replaced by project activity (tCO <sub>2</sub> /GJ)
$EF_{CO_2,i}$	CO <sub>2</sub> emissions factor of fuel used for vehicle operation (tC/TJ)
$Eff_V$	Vehicle engine efficiency (%)
44/12	Carbon to Carbon Dioxide conversion factor
1/1000	TJ to GJ conversion factor





To estimate vehicle engine efficiency, project participants should select the highest value among the following three values as a conservative approach:

- Measured fuel efficiency prior to project implementation;
- Measured fuel efficiency during monitoring;
- Manufacturer reported data for efficiency for vehicle.

### Leakage

The formula for leakage is given as follows

$$LE_y = LE_{d,y} + LE_{o,y} \quad (25)$$

where:

$LE_y$	Leakage emissions in year y (tCO <sub>2</sub> e)
$LE_{d,y}$	Leakage emissions due to displacement of other baseline thermal energy uses of methane in year y (tCO <sub>2</sub> e)
$LE_{o,y}$	Leakage emissions due to other uncertainties in year y (tCO <sub>2</sub> e)

#### 1.7 Displacement of other thermal energy uses

Leakage for this type of project may occur if the project activity prevents CMM from being used to meet baseline thermal energy demand, whether as a result of physical constraints on delivery, or price changes. If this occurs, the project activity may cause increased emissions outside the project boundary associated with meeting thermal energy demand with other fuels. Because of likely day-to-day fluctuations in CMM extraction rates, and to ensure a conservative result, CERs should not be calculated solely from annual data. Any CERs generated from methane destruction should be calculated using daily logs of project-case CMM emissions compared against estimates of baseline CMM emissions. For each day of the crediting period, this form of leakage must be calculated if:

$$ME_k - (MM_{FL,k} + MM_{ELEC,k} + MM_{GAS,k} + MM_{HEAT,k}) < TH_{b,k} \quad (26)$$

where:

$ME_k$	methane extracted on day k (tCH <sub>4</sub> )
$MM_{ELEC,k}$	Methane measured sent to power plant on day k (tCH <sub>4</sub> )
$MM_{HEAT}$	Methane measured sent to heat plant on day k in the Project Scenario that would not have been sent in the Baseline Scenario to serve thermal demand (tCH <sub>4</sub> )
$MM_{GAS}$	Methane measured supplied on day k to gas grid for vehicle use or heat/power generation off-site (tCH <sub>4</sub> )
$MM_{FL}$	Methane measured sent to flare (on day k tCH <sub>4</sub> )
$TH_{b,k}$	Methane used to serve thermal energy demand in the baseline for on day k (tCH <sub>4</sub> )

And, under this condition, some portion of CMM that would have gone to meet thermal energy demand in the baseline scenario is instead used by the project. A corresponding amount of thermal energy demand in the project scenario will have to be met by an alternative fuel, leading to possible increased emissions. To calculate such emissions, the following approach should be used.



The amount of thermal energy from CMM diverted from thermal uses existing in the baseline diverted to other uses by the project should be calculated on a daily basis as indicated in equation 27, and then summed up for each year  $y$ :

$$ED_{th,k} = (TH_{y,k} - (ME_k - (MM_{FL,k} + MM_{ELEC,k} + MM_{GAS,k} + MM_{HEAT,k}))) \times NCV_{CH_4} \quad (27)$$

where:

$ED_{th,k}$	Quantity of thermal energy displaced by the project activity on day $k$ (GJ)
$ME_k$	Total methane extracted on day $k$ (tCH <sub>4</sub> )
$MM_{ELEC,k}$	Methane measured sent to power plant on day $k$ (tCH <sub>4</sub> )
$MM_{HEAT,k}$	Methane measured sent to heat plant in the Project Scenario that would not have been sent in the Baseline Scenario to serve thermal demand on day $k$ (tCH <sub>4</sub> )
$MM_{GAS,k}$	Methane measured supplied to gas grid for vehicle use or heat/power generation off-site on day $k$ (tCH <sub>4</sub> )
$MM_{FL,k}$	Methane measured sent to flare on day $k$ (tCH <sub>4</sub> )
$NCV_{CH_4}$	Net calorific value for methane on day $k$ (GJ/tCH <sub>4</sub> )

Project participants must describe and justify what alternative fuel(s) is (are) used to provide thermal energy in the area when CMM is not available. They must then calculate the amount of alternative fuel required to provide the same heat output as the CMM.

$$Q_{AF,y} = ED_{th,y} / NCV_{AF} \quad (28)$$

where:

