**Approved consolidated baseline methodology ACM0008**

**"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".

## 1 Definitions

*Coalbed methane (CBM)* - a generic term (USA) for the methane originating in coal seams that is drained from surface boreholes before mining takes place.

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

*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.

*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* (also known as pre drainage) –methane extraction prior to the mining process from underground boreholes in the mine (for safety reasons).

*Post mining CMM* (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.

## 2 Applicability

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

- surface drainage wells to capture CBM associated with mining activities;
- underground boreholes in the mine to capture pre mining CMM ;
- surface goaf wells, underground 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.

Project participants must be able to supply the necessary to data for ex-ante projections of methane demand as described in Sections 7 and 8 to use this methodology.

The methodology applies to both new and existing mining activities.

The methodology **does not apply** to project activities with any of the following features:
- Operate in open cast mines;
- 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;
- Use CO2 or any other fluid/gas to enhance CBM drainage before mining takes place.

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”(ACM0008).

## 3 Project boundary

For the purpose of determining *project activity emissions*, project participants shall include:
- $CO_2$ emissions from the combustion of methane in a flare, engine, power plant or heat generation plant;

- $CO_2$ emissions from the combustion of non methane hydrocarbons (NMHCs), if they represent more than 1% by volume of the extracted coal mine gas;
- $CO_2$ emissions from on-site fuel consumption due to the project activity, including transport of the fuel.
- Fugitive emissions from unburned methane

For the purpose of determining *baseline emissions*, project participants shall include the following emission sources:
- $CH_4$ emissions as a result of venting gas that would be captured in the project scenario;
- $CO_2$ emissions from the destruction of methane in the baseline scenario;
- $CO_2$ 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"[1]).

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

[1] 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 | $CH_4$ | Included | • Main emission source. However, certain sources of methane may not be included, as noted in the applicability conditions.<br>• 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.<br>• Recovery of methane from abandoned coalmines will not be included.<br>• The amount of methane to be released depends on the amount used (for local consumption, gas sales, etc) in the baseline. |
| Emissions from destruction of methane in the baseline | $CO_2$ | Included | • Considers any flaring or use for heat and power in the baseline scenario. |
| | $CH_4$ | Excluded | • Excluded for simplification. This is conservative. |
| | $N_2O$ | Excluded | • Excluded for simplification. This is conservative. |
| Grid electricity generation (electricity provided to the grid) | $CO_2$ | Included | • Only $CO_2$ 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.<br>• Use of combined margin method as described in ACM0002 should be used. |
| | $CH_4$ | Excluded | • Excluded for simplification. This is conservative. |
| | $N_2O$ | Excluded | • Excluded for simplification. This is conservative. |
| Captive power and/or heat, and vehicle fuel use | $CO_2$ | Included | • Only when the baseline scenario involves such usage. |
| | $CH_4$ | Excluded | • Excluded for simplification. This is conservative. |
| | $N_2O$ | Excluded | • Excluded for simplification. This is conservative. |

**Project activity**

| Source | Gas | | Justification / Explanation |
|---|---|---|---|
| Emissions of methane as a result of continued venting | $CH_4$ | Excluded | • Only the change in CMM/CBM emissions release will be taken into account, by monitoring the methane used or destroyed by the project activity. |
| On-site fuel consumption due to the project activity, including transport of the gas | $CO_2$ | Included | • 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. |
| | $CH_4$ | Excluded | • Excluded for simplification. This emission source is assumed to be very small. |
| | $N_2O$ | Excluded | • Excluded for simplification. This emission source is assumed to be very small. |
| Emissions from methane destruction | $CO_2$ | Included | • From the combustion of methane in a flare, or heat/power generation. |

| | | | |
|---|---|---|---|
| Emissions from NMHC destruction | $CO_2$ | Included | • 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. |
| Fugitive emissions of unburned methane | $CH_4$ | Included | • Small amounts of methane will remain unburned in flares or heat/power generation. |
| Fugitive methane emissions from on-site equipment | $CH_4$ | 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 | $CH_4$ | Excluded | • Excluded for simplification. However taken into account among other potential leakage effects (see leakage section) |
| Accidental methane release | $CH_4$ | Excluded | • Excluded for simplification. This emission source is assumed to be very small. |

## 4 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:

A. Ventilation air methane;
B. Pre mining CMM extraction including CBM to Goaf drainage and/or Indirect CBM to Goaf only;
C. Post mining CMM extraction;
D. 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 proposed project activity not implemented as a CDM project.

*Step 1c. Options for energy production*

The baseline scenario alternatives should include all possible options to generate electricity (grid, captive power plant using CBM/CMM or other fuels) and/or heat (using CBM/CMM or another fuel) and/or to fuel vehicles.

These options should include the proposed project activity that has however not been implemented as a CDM project activity.

**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.

All alternative(s) shall be in compliance with all applicable legal and regulatory requirements, even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution. This does not consider national and local policies that do not have legally-binding status.

If an alternative does not comply with all applicable legislation and regulations, then show that, based on an examination of current practice in the country or region in which the law or regulation applies, those applicable legal or regulatory requirements are systematically not enforced and that non-compliance with those requirements is widespread in the country. If this cannot be shown, then eliminate the alternative from further consideration;

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:

(a) Relevant legislation, regulatory information or industry norms;
(b) Relevant (sectoral) studies or surveys (e.g. market surveys, technology studies, etc) undertaken by universities, research institutions, industry associations, companies, bilateral/multilateral institutions, etc;
(c) Relevant statistical data from national or international statistics;
(d) Documentation of relevant market data (e.g. market prices, tariffs, rules);
(e) 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;
(f) Documents prepared by the project developer, contractors or project partners in the context of the proposed project activity or similar previous project implementations;
(g) 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 all project alternatives are prevented by at least one barrier, either the proposed CDM project is itself the baseline, or the set of project alternatives has to be completed to include the potential baseline.

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

1. either choose the most conservative (results in least emissions) alternative as the baseline scenario, or
2. 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 <u>one or more</u> 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[2], 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[3], ODA, etc. where applicable), and, as appropriate, non-market cost and benefits in the case of public investors.

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.

[2] 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.

[3] This provision may be further elaborated depending on deliberations by the Board on national and sectoral policies.

***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.*

## 5 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[4].*

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 more attractive than the CDM project activity if not registered as a CDM project.