$Q_{AF,y}$	Quantity of alternative fuels displaced by the project activity in year $y$ (tonnes or m <sup>3</sup> )
$ED_{th,y}$	Quantity of thermal energy displaced by the project activity in year $y$ (GJ)
$NCV_{AF}$	Net calorific value for alternative fuels (GJ/tonne or m <sup>3</sup> )

Emissions from the use of alternative fuels are calculated as follows:

$$LE_{d,y} = Q_{AF} \times NCV_{AF} \times EF_{AF} \times OXID \quad (29)$$

where:

$LE_{d,y}$	Leakage emissions in year $y$ (tCO <sub>2</sub> e)
$Q_{AF,y}$	Quantity of alternative fuels displaced by the project activity in year $y$ (tonnes or m <sup>3</sup> )
$NCV_{AF}$	Net calorific value for alternative fuels (GJ/tonne or m <sup>3</sup> )
$EF_{AF}$	Emissions factor for alternative fuel (tCO <sub>2</sub> /GJ), sourced from IPCC
$OXID$	Oxidation efficiency of combustion (%), sourced from IPCC

### 1.8 Other issues

There are a range of other uncertainties associated with the evolution of the baseline and project scenarios for these project types. The current list of uncertainty has been established:

- 1) For a new mine it may be difficult to assess whether and what type of CBM/CMM drainage system would have been implemented without the CDM project activity. Corresponding CBM/CMM destruction would not be additional.
- 2) CBM drainage wells can in some cases drain gas from seams that are outside the de-stressed zone for 140m specified in this methodology, or could extract from an area larger than the circular zone



of influence used in this methodology. Corresponding CBM/CMM destruction would not be additional.

- 3) There are uncertainties regarding potential economic influence of the CERs on :
  - 3.a) the release of certain constraints that currently limit mining operations : calculations show that in cases of gassy mines where production is constrained by gas drainage capacity (too high concentration requires temporary interruption of mining operation), CERs value can cover both the cost of CMM/CBM destruction and increase of extraction capacity to release the concentration constrain, then allowing to increase coal production to the point that emissions associated to the use of the additional coal produced will offset the emission reduction achieved through CMM/CBM destruction.
  - 3.b) the new net cost and price of the coal: depending on relative market price of coal and CERs, the new carbon revenue could theoretically eventually induce a decrease of carbon price and, as a result, led to an increase of coal demand (rebound effect). Share of coal in energy demand may eventually increase, leading to higher emissions that could offset emission reduction achieved through CMM/CBM destruction.
- 4) There may also be leaks-type fugitive CH<sub>4</sub> emissions from transport and use of non eligible CBM (especially as vehicle fuel).

**Option 1:** For these reasons, in order to mitigate the risk of issuing too many CERs, and to ensure that the methodology is conservative, a generic discount of 10% of emissions reductions is included. Such a conservative measure may be revised later on the light of reliable quantification of such effects.

$$LE_{o,y} = (BE_y - PE_y) \times 0.1 \quad (30)$$

**Option 2:** While the cause and effect between CMM/CBM utilization and increased coal production may theoretically happen, it is detached from the current thinking of the coal industry, which regards methane as a dangerous substance which hinders coal mining activities. The coal industry regards gassy mines as a negative trait, not as a positive one.

The anticipated revenue for CERs in relation to coal revenue is about 1% for all five projects, which is hardly a justification to enter into potentially gassy mines. While a much higher percentage is theoretically possible, this is based on the unrealistic assumption that all underground methane will be recovered and is used.

Therefore, the project proponents will undertake present an assessment of these affects and, if not found significant, leakage from these factors can be considered as zero.

### Emission Reductions

The emission reduction  $ER_y$  by the project activity during a given year  $y$  is the difference between the baseline emissions ( $BE_y$ ) and project emissions ( $PE_y$ ), as follows:

$$ER_y = BE_y - PE_y - LE_y \quad (31)$$

where:

$ER_y$	emissions reductions of the project activity during the year $y$ (tCO <sub>2</sub> e)
$BE_y$	baseline emissions during the year $y$ (tCO <sub>2</sub> e)
$PE_y$	project emissions during the year $y$ (tCO <sub>2</sub> e)
$LE_y$	leakage emissions in year $y$ (tCO <sub>2</sub> e)



Note that, because emissions reductions from CBM are only credited when the seam is mined through, there could be cases where CBM drainage commenced before the start of the crediting period.