## 6 Project Emissions

Project emissions are defined by the following equation

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

where:

| | |
|---|---|
| $PE_y$ | Project emissions in year y ($tCO_2e$) |
| $PE_{ME}$ | Project emissions from energy use to capture and use methane ($tCO_2e$) |
| $PE_{MD}$ | Project emissions from methane destroyed ($tCO_2e$) |
| $PE_{UM}$ | Project emissions from un-combusted methane ($tCO_2e$) |

### *6.1 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.

$$PE_{ME} = CONS_{ELEC,PJ} \text{ x } CEF_{ELEC} + CONS_{HEAT,PJ} \text{ x } CEF_{HEAT} + CONS_{Foss\ Fuel,PJ} \text{ x } CEF_{Foss\ Fuel} \quad \textbf{(2)}$$

[4] Please refer to: <http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

| | |
|---|---|
| $PE_{ME}$ | Project emissions from energy use to capture and use methane ($tCO_2e$) |
| $CONS_{ELEC,PJ}$ | Additional electricity consumption for capture and use of methane, if any (MWh) |
| $CEF_{ELEC}$ | Carbon emissions factor of electricity used by coal mine ($tCO_2e/MWh$) |
| $CONS_{HEAT,PJ}$ | Additional heat consumption for capture and use of methane, if any (GJ) |
| $CEF_{HEAT}$ | Carbon emissions factor of heat used by coal mine ($tCO_2e/GJ$) |
| $CONS_{FossFuel,PJ}$ | Additional fossil fuel consumption for capture and use of methane, if any (GJ) |
| $CEF_{FossFuel}$ | Carbon emissions factor of fossil fuel used by coal mine ($tCO_2e/GJ$) |

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 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.

### *6.2 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.

$$PE_{MD} = (MD_{FL} + MD_{ELEC} + MD_{HEAT} + MD_{GAS}) \times (CEF_{CH4} + r \times CEF_{NMHC}) \quad \textbf{(3)}$$

with:

$$r = PC_{NMHC} / PC_{CH4} \quad \textbf{(4)}$$

where:[5]

| | |
|---|---|
| $PE_{MD}$ | Project emissions from CMM/CBM destroyed ($tCO_2e$) |
| $MD_{FL}$ | Methane destroyed through flaring ($tCH_4$) |
| $MD_{ELEC}$ | Methane destroyed through power generation ($tCH_4$) |
| $MD_{HEAT}$ | Methane destroyed through heat generation ($tCH_4$) |
| $MD_{GAS}$ | Methane destroyed after being supplied to gas grid or for vehicle use ($tCH_4$) |
| $CEF_{CH4}$ | Carbon emission factor for combusted methane (2.75 $tCO_2e/tCH_4$) |
| $CEF_{NMHC}$ | Carbon emission factor for combusted non methane hydrocarbons (the concentration varies and, therefore, to be obtained through periodical analysis of captured methane) ($tCO_2eq/tNMHC$) |
| r | Relative proportion of NMHC compared to methane |
| $PC_{CH4}$ | 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.

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

where:

[5] 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.

$MD_{FL}$ Methane destroyed through flaring ($tCH_4$)
$MM_{FL}$ Methane measured sent to flare ($tCH_4$)
$Eff_{FL}$ Efficiency of flare

The flare efficiency ($Eff_{FL}$) shall be calculated 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. Project participants may assume a default efficiency of 99% for closed flares for the ex ante calculation. Flare efficiency will be monitored ex-post.

In case open flares are used, since flare efficiency cannot be measured in a reliable manner (i.e. 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% may be used.

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

where:

$MD_{ELEC}$ Methane destroyed through power generation ($tCH_4$)
$MM_{ELEC}$ Methane measured sent to power plant ($tCH_4$)
$Eff_{ELEC}$ Efficiency of methane destruction/oxidation in power plant (taken as 99.5% from IPCC)

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

where:

$MD_{HEAT}$ Methane destroyed through heat generation ($tCH_4$)
$MM_{HEAT}$ Methane measured sent to heat plant ($tCH_4$)
$Eff_{HEAT}$ Efficiency of methane destruction/oxidation in heat plant (taken as 99.5% from IPCC)

$$MD_{GAS} = MM_{GAS} \times Eff_{GAS} \quad \textbf{(8)}$$

where:

$MD_{GAS}$ Methane destroyed after being supplied to gas grid ($tCH_4$)
$MM_{GAS}$ Methane measured supplied to gas grid for vehicle use or heat/power generation off-site ($tCH_4$)
$Eff_{GAS}$ 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)[6]

[6]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 118,000kgCH4/PJ on the basis of gas consumption, which is 0.6%. Leakage in the residential and commercial sectors is given as 0 to 87,000kgCH4/PJ, which is 0.4%, or in industrial plants and power station the losses are 0 to 175,000kg/CH4/PJ, which is 0.8%. These leakage estimates are additive. $Eff_{GAS}$ can now be calculated as the product of these three efficiency factors, giving a total efficiency of (99.5% * 99.4%

### *6.3 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:

$$PE_{UM} = GWP_{CH4} \times \sum_i MM_i \times (1 - Eff_i) \qquad \textbf{(9)}$$

where:

| | |
|---|---|
| $PE_{UM}$ | Project emissions from un-combusted methane ($tCO_2e$) |
| $GWP_{CH4}$ | Global warming potential of methane (21 $tCO_2e/tCH_4$) |
| i | Use of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses) |
| $MM_i$ | Methane measured sent to use i ($tCH_4$) |
| $Eff_i$ | Efficiency of methane destruction in use i (%) |

## 7 Baseline Emissions

Baseline emissions are given by the following equation:

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y} \qquad \textbf{(10)}$$

| | |
|---|---|
| $BE_y$ | Baseline emissions in year y ($tCO_2e$) |
| $BE_{MD,y}$ | Baseline emissions from destruction of methane in the baseline scenario in year y ($tCO_2e$) |
| $BE_{MR,y}$ | Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity ($tCO_2e$) |
| $BE_{Use,y}$ | Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year y ($tCO_2e$) |

### *7.1 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 $CO_2$ emissions resulting from the destruction of that methane.

$$BE_{MRy} = (CEF_{CH4} + r \times CEF_{NMHC}) \times \sum_i (CBM_{BLi,y} + CMM_{BLi,y} + PMM_{BLi,y}) \qquad \textbf{(11)}$$

where:

* 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.

| | |
|---|---|
| $BE_{MD,y}$ | Baseline emissions from destruction of methane in the baseline scenario in year y ($tCO_2e$) |
| 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 $tCH_4$) |
| $CMM_{BL,i,y}$ | Pre-mining CMM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year y (expressed in $tCH_4$) |
| $PMM_{BLi,,y}$ | post-mining CMM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year y ($tCH_4$) |
| $CEF_{CH4}$ | Carbon emission factor for combusted methane (2.75 tCO2e/tCH4) |
| $CEF_{NMHC}$ | Carbon emission factor for combusted non methane hydrocarbons (various. To be obtained through periodical analysis of captured methane) (tCO2eq/tNMHC) |
| r | Relative proportion of NMHC compared to methane |

with :
$r = PC_{NMHC} / PC_{CH4}$

| | |
|---|---|
| $PC_{CH4}$ | Concentration (in mass) of methane in extracted gas (%) |
| $PC_{NMHC}$ | NMHC concentration (in mass) in extracted gas (%) |

Note that to estimate conservatively methane destruction in the baseline over time, it is important to understand the characteristics of any **ex ante** thermal demand for methane in the baseline scenario. As stated in the applicability conditions of this methodology, project participants must be able to supply the necessary to data for ex-ante projections of methane demand in order to use this methodology.

### 7.2 Calculation of the mean annual demand (Thy) for each year of the crediting period

For **thermal demand**, which includes on-site heat generation and supply to the gas grid for various combustion end uses, demand can vary within the year. More importantly, 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**

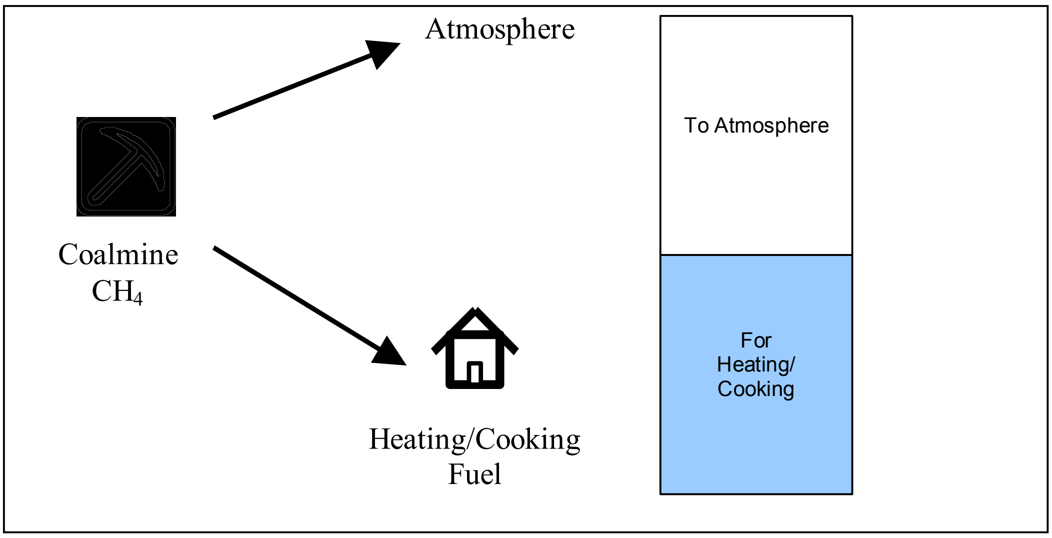
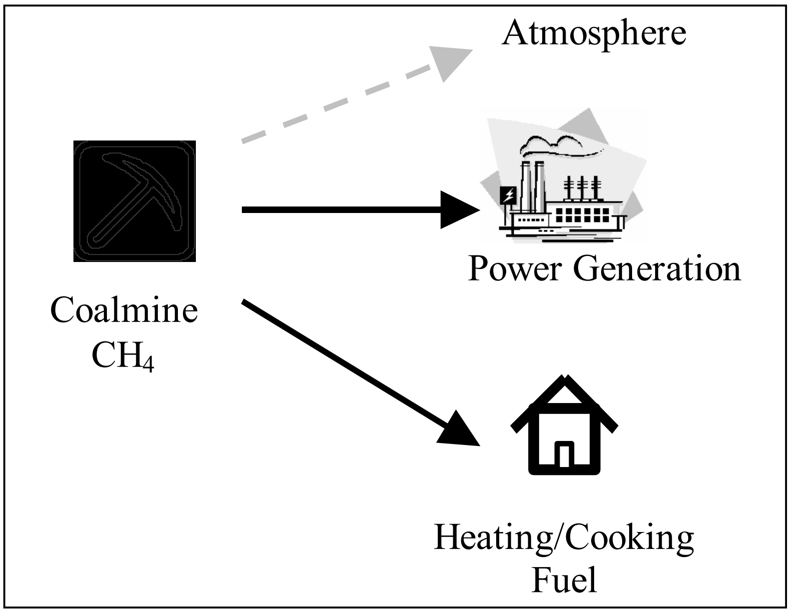


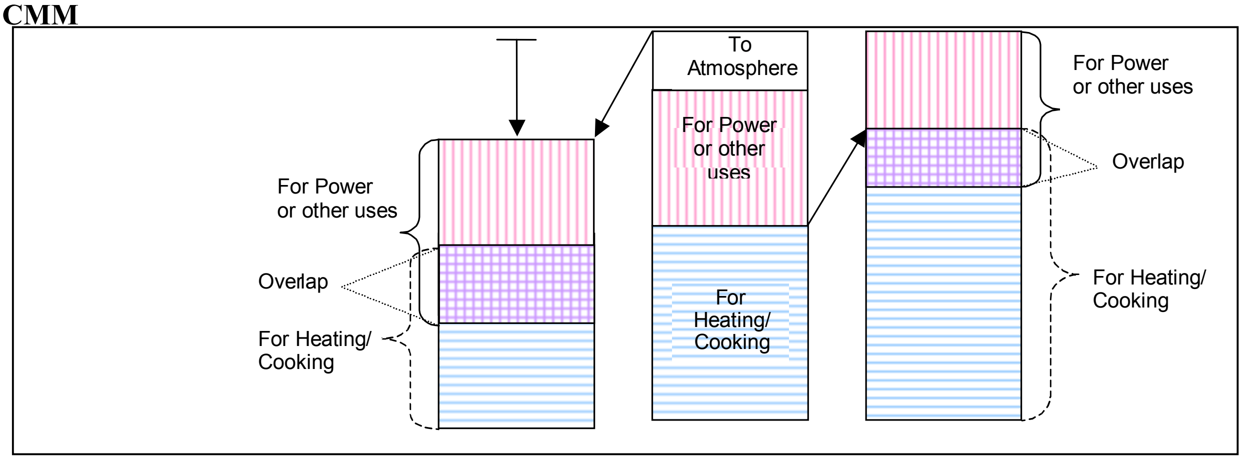
**Figure 2. Project Case Disposition of CMM/CBM**