### Draft consolidated monitoring methodology ACM00XX

#### “Consolidated monitoring methodology for virgin coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat and/or destruction by flaring”

#### Sources

This consolidated monitoring methodology is based on elements from the following methodologies:

- NM0066 “Monitoring methodology for grid-connected coalmine methane power generation at an active coal mine with existing methane extraction and partial utilization,” submitted by Hegang Coal Industry Group Limited
- NM0075 “Monitoring methodology for coal mine methane (CMM) utilization and destruction at a working coal mine,” prepared by IT Power
- NM0093 “Monitoring methodology for methane utilization and destruction project activities at working coal mines where both coal mine methane (drained from within the mine) and coal bed methane (drained from the surface within the coal mining concession area) is used and/or destroyed,” prepared by Westlake Associates, Ltd and Asian Development Bank
- NM0094 “Monitoring methodology for coal mine methane recovery and utilization at active coal mines,” prepared by Millennium Capital Services, Co.
- NM0102 “Generalised monitoring methodology for coal mine methane (CMM) power generation,” prepared by the Prototype Carbon Fund

For more information regarding the proposals and their consideration by the Executive Board please refer to <http://cdm.unfccc.int/methodologies/approved>. This methodology also refers to the “Consolidated monitoring methodology for grid-connected electricity generation from renewable sources” (ACM0002) and the “Tool for the demonstration and assessment of additionality”.

#### Applicability

This methodology applies to project activities that:

- Use surface drainage wells to capture virgin CBM;
- Use surface drainage wells to capture CBM to Goaf well methane and Indirect CBM to Goaf well methane;
- Use underground inclined or horizontal boreholes in the mine to capture CMM pre mining;
- Use surface goaf wells, underground inclined or horizontal boreholes, gas drainage galleries or other goaf gas capture techniques to capture post mining CMM;
- Use ventilation CMM that would normally be vented.

This methodology applies to CMM capture, utilisation and destruction project activities at a working coal mine, where the baseline is the partial or total atmospheric release of the methane and the project activities include the following situations:

- The methane is captured and destroyed through flaring; and/or
- The methane is captured and destroyed through utilisation to produce electricity, motive power and/or thermal energy; emission reductions may or may not be claimed for displacing or avoiding energy from other sources.

The methodology applies to both new and existing mining activities.



The methodology does not apply to project activities that:

- Capture methane from abandoned/decommissioned coal mines;
- Are not able to monitor the necessary parameters, as indicated in the relevant monitoring methodology, to provide a conservative and transparent estimate of emissions reductions achieved
- Operate in open cast mines.

This monitoring methodology shall be used in conjunction with the approved consolidated baseline methodology for “Consolidated baseline methodology for coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat and/or destruction by flaring”(ACM00XX).

**Methane collected and flared:** The amount of methane actually flared will be determined by monitoring the:

- amount of CMM/CBM gas collected, using a continuous flow meter and monitoring of temperature and pressure
- percentage of CMM/CBM gas that is methane (%), using a continuous analyser
- flare working hours (hours) using a run time meter connected to a flame detector
- The fraction of methane in the CMM/CBM gas should be measured with a continuous analyzer or, alternatively, with periodical measurements, at a 95% confidence level, using calibrated portable gas meters and taking a statistically valid number of samples.
- The flare efficiency ( $Eff_{FL}$ ), measured as :
  - the fraction of time in which the gas is combusted in the flare ;
  - multiplied by the efficiency of the flaring process. For this purpose, the methane content of the flare emissions should be measured at least quarterly. This procedure requires the use of enclosed flares. In case open flares are used, since flare efficiency cannot be measured in a reliable manner (external air will be mixed and lower the concentration of methane) a conservative destruction efficiency factor should be provided and documented. If it cannot be done, a default value of 50% should be used.
- Temperature (T) and pressure (P) of the CMM/CBM gas are required to determine the density of methane in the CMM/CBM gas.



## 1. Project Emissions

## 1.9 Overall

ID no.	Symbol	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
P1	PE <sub>y</sub>	Project emissions in year y	tCO <sub>2</sub> e	c	Monthly	100%	Electronic	Crediting period + 2 yrs	
P2	PE <sub>ME</sub>	Project emissions from energy use to capture and use methane	tCO <sub>2</sub> e	c	Monthly	100%	Electronic	Crediting period + 2 yrs	
P3	PE <sub>MD</sub>	Project emissions from methane destroyed	tCO <sub>2</sub> e	c	Monthly	100%	Electronic	Crediting period + 2 yrs	
P4	PE <sub>UM</sub>	Project emissions from un-combusted methane	tCO <sub>2</sub> e	c	Monthly	100%	Electronic	Crediting period + 2 yrs	

Project emissions are defined by the following equation

$$PE_y = PE_{ME} + PE_{MD} + PE_{UM} \quad (1)$$

*1.10 Combustion emissions from additional energy required for CBM/CMM capture and use*

ID no.	Symbol	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
P5	CONS <sub>EL</sub> EC,PJ	Additional electricity consumption by project	MWh	m	Continuous	100%	Electronic	Crediting period + 2 yrs	If any
P6	CONS <sub>HE</sub> AT,PJ	Additional heat consumption by project	GJ	m	Continuous	100%	Electronic	Crediting period + 2 yrs	If any
P7	CONS <sub>FF</sub> _PJ	Additional fossil fuel consumption by project	GJ	m	Continuous	100%	Electronic	Crediting period + 2 yrs	If any
P8	CEF <sub>ELEC</sub> _PJ	Carbon emission factor of CONS <sub>ELEC</sub> PJ	t-CO <sub>2</sub> /GJ	m, c or e	Ex ante	100%	Electronic	Crediting period + 2 yrs	
P9	CEF <sub>HEA</sub> T_PJ	Carbon emission factor of CONS <sub>HEAT</sub> PJ	t-CO <sub>2</sub> /GJ	m, c or e	Ex ante	100%	Electronic	Crediting period + 2 yrs	
P10	CEF <sub>FF</sub> PJ	Carbon emission factor of CONS <sub>FF</sub> PJ	t-CO <sub>2</sub> /GJ	m, c or e	Ex ante	100%	Electronic	Crediting period + 2 yrs	Use of IPCC default or national values would suffice





Project emissions from energy use to capture and use methane ( $PE_{ME,}$ ) is obtained by the equation

$$PE_{ME} = CONS_{ELEC,PJ} \times CEF_{ELEC} + CONS_{HEAT,PJ} \times CEF_{HEAT} + CONS_{Foss\ Fuel,PJ} \times CEF_{Foss\ Fuel}$$

*1.11 Combustion emissions from use of captured methane*

ID no.	Symbol	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
P11	MD <sub>FL</sub>	Methane destroyed by flare	tCH <sub>4</sub>	c	Calculated monthly	100%	Electronic	Crediting period + 2 yrs	
P12	MM <sub>FL</sub>	Methane sent to flare	tCH <sub>4</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	Flow meters will record gas volumes, pressure and temperature. Density of methane under normal conditions of temperature and pressure is 0.67kg/m <sup>3</sup> (Revised 1996 IPCC Reference Manual p 1.24 and 1.16)
P13	Eff <sub>FL</sub>	Flare/combustion efficiency, determined by the operation hours and the methane content in the exhaust gas	%	m / c	(1) continuously (2) quarterly, monthly if unstable	n/a	Electronic	During the crediting period and two years after	(1) Continuous measurement of operation time of flare (e.g. with temperature) (2) Periodic measurement of methane content of flare exhaust gas. In this case the operation of flare will be continuously be monitored by run time meter connected to a flame detector.



ID no.	Symbol	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
P14	MD <sub>ELEC</sub>	Methane destroyed by power generation	tCH <sub>4</sub>	c	Calculated monthly	100%	Electronic	Crediting period + 2 yrs	
P15	MM <sub>ELEC</sub>	Methane sent to power plant	tCH <sub>4</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	Flow meters will record gas volumes, pressure and temperature. Density of methane under normal conditions of temperature and pressure is 0.67kg/m <sup>3</sup> (Revised 1996 IPCC Reference Manual p 1.24 and 1.16)
P16	Eff <sub>ELEC</sub>	Efficiency of methane destruction/oxidation in power plant	-	e	Ex ante				set at 99.5%(IPCC)
P17	MD <sub>HEAT</sub>	Methane destroyed by heat generation	tCH <sub>4</sub>	c	Calculated monthly	100%	Electronic	Crediting period + 2 yrs	
P18	MM <sub>HEAT</sub>	Methane sent to boiler	tCH <sub>4</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	Flow meters will record gas volumes, pressure and temperature. Density of methane under normal conditions of temperature and pressure is 0.67kg/m <sup>3</sup>