For applicable projects, some or all of the CMM/CBM used to generate electricity would be emitted to the atmosphere under the baseline (Figure 1). Appropriate CMM/CBM 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/CBM used by a project for power generation might otherwise have gone to produce thermal energy under the baseline. This situation is shown in Figure 3, indicating an "overlap" between CMM/CBM 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 3), or if baseline thermal energy demand exceeds expected levels (right column at bottom of Figure 3). Such overlaps may occur even where total annual CMM/CBM volumes are more than enough to cover annual thermal energy and power requirements (as in Figure 3). 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).

**Figure 3. Project Case CMM/CBM for Power (or other uses) Overlaps with Baseline Thermal CMM**




Note that 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/monthly 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 CBM/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 are combined into a single distribution around daily estimates of thermal energy demand. This distribution is in equation below, in which the mean daily baseline thermal demand is multiplied by the daily scalar adjustment factor, $d_k^{max}$.

Baseline thermal demand is estimated with the following equation:

$$(CBM_{BL,th,y} + CMM_{BL,th,y} + PMM_{BL,th,y}) = \sum_{k=1}^{365} TH_{BL,k} \qquad \textbf{(12)}$$

where:

| | |
|---|---|
| $CBM_{BL,th,,y}$ | CBM that would have been captured and destroyed by thermal demand in the baseline scenario ($tCH_4$) |
| $CMM_{BL,th,y}$ | Pre-mining CMM that would have been captured and destroyed by thermal demand in the baseline scenario ($tCH_4$) |
| $PMM_{BLth,,y}$ | post-mining CMM that would have been captured and destroyed by thermal demand in the baseline scenario ($tCH_4$) |
| th | index for thermal use of CBM, CMM and PMM in the baseline, which includes on-site heat generation and supply to the gas grid for various combustion end uses |
| $TH_{BL,k}$ | Methane used to serve estimated thermal energy demand in the baseline for day k of year y($tCH_4$) |

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

$$TH_{BL,k} = \frac{TH_{BL,y}}{365} \times d_k^{max} \qquad \textbf{(13)}$$

where:

| | |
|---|---|
| $TH_{BL,k}$ | Methane used to serve estimated thermal energy demand in the baseline for day k in year y ($tCH_4$) |
| $TH_{BL,y}$ | Projected annual baseline thermal demand for year y ($tCH_4$) |
| $d_k$ | scalar adjustment factor for day k to reflect seasonal variations, such that $\Sigma d_k=365$ |
| $d^{max}{}_k$ | maximum scalar adjustment factor for day k over the 5 years prior to the start of the project activity (i.e. $\Sigma d^{max}{}_k>365$) |

The scalar adjustment factor for the day k of a year prior to the commencement of the project activity is the ratio between the demand for that day k and the mean daily demand for that year. 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 (i.e. $d^{max}{}_k$).

**If daily data are not available for estimating the scalar factor $d_k$, then monthly data may be used.**

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.

### *7.3 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 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:

$$BE_{MRy} = GWP_{CH4} \times [\sum_i (CBMe_{i,y} - CBM_{BL\,i,y}) + \sum_i (CMM_{PJi,y} - CMM_{BL\,i,y}) + \sum_i (PMM_{PJi,y} - PMM_{BL\,i,y})] \quad \textbf{(14)}$$

Where,

| | |
|---|---|
| $BE_{MR,y}$ | Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity ($tCO_2e$) |
| 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 $tCH_4$) |
| $CBM_{BLi,,y}$ | CBM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in the year y (expressed in $tCH_4$) |
| $CMM_{PJ,i,y}$ | Pre-mining CMM captured, sent to and destroyed by use *i* in the project activity in year y (expressed in $tCH_4$) |
| $CMM_{BL,i,y}$ | Pre-mining CMM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year y (expressed in $tCH_4$) |
| $PMM_{PJ,i,y}$ | post-mining CMM captured, sent to and destroyed by use *i* in the project activity in year y ($tCH_4$) |
| $PMM_{BLi,,y}$ | post-mining CMM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year y ($tCH_4$) |
| $GWP_{CH4}$ | Global warming potential of methane (21 $tCO_2e/tCH_4$) |
| $CEF_{CH4}$ | Carbon emission factor for combusted methane (2.75 tCO2e/tCH4) |
| $CEF_{NMHC}$ | Carbon emission factor for combusted non methane hydrocarbons (various. To be obtained through periodical analysis of captured methane) (tCO2eq/tNMHC) |
| r | Relative proportion of NMHC compared to methane |

with :

$r = PC_{NMHC} / PC_{CH4}$

| | |
|---|---|
| $PC_{CH4}$ | Concentration (in mass) of methane in extracted gas (%) |
| $PC_{NMHC}$ | NMHC concentration (in mass) in extracted gas (%) |

The methane that still vented in the project scenario is not accounted for in the project emissions or 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.

### *7.3.1 Eligible CBM*

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

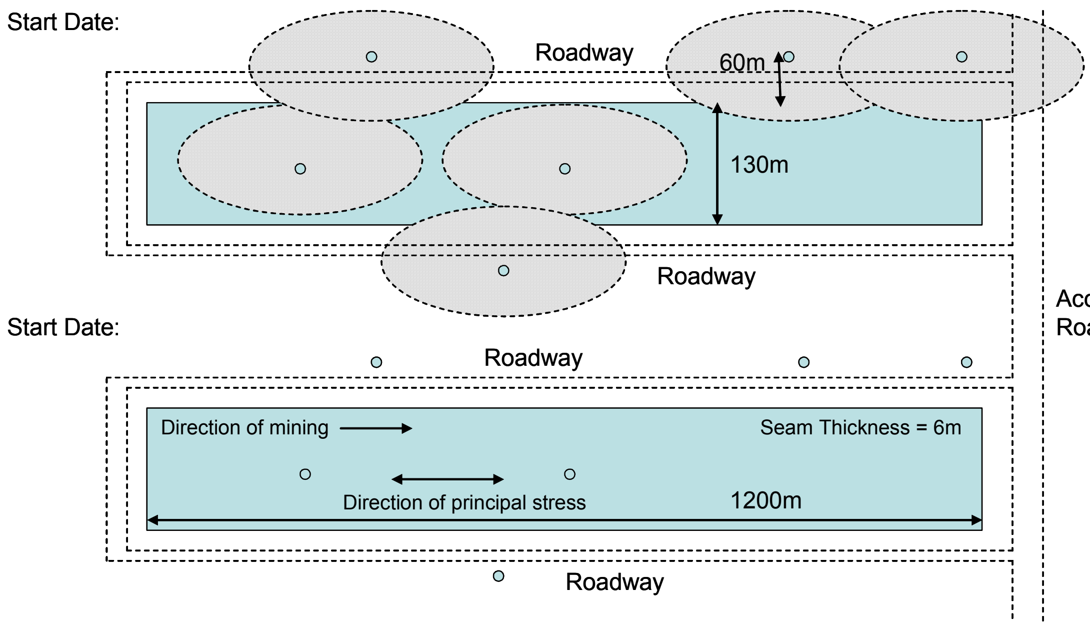
***Step 1: Identify relevant wells***

The first step is to identify the drilling plan and the wells that will be intersected by mining or are likely to extract methane from an area that will overlap with future coal extraction :

The location of CBM wells 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 relevant CBM wells and their zones of influence is shown in Figure 3.

*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, relevant CBM wells and their zones of influence




***Step 2. Estimation of the Zone of Influence of a CBM Well and eligible methane***

This methodology estimates the overlap between a cylindrical 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 an individual well:

$$R = ((V_w)/(\pi \times T \times \rho_{coal} \times g_{coal}))^{0.5} \qquad \textbf{(15)}$$

where:

| | |
|---|---|
| $R$ | Cumulative radius of zone of influence (m) |
| $V_w$ | Cumulative flow measured at an individual well ($m^3$) |
| $T$ | Total thickness of coal in section accessed by well (m) |
| $\rho_{coal}$ | Density of locally mined coal ($t/m^3$)– default value 1.4 $t/m^3$ |
| $g_{coal}$ | Gas content of the coal ($m^3$ $CH_4$/tonne coal) |

(ii) using cumulative flow from a number of wells

$$R = ((n \times V_a)/(\pi \times T \times \rho_{coal} \times g_{coal}))^{0.5} \qquad \textbf{(16)}$$

where:

| | |
|---|---|
| $R$ | Cumulative radius of zone of influence (m) |
| $n$ | Number of days the selected wells are operational |
| $V_a$ | Average flow per day across all wells ($m^3$/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

$$V_a = V_c / N = \frac{\sum V_w}{N} \qquad \textbf{(17)}$$

where:

| | |
|---|---|
| $V_a$ | Average flow per day ($m^3$/d) |
| $V_c$ | Total cumulative gas drained from all the wells measured at the centralised monitoring station ($m^3$) |
| $V_w$ | Cumulative flow measured at an individual well ($m^3$) |
| $N$ | Sum of days that all wells have been operational (days) |

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 ‘n’ the corresponding radius of zone of influence will be n x20 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.

<u>Horizontal plane:</u> 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:

$$ES_h = \frac{\sum_w AO_w}{\sum_w AT_w} \tag{18}$$

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 | CBM wells with zones of influence that overlap with mining activity |

Note that for CBM wells which will be physically intersected by mining, $ES_h$ is unity by definition. In other words, all of the CBM drained from this type of well is eligible, unless there is gas coming from seams beyond the de-stressing zone.

<u>Vertical plane:</u> The de-stressing zone typically extends upwards 140 m and downwards 40 metres. If cased boreholes are used and the seams are fracced 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 fracced, then this gas must be excluded from the eligible CBM. The eligible share is defined as follows:

$$ES_v = \frac{t}{T} \tag{19}$$

where:

| | |
|---|---|
| $ES_v$ | 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 $ES_v$ would be 1 for cased boreholes where fraccing 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.

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

$$ES_t = ES_h \times ES_v \tag{20}$$

where:

| | |
|---|---|
| $ES_t$ | total eligible share of CBM (%) |
| $ES_h$ | eligible share of CBM based on the horizontal plane overlap (%) |
| $ES_v$ | eligible share of CBM based on the vertical plane overlap (%) |

*$CO_2$ 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 $CO_2$ resulting from the use or the destruction of all the CBM extracted should be accounted as project emissions.

Note that once a CBM well has been mined through, then the well acts in the same manner as conventional underground post mining CMM drainage (surface goaf well) 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 relevant CBM wells will be determined after proper risk assessments and taking into account local conditions for drilling.

If any CBM wells that were planned to be intersected by mining, or their zones of influence overlap with mining, are not reached by the mining activities, then corresponding methane extracted should not be taken into account in the emission reduction calculation.

***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:

$$CBM_{e,y} = \left[ ES_t \times \sum_{w} \sum_{m=1}^{y-b} V_{w,y-m} \right] + \left[ ES_t \times \sum_{w} V_{w,y} \right] \quad \textbf{(21)}$$

where:

| | |
|---|---|
| $CBM_{e.y}$ | Eligible CBM captured by the project for year *y* ($tCH_4$) |
| $ES_t$ | total eligible share of CBM (%) |
| $V_{w,y-m}$ | Volume of methane captured from well *w* in year *y-m* ($tCH_4$) |
| $V_{w,y}$ | Volume of methane captured from well *w* in year *y* ($tCH_4$) |
| w | number of wells where mining reached the zone of influence in year y |
| b | initial year of crediting period |

Note that the first term covers the sum of all the methane drained from **each new well** for which mining has actually entered the zone of influence during a given year y, from the start of the crediting period to the end of the previous year (i.e. end of year y-1). The second term covers the sum of all methane drained from **each well** for which mining has entered the zone of influence for the year y. For example, at a mine in which 5 CBM wells had been drilled, if mining entered the zone of influence of all five wells in year 4, then in years 1 to 3 the eligible CBM would be zero. In year 4 it would be the cumulative volume for the previous 3 years plus the volume extracted in year 4. In year 5 it would only be the volume extracted in year 5.