ID no.	Symbol	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
									(Revised 1996 IPCC Reference Manual p 1.24 and 1.16)
P19	Eff <sub>HEAT</sub>	Efficiency of methane destruction/oxidation in heat plant	-	e	Ex ante				set at 99.5%(IPCC)
P20	MD <sub>GAS</sub>	Methane destroyed by gas grid end-users	tCH <sub>4</sub>	c		100%	Electronic	Crediting period + 2 yrs	
P21	MM <sub>GAS</sub>	Methane sent to gas grid for end users	tCH <sub>4</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	Flow meters will record gas volumes, pressure and temperature. Density of methane under normal conditions of temperature and pressure is 0.67kg/m <sup>3</sup> (Revised 1996 IPCC Reference Manual p 1.24 and 1.16)
P22	Eff <sub>GAS</sub>	Overall efficiency of methane destruction / oxidation through gas grid	-	e	Ex ante				set at 98.5% (IPCC)



ID no.	Symbol	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
P23	CEFC <sub>CH4</sub>	Carbon emission factor for combusted methane							set at 2.75 tCO <sub>2</sub> e/tCH <sub>4</sub>
P24	CEFC <sub>NMHC</sub>	Carbon emission factor for combusted non methane hydrocarbons (various)							To be obtained through periodical analysis of the fractional composition of captured
P25	Pc <sub>CH4</sub>	Concentration of methane in extracted gas	%	m (concentration meters, optical and calorific)	Hourly/Daily	100%	Electronic	Minimum of two years after last issuance of CERs	
P26	Pc <sub>NMHC</sub>	NMHC concentration in coal mine gas	%	m (concentration meters, optical and calorific)	annually	100%		Crediting period + 2 yrs	Used to check if more than 1% of emissions and to calculate r
P27	r	Relative proportion of NMHC compared to methane	%	c	annually	100%		Crediting period + 2 yrs	

Project emissions from methane destroyed (PE<sub>MD</sub>) can be obtained by the equation

$$PE_{MD} = (MD_{FL} + MD_{ELEC} + MD_{HEAT} + MD_{GAS}) \times (CEFC_{CH4} + r \times CEFC_{NMHC})$$



with :

$$r = P_{\text{CNMHC}} / P_{\text{CCH}_4}$$

where:<sup>8</sup>

$PE_{\text{MD}}$	Project emissions from CMM/CBM destroyed (tCO <sub>2</sub> e)
$MD_{\text{FL}}$	Methane destroyed through flaring (tCH <sub>4</sub> )
$MD_{\text{ELEC}}$	Methane destroyed through power generation (tCH <sub>4</sub> )
$MD_{\text{HEAT}}$	Methane destroyed through heat generation (tCH <sub>4</sub> )
$MD_{\text{GAS}}$	Methane destroyed after being supplied to gas grid or for vehicle use (tCH <sub>4</sub> )
$CEF_{\text{CH}_4}$	Carbon emission factor for combusted methane (2.75 tCO <sub>2</sub> e/tCH <sub>4</sub> )
$CEF_{\text{NMHC}}$	Carbon emission factor for combusted non methane hydrocarbons (various) (tCO <sub>2</sub> eq/tNMHC)
$r$	Relative proportion of NMHC compared to methane
$P_{\text{CCH}_4}$	Concentration (in mass) of methane in extracted gas (%)
$P_{\text{CNMHC}}$	NMHC concentration (in mass) in extracted gas (%)

In each end-use, the amount of gas destroyed depends on the efficiency of combustion of each end use.

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<sup>8</sup> Note that throughout this baseline methodology, it is assumed that measured quantities of coal mine gas are converted to tonnes of methane using the measured methane concentration of the coal mine gas and the density of methane.

*1.12 Un-combusted methane from flaring and end uses*

ID no.	Symbol	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/paper)	For how long is archived data to be kept?	Comment
P28	$GWP_{CH_4}$	Global warming potential of methane	-	e	Ex ante				set at 21
P29	$MM_i$	Methane measured sent to use i	tCH <sub>4</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	Flow meters will record gas volumes, pressure and temperature
P30	$Eff_i$	Efficiency of methane destruction / oxidation through use i	-	m, c, or e	Ex ante or ex post	100%	Electronic	Crediting period + 2 yrs	Project-by-project basis

Uncombusted methane from flaring and end uses ( $PE_{UM}$ ) can be obtained through the equation:

$$PE_{UM} = GWP_{CH_4} * MM_i * \Sigma(1-EFF_i)$$



## 2. Baseline emissions

## 1.13 Overall

ID no.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B1	BE <sub>y</sub>	Baseline emissions in year y	tCO <sub>2</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	
B2	BE <sub>MD,y</sub>	Baseline emissions from destruction of methane in the baseline scenario in year y	tCO <sub>2</sub>	c	Yearly	100%	Electronic	Crediting period + 2 yrs	
B3	BE <sub>MR,y</sub>	Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity	tCO <sub>2</sub>	c	Yearly	100%	Electronic	Crediting period + 2 yrs	