### *7.3.2 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.

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

For emissions from displacing other energy forms, it is necessary to distinguish between emissions reductions derived from the use of CBM versus CMM, because CBM emissions reductions should only be credited once the mining area has intersected the zone of influence of the CBM well.

$$BE_{Use,y} = ED_{CBMw,y} + ED_{CBMz,y} + ED_{CPMM,y} \qquad \textbf{(22)}$$

| | |
|---|---|
| $BE_{Use,y}$ | Total baseline emissions from the production of power or heat replaced by the project activity in year y ($tCO_2$) |
| $ED_{CBMw,y}$ | Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersected the zone of influence in year y ($tCO_2$) |
| $ED_{CBMz,y}$ | Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersected the zone of influence prior to year y ($tCO_2$) |
| $ED_{CPMM,y}$ | Emissions from displacement of end uses by use of coal mine methane and post-mining methane ($tCO_2$) |

The total methane captured during year y can be described as follows:

$$CBMM_{tot,y} = CBM_{w,y} + CBM_{z,y} + CBM_{x,y} + CMM_{PJ,y} + PMM_{PJ,y} \qquad \textbf{(23)}$$

| | |
|---|---|
| $CBMM_{tot,y}$ | Total CBM and CMM captured and utilised by the project activity ($tCH_4$) |
| $CBM_{w,.y}$ | CBM captured from wells where the mining area intersected the zone of influence in year y ($tCH_4$) |
| $CBM_{z,.y}$ | CBM captured from wells where the mining area intersected the zone of influence prior to year y ($tCH_4$) |
| $CBM_{x,.y}$ | CBM captured from wells where the mining area has not yet intersected the zone of influence in year y ($tCH_4$) |
| $CMM_{PJ,i,y}$ | Pre-mining CMM captured by the project activity in year y ($tCH_4$) |
| $PMM_{PJ,i,y}$ | Post-mining CMM captured by the project activity in year y ($tCH_4$) |

The total potential emissions reductions from displacement of power/heat generation and vehicle fuels are given by the following equation:

$$PBE_{Use,y} = GEN_{,y} \text{ x } EF_{ELEC} + HEAT_y \text{ x } EF_{HEAT} + VFUEL_y \text{ x } EF_V \qquad \textbf{(24)}$$

Where,

| | |
|---|---|
| $PBE_{Use,y}$ | Potential total baseline emissions from the production of power or heat replaced by the project activity in year y ($tCO_2e$) |

| | |
|---|---|
| $GEN_y$ | 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 ($tCO_2$/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 ($tCO_2$/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 ($tCO_2$/GJ) |

To identify the CBM/CMM that should receive credits in the year during which the gas is captured and used, the following formulae are used, assuming that CMM and CBM are used for various end uses in the same proportions as the overall supply for that year of different gas sources:

$$ED_{CBMz,y} = \frac{CBM_{z,y}}{CBMM_{tot,y}} \times PBE_{Use,y} \qquad \textbf{(25)}$$

Where,

| | |
|---|---|
| $ED_{CBMz,y}$ | Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersected the zone of influence prior to year y ($tCO_2e$) |
| $CBM_{z,.y}$ | CBM captured from wells where the mining area intersected the zone of influence prior to year y ($tCH_4$) |
| $CBMM_{tot,y}$ | Total CBM and CMM captured and utilised by the project activity in year y ($tCH_4$) |
| $PBE_{Use,y}$ | Potential total baseline emissions from the production of power or heat replaced by the project activity in year y ($tCO_2e$) |

$$ED_{CPMM,y} = \frac{CMM_{PJ,y} + PMM_{PJ,y}}{CBMM_{tot,y}} \times PBE_{Use,y} \qquad \textbf{(26)}$$

Where,

| | |
|---|---|
| $ED_{CPMM,y}$ | Emissions from displacement of end uses by use of coal mine methane and post-mining methane ($tCO_2e$) |
| $CMM_{PJ,i,y}$ | Pre-mining CMM captured by the project activity in year y ($tCH_4$) |
| $PMM_{PJ,i,y}$ | Post-mining CMM captured by the project activity in year y ($tCH_4$) |
| $CBMM_{tot,y}$ | Total CBM and CMM captured and utilised by the project activity in year y ($tCH_4$) |
| $PBE_{Use,y}$ | Potential total baseline emissions from the production of power or heat replaced by the project activity in year y ($tCO_2e$) |

$$ED_{CBMw,y} = \sum_{m=0}^{y-b} \left[ \frac{CBM_{w,y-m}}{CBMM_{tot,y-m}} \times PBE_{y-m} \right] \qquad \textbf{(27)}$$

Where,

| | |
|---|---|
| $ED_{CBMw,y}$ | Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersects the zone of influence in year y ($tCO_2e$) |
| $CBM_{w,.y-m}$ | CBM captured in the year y-m from wells where the mining area intersected the zone of influence in year y ($tCH_4$) |
| $CBMM_{tot,y-m}$ | Total CBM and CMM captured and utilised by the project activity in year y-m ($tCH_4$) |
| $PBE_{Use,y-m}$ | Potential total baseline emissions from the production of power or heat replaced by the project activity in year y-m ($tCO_2e$) |
| b | initial year of crediting period |

Note that no emissions reductions are associated with $CBM_{x,y}$, so the actual baseline emissions in each year will vary from the potential baseline emissions.

### *7.4.1 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.

### *7.4.2 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:

$$EF_{captive,y} = \frac{EF_{CO2,i}}{Eff_{captive}} \times \frac{44}{12} \times \frac{3.6TJ}{1000MWh} \tag{28}$$

where:

| | |
|---|---|
| $EF_{captive,y}$ | Emissions factor for captive power generation ($tCO_2/MWh$) |
| $EF_{CO2,i}$ | $CO_2$ 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 |

### *7.4.3 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.

$$EF_{ELEC,y} = s_{grid} \cdot EF_{grid,y} + s_{captive} \cdot EF_{captive,y} \tag{29}$$

where:

| | |
|---|---|
| $EF_{ELEC.,y}$ | $CO_2$ baseline emission factor for the electricity displaced due to the project activity during the year *y* ($tCO_2/MWh$). |
| $EF_{grid,y}$ | $CO_2$ baseline emission factor for the grid electricity displaced due to the project activity during the year *y* ($tCO_2/MWh$). |
| $EF_{captive,y}$ | $CO_2$ baseline emission factor for the captive electricity displaced due to the project activity during the year *y* ($tCO_2/MWh$). |
| $s_{grid}$ | Share of facility electricity demand supplied by grid imports over the last 3 years (%)[7] |
| $s_{captive}$ | Share of facility electricity demand supplied by captive power over the last 3 years (%)[2] |

[7] 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.