ID no.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B4	BE <sub>Use,y</sub>	Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year y	tCO <sub>2</sub>	c	Eearly	100%	Electronic	Crediting period + 2 yrs	

Baseline emissions are given by the following equation:

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y}$$

*1.14 Methane destruction due to thermal demand in the baseline*

ID no.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B5	$CBM_{BLi,y}$	CBM that would have been captured, used and destroyed by use <i>i</i> in the baseline scenario in year <i>y</i>	tCH <sub>4</sub>	e	Estimated ex-ante at start of project	100%	Electronic	Crediting period + 2 yrs	
B6	$CMM_{BLi}$	CMM that would have been captured, used and destroyed by use <i>i</i> in the baseline scenario in year <i>y</i>	tCH <sub>4</sub>	e	Estimated ex-ante at start of project	100%	Electronic	Crediting period + 2 yrs	



ID no.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B7	$PMM_{BLi}$	PMM that would have been captured, used and destroyed by use $i$ in the baseline scenario in year $y$	tCH <sub>4</sub>	e	Estimated ex-ante at start of project	100%	Electronic	Crediting period + 2 yrs	
B9	$TH_y$	Annual average baseline CMM / CBM demand for thermal energy uses in the baseline	tCH <sub>4</sub>	c	Ex ante	100%	Electronic	Crediting period + 2yrs	Estimated on procedure defined in the corresponding baseline methodology
B10	$CEF_{CH4}$	Carbon emission factor for methane	-	e					2.75 tCO <sub>2</sub> e/tCH <sub>4</sub>
	$d_k$	scalar adjustment factor for day $I$ , based on the seasonal load shape ( $\sum d_k = 365$ )	-						As per NM0066



Methane destruction due to thermal demand in the baseline ( $BE_{MD,y}$ ) is obtained by the equation:

$$BE_{MRy} = (CEF_{CH_4} + r \times CEF_{NMHC}) \times \sum_i (CBM_{BLi,y} + CMM_{BLi,y} + PMM_{BLi,y})$$

where:

$BE_{MD,y}$	Baseline emissions from destruction of methane in the baseline scenario in year y (tCO <sub>2</sub> e)
$i$	Use of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses)
$CBM_{BLi,y}$	CBM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in the year y (expressed in tCH <sub>4</sub> )
$CMM_{BLi,y}$	Pre-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year y (expressed in tCH <sub>4</sub> )
$PMM_{BLi,y}$	post-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year y (tCH <sub>4</sub> )
$CEF_{CH_4}$	Carbon emission factor for combusted methane (2.75 tCO <sub>2</sub> e/tCH <sub>4</sub> )
$CEF_{NMHC}$	Carbon emission factor for combusted non methane hydrocarbons (various. To be obtained through periodical analysis of captured methane) (tCO <sub>2</sub> eq/tNMHC)
$r$	Relative proportion of NMHC compared to methane

with :

$$r = P_{cNMHC} / P_{cCH_4}$$

$P_{cCH_4}$  Concentration (in mass) of methane in extracted gas (%)

$P_{cNMHC}$  NMHC concentration (in mass) in extracted gas (%)

In the special case  $\sum_i (CBM_{BLi,y} + CMM_{BLi,y} + PMM_{BLi,y})$  in the equation mentioned above should be substituted, for each year y,

by the following  $\sum_{k=1 \text{ to } 365} (TH_{b,k})$

$TH_{b,k}$  daily baseline CMM and CBM demand for existing thermal energy uses in the baseline such as heating and cooking for day k (tCH<sub>4</sub>)

$$TH_{b,k} = (TH_y / 365) \times d_k$$

(11)

*1.15 Baseline emissions from methane released into the atmosphere**i. Overall*

ID nos.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B11	$CBMe_{i,y}$	Eligible CBM captured, sent to and destroyed by use $i$ in the project for year $y$	tCH <sub>4</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	
B12	$CBM_{BL,i,y}$	CBM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario	tCH <sub>4</sub>	c,e	Ex ante	100%	Electronic	Crediting period + 2 yrs	
B13	$CMM_{PJ,i,y}$	Pre-mining CMM captured, sent to and destroyed by use $i$ in the project activity in year $y$	tCH <sub>4</sub>	m	Continuous	100%	Electronic	Crediting period + 2 yrs	



ID nos.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B14	$CMM_{BL, i, y}$	Pre-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year $y$	tCH <sub>4</sub>	c,e	Ex ante	100%	Electronic	Crediting period + 2 yrs	
B15	$PMM_{PJ, i, y}$	post-mining CMM captured, sent to and destroyed by use $i$ in the project activity in year $y$	tCH <sub>4</sub>	m	Continuous	100%	Electronic & Paper	Crediting period + 2 yrs	
B16	$PMM_{BL, i, y}$	post-mining CMM that would have been captured, sent to and destroyed by use $i$ in the baseline scenario in year $y$	tCH <sub>4</sub>	c,e	Ex ante	100%	Electronic	Crediting period + 2 yrs	



ID nos.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B17	$GWP_{CH_4}$	Global warming potential of methane							21 tCO <sub>2</sub> e/tCH <sub>4</sub>
B18	$CEF_{CH_4}$	Carbon emission factor for combusted methane							44/16 = 2.75 tCO <sub>2</sub> e/tCH <sub>4</sub>

The baseline emissions from release of methane into the atmosphere in the year y ( $BE_{MR,y}$ ) is obtained by the following equation:

$$BE_{MR,y} = [(CBM_{e,y} - CBM_{BL,y}) + (CMM_{PJ,y} - CMM_{BL,y}) + (PMM_{PJ,y} - PMM_{BL,y})] \times GWP_{CH_4} + [CBM_{BL,y} + CMM_{BL,y} + PMM_{BL,y} - BE_{MD,y}] \times CEF_{CH_4}$$

*ii. Estimation of eligible CBM*

ID number	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B19	R	Cumulative radius of zone of influence	m	m	Annually	100%	electronic	Crediting period + 2 yrs	
B20	V <sub>c</sub>	Cumulative flow at well	m <sup>3</sup>	c		100%	Electronic & Paper	Crediting period + 2 yrs	Monitoring at each well should record gas flow, methane concentration, pressure, and temperature
B21	T	Thickness of all coal accessed by wells	m coal	m	Annually	100%	Electronic & Paper	Crediting period + 2 yrs	Depth of fractures into respective seams and casing used should be recorded at time of drilling
B22	ρ <sub>coal</sub>	density of locally mined coal	t/m <sup>3</sup>	m	At start of each crediting period	sample	Electronic & Paper	Crediting period + 2 yrs	default value is 1.4
B23	g <sub>coal</sub>	gas content of coal	m <sup>3</sup> CH <sub>4</sub> /t coal	m	At start of each crediting period	sample	Electronic & Paper	Crediting period + 2 yrs	
B24	n	number of days the selected well is operational	days	m			Electronic & Paper	Crediting period + 2 yrs	
B25	V <sub>a</sub>	Average flow per day	m <sup>3</sup>	c		100%	Electronic & Paper	Crediting period + 2 yrs	





ID number	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B26	$V_{tc}$	Cumulative flow from all wells	m <sup>3</sup>	m		100%	Electronic & Paper	Crediting period + 2 yrs	Total flow from all boreholes measured at collection manifold using automatic remote monitoring of gas flow, methane concentration, pressure and temperature
B27	N	sum of days all wells operational	days	c			Electronic & Paper	Crediting period + 2 yrs	
B28		Position of wells relative to mining plan	coordinates	m	Annually	100%	Electronic & Paper	Crediting period + 2 yrs	Recorded in PDD ex-ante. New drawing produced each year.
B29		Well profile	coordinates	m	Annually	100%	Electronic & Paper	Crediting period + 2 yrs	Shows each well and zone of influence against latest mining plan
B30		Well depth	m	m	At time of drilling	100%	Electronic & Paper	Crediting period + 2 yrs	Based on actual drilling records
B31	t	Total thickness of coal in longwall emission zone	m	m	At start of each crediting period		Electronic & Paper	Crediting period + 2 yrs	From geology report and drilling records
B32	$ES_t$	total eligible share of CBM	%						



ID number	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/paper)	For how long is archived data kept?	Comment
B33	ES <sub>h</sub>	eligible share of CBM based on the horizontal plane overlap	%						
B34	ES <sub>v</sub>	eligible share of CBM based on the vertical plane overlap	%						
B35	AO <sub>w</sub>	Area of overlap with longwall panel	m <sup>2</sup>	e			Electronic & Paper	Crediting period + 2 yrs	Only relevant for type 2 wells.
B36	AT <sub>w</sub>	Total zone of influence	m <sup>2</sup>	c			Electronic & Paper	Crediting period + 2 yrs	Only relevant for type 2 wells.
B37	w	wells classified as Type 2 wells							

The approach to quantify the eligible CBM is to identify the zone of influence of CBM to goaf wells and indirect CDM to goaf wells, and when these are impacted by mining activities.