### *7.4.4 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:

$$EF_{heat,y} = \frac{EF_{CO2,i}}{Eff_{heat}} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \quad \textbf{(30)}$$

where:

| | |
|---|---|
| $EF_{heat,y}$ | Emissions factor for heat generation ($tCO_2$/GJ) |
| $EF_{CO2,i}$ | $CO_2$ 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:

<u>Option A</u>
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.

<u>Option B</u>
Assume a boiler efficiency of 100% based on the net calorific values as a conservative approach.

### *7.4.5 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:

$$EF_V = \frac{EF_{CO2,i}}{Eff_V} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \quad \textbf{(31)}$$

where:

| | |
|---|---|
| $EF_V$ | Emissions factor for vehicle operation replaced by project activity (tCO2/GJ) |
| $EF_{CO2,i}$ | $CO_2$ 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.

## 8 Leakage

The formula for leakage is given as follows

$$LE_y = LE_{d,y} + LE_{o,y} \quad \textbf{(32)}$$

where:

| | |
|---|---|
| $LE_y$ | Leakage emissions in year y ($tCO_2e$) |
| $LE_{d,y}$ | Leakage emissions due to displacement of other baseline thermal energy uses of methane in year y ($tCO_2e$) |
| $LE_{o,y}$ | Leakage emissions due to other uncertainties in year y ($tCO_2e$) |

### *8.1 Displacement of baseline thermal energy uses*

Leakage may occur if the project activity prevents CMM/CBM from being used to meet baseline thermal energy demand, whether as a result of physical constraints on delivery, or price changes. Where regulations require that local thermal demand is met before all other uses, which is common in many jurisdictions, then this leakage can be ignored.

If displacement does occur, 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, 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, or monthly logs if daily data is not available, of project-case demand for CMM for non-thermal uses compared against estimates of baseline CMM demand for thermal uses. For each day (or month) of the crediting period, this form of leakage must be calculated if:

$$ME_k - (MM_{ELEC,k} + MM_{HEAT,k}) < TH_k \quad \textbf{(33)}$$

with:

$$TH_k = \frac{\overline{TH_{BL}}}{365} \times d_k^{\max} \quad \textbf{(34)}$$

where:

| | |
|---|---|
| $ME_k$ | Methane extracted on day k (tCH4) |
| $MM_{ELEC,k}$ | Methane measured sent to power plant on day k ($tCH_4$) |
| $MM_{HEAT,k}$ | Methane measured sent to **new** heat generation uses on day k in the Project Scenario that would not have been sent in the Baseline Scenario on day k ($tCH_4$) |
| $TH_k$ | Methane used to serve thermal energy demand in the baseline for day k ($tCH_4$) |
| $TH_{BL}$ | Average annual thermal demand over the past 5 years (tCH4) |
| $d_k$ | scalar adjustment factor for day k to reflect seasonal variations such that $\Sigma d_k=365$ |
| $d^{max}{}_k$ | maximum scalar adjustment factor for day k over the past 5 years (i.e. $\Sigma d^{max}{}_k>365$) |

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, and then summed up for each year y:

$$ED_{th,y} = \Sigma(ED_{th,k}) = \Sigma[\max(0, (TH_k - (ME_k - (MM_{ELEC,k} + MM_{HEAT,k})))\ x\ NCV_{CH4}] \quad \textbf{(35)}$$

where:

| | |
|---|---|
| $ED_{th,y}$ | Quantity of thermal energy displaced by the project activity in year y (GJ) |
| $ED_{th,k}$ | Quantity of thermal energy displaced by the project activity on day k (GJ) |
| $ME_k$ | Total methane extracted on day k (tCH4) |
| $MM_{ELEC,k}$ | Methane measured sent to power plant on day k ($tCH_4$) |
| $MM_{HEAT,k}$ | Methane measured sent to **new** heat generation uses on day k in the Project Scenario that would not have been sent in the Baseline Scenario on day k ($tCH_4$) |
| $NCV_{CH4}$ | Net calorific value for methane ($GJ/tCH_4$) |

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.

$$Q_{AF,y} = ED_{th,y} / NCV_{AF} \quad \textbf{(36)}$$

where:

| | |
|---|---|
| $Q_{AF,y}$ | Quantity of alternative fuels displaced by the project activity in year y (tonnes or $m^3$) |
| $ED_{th,y}$ | Quantity of thermal energy displaced by the project activity in year y (GJ) |
| $NCV_{AF}$ | Net calorific value for alternative fuels (GJ/tonne or $m_3$) |

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

$$LE_{d,y} = Q_{AF}\ x\ NCV_{AF}\ x\ EF_{AF}\ x\ OXID \quad \textbf{(37)}$$

where:

| | |
|---|---|
| $LE_{d,y}$ | Leakage emissions in year y ($tCO_2e$) |
| $Q_{AF,y}$ | Quantity of alternative fuels displaced by the project activity in year y (tonnes or $m^3$) |
| $NCV_{AF}$ | Net calorific value for alternative fuels (GJ/tonne or $m_3$) |
| $EF_{AF}$ | Emissions factor for alternative fuel ($tCO_2/GJ$), sourced from IPCC |
| OXID | Oxidation efficiency of combustion (%), sourced from IPCC |

### *8.2 CBM drainage from outside the de-stressed zone*

Surface 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. The vertical leakage would only occur if the surface wells were not cased. Similarly, if there is surface CBM extraction in the baseline, then the gas drawn from other seams would be the same in the baseline and project scenario. Therefore, in cases where:

1. Surface boreholes drilled in the project activity are not cased, AND
2. There are no surface boreholes for CBM draining present in the baseline scenario

Project participants should discount the total emissions reductions achieved. The amount of discount should be based on:
Option 1: a comparison of ex-ante engineering estimates of CBM production from surface boreholes versus actual project activity CBM production
Option 2: a standard discount factor of 10%

### *8.3 Impact of CDM project activity on coal production*

The additional CBM/CMM extraction from the CDM project activity could in some cases release certain constraints that currently limit mining operations. In cases of gassy mines where production is constrained by gas drainage capacity (i.e. too high concentration requires temporary interruption of mining operation), CER value can cover both the cost of CMM/CBM destruction and increase of extraction capacity to release the concentration constraint, then allowing increased coal production. This will only be the case, however, when no CBM/CMM extraction is present in the baseline scenario (i.e. the baseline scenario is ventilation of mine gas only).

If the project activity is CBM/CMM extraction and the baseline scenario is ventilation only, project participants should:

Option 1: calculate the extra coal production likely by the relaxing of the production constraint. The emission reductions claimed by the project should then be discounted so that CBM/CMM capture from the additional coal production is not included.
Option 2: apply a standard discount factor of 10%. Note that for projects using CBM this leakage is to be calculated in addition to leakage described in section 8.2 above.

### *8.4 Impact of CDM project activity on coal prices and market dynamics*

Depending on relative market price of coal and the value of CERs for the CDM project activity, the new carbon revenue could theoretically eventually induce a decrease in coal prices and, as a result, lead to an increase of coal demand (i.e. a rebound effect). The share of coal in national energy demand could therefore increase, leading to higher emissions that could offset emission reduction achieved through CMM/CBM destruction.

While this impact is theoretically possible, reliable scientific information is not currently available to assess this risk and check if the phenomenon would be negligible or not. Moreover, it is difficult to assess ex-ante the contribution of any particular project given the dynamic nature of local and global coal markets.[8]

[8] The Meth Panel recommends that the EB further investigate and monitor this issue after approving this methodology and considers to decide after 2-3 years of projects being implemented using this methodology, whether it should be revised to reflect price and market impacts.

## 9 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:

$$ER_y = BE_y - PE_y - LE_y \qquad \textbf{(38)}$$

where:

| | |
|---|---|
| $ER_y$ | emissions reductions of the project activity during the year $y$ ($tCO_2e$) |
| $BE_{,y}$ | baseline emissions during the year $y$ ($tCO_2e$) |
| $PE_y$ | project emissions during the year $y$ ($tCO_2e$) |
| $LE_y$ | leakage emissions in year y ($tCO_2e$) |

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.

**Approved consolidated monitoring methodology ACM0008**

**"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".

**10 Applicability**

This methodology applies to project activities that:
- Use surface drainage wells to capture CBM;
- Use underground boreholes in the mine to capture pre mining CMM ;
- Use surface goaf wells, underground 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 opencast 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"(ACM0008). Project participants must be able to supply the necessary to data for ex-ante projections of methane demand as described in Sections 7 and 8 of the baseline methodology to use this methodology.

**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 ($Eff_{FL}$) shall be calculated 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. Project participants may assume a default efficiency of 99% for closed flares.

  In case open flares are used, since flare efficiency cannot be measured in a reliable manner (i.e. 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% may 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.

**11 1. Project Emissions**

***11.1 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 | $PE_y$ | Project emissions in year y | $tCO_2e$ | c | monthly | 100% | electronic | Crediting period + 2 yrs | |
| P2 | $PE_{ME}$ | Project emissions from energy use to capture and use methane | $tCO_2e$ | c | monthly | 100% | electronic | Crediting period + 2 yrs | |
| P3 | $PE_{MD}$ | Project emissions from methane destroyed | $tCO_2e$ | c | monthly | 100% | electronic | Crediting period + 2 yrs | |
| P4 | $PE_{UM}$ | Project emissions from un-combusted methane | $tCO_2e$ | c | monthly | 100% | electronic | Crediting period + 2 yrs | |

Project emissions are defined by the following equation

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

*11.2 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 | $CONS_{ELEC,PJ}$ | Additional electricity consumption by project | MWh | m | continuous | 100% | electronic | Crediting period + 2 yrs | If any |
| P6 | $CONS_{HEAT,PJ}$ | Additional heat consumption by project | GJ | m | continuous | 100% | electronic | Crediting period + 2 yrs | If any |
| P7 | $CONS_{FF\_PJ}$ | Additional fossil fuel consumption by project | GJ | m | continuous | 100% | electronic | Crediting period + 2 yrs | If any |
| P8 | $CEF_{ELEC\_PJ}$ | Carbon emission factor of $CONS_{ELEC\_PJ}$ | $tCO_2$/ GJ | m, c or e | ex ante | 100% | electronic | Crediting period + 2 yrs | |
| P9 | $CEF_{HEAT\_PJ}$ | Carbon emission factor of $CONS_{HEAT\_PJ}$ | $tCO_2$/ GJ | m, c or e | ex ante | 100% | electronic | Crediting period + 2 yrs | |
| P10 | $CEF_{FF\_PJ}$ | Carbon emission factor of $CONS_{FF\_PJ}$ | $tCO_2$/ 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:

$$PE_{ME} = CONS_{ELEC,PJ} \text{ x } CEF_{ELEC} + CONS_{HEAT,PJ} \text{ x } CEF_{HEAT} + CONS_{Foss\ Fuel,PJ} \text{ x } CEF_{Foss\ Fuel} \quad \textbf{(2)}$$

*11.3 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 | $MD_{FL}$ | Methane destroyed by flare | $tCH_4$ | c | calculated monthly | 100% | electronic | Crediting period + 2 yrs | |
| P12 | $MM_{FL}$ | Methane sent to flare | $tCH_4$ | 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/m3 (Revised 1996 IPCC Reference Manual p 1.24 and 1.16) |
| P13 | $Eff_{FL}$ | Flare/combustion efficiency, determined by the operation hours and the methane content in the exhaust gas | % | m / c | annually | 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 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 | $MD_{ELEC}$ | Methane destroyed by power generation | $tCH_4$ | c | calculated monthly | 100% | electronic | Crediting period + 2 yrs | |
| P15 | $MM_{ELEC}$ | Methane sent to power plant | $tCH_4$ | 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/m3 (Revised 1996 IPCC Reference Manual p 1.24 and 1.16) |
| P16 | $Eff_{ELEC}$ | Efficiency of methane destruction/oxidation in power plant | - | e | ex-ante | | | | set at 99.5%(IPCC) |
| P17 | $MD_{HEAT}$ | Methane destroyed by heat generation | $