*1.16 Baseline emissions from power/heat generation and vehicle replaced by project*

ID no.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
B38	GEN <sub>y</sub>	Electricity generation by project	MWh	m	Continuous	100%	electronic	Crediting period + 2 yrs	
B39	HEAT <sub>y</sub>	Heat generation by project	GJ	m	Continuous	100%	electronic	Crediting period + 2 yrs	
B40	VFUEL <sub>y</sub>	Vehicle power supplied by project	GJ	m	Continuous	100%	electronic	Crediting period + 2 yrs	
B41	EF <sub>ELEC</sub>	CO <sub>2</sub> emission factor of the grid	tCO <sub>2</sub> /MWh	c	Annually	100%	electronic	Crediting period + 2 yrs	Calculated as per ACM0002
B42	EF <sub>OM,y</sub>	CO <sub>2</sub> Operating Margin emission factor of the grid	tCO <sub>2</sub> /MWh	c	Annually or ex ante	100%	electronic	Crediting period + 2 yrs	Calculated as per ACM0002
B43	EF <sub>BM,y</sub>	CO <sub>2</sub> Build Margin emission factor of the grid	tCO <sub>2</sub> /MWh	c	Annually or ex ante	100%	electronic	Crediting period + 2 yrs	Calculated as per ACM0002
B44	F <sub>i,j,y</sub>	Amount of each fossil fuel consumed by each power source / plant	t or m <sub>3</sub> /yr	m	Annually or ex ante	100%	electronic	Crediting period + 2 yrs	Obtained from the power producers, dispatch centers or latest local statistics,.



ID no.	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
B45	COEF <sub>i,k</sub>	CO <sub>2</sub> emission coefficient of each fuel type and each power source / plant	tCO <sub>2</sub> / t or m <sup>3</sup>	m	Annually	100%	Electronic	Crediting period + 2 yrs	Plant or country-specific values to calculate COEF are preferred to IPCC default values, in case of obtaining EF <sub>OM</sub> ex post..
B46	GEN <sub>j,y</sub>	Electricity generation of each power source / plant	MWh/yr	m	Annually or ex ante	100%	Electronic	Crediting period + 2 yrs	Obtained from the power producers, dispatch centers or latest local statistics..
B47	EF <sub>CO<sub>2</sub>,i</sub>	CO <sub>2</sub> emission factor of fuel used for captive power or heat	tC/TJ	e	Annually or ex ante	100%	Electronic	Crediting period + 2 yrs	National sources or IPCC defaults
B48	Eff <sub>captive</sub>	Energy efficiency of captive power plant	%	m	Annually	100%	Electronic	Crediting period + 2 yrs	Depending on option chosen in baseline, measured before or after project implementation
B49	Eff <sub>heat</sub>	Energy efficiency of heat plant	%	m	Annually	100%	Electronic	Crediting period + 2 yrs	
B50	Eff <sub>v</sub>	Efficiency of vehicle engine	%	m, e	Annually	100%	Electronic	Crediting period + 2 yrs	



Emissions from power/heat generation and vehicle fuel replaced by project ( $BE_{Use,y}$ ) can be obtained by:

$$BE_{Use,y} = GEN_y \times EF_{ELEC} + HEAT_y \times EF_{HEAT} + VFUEL_y \times EF_V \quad (20)$$

where:

$BE_{Use,y}$	Baseline emissions from the production of power or heat replaced by the project activity in year y (tCO <sub>2</sub> e)
$GEN_y$	Electricity generated by project activity in year y (MWh), including through the use of CBM
$EF_{ELEC}$	Emissions factor of electricity (grid, captive or a combination) replaced by project (tCO <sub>2</sub> /MWh)
$HEAT_y$	Heat generation by project activity in year y (GJ), including through the use of CBM
$EF_{HEAT}$	Emissions factor for heat production replaced by project activity (tCO <sub>2</sub> /GJ)
$VFUEL_y$	Vehicle fuel provided by the project activity in year y (GJ), including through the use of CBM
$EF_V$	Emissions factor for vehicle operation replaced by project activity (tCO <sub>2</sub> /GJ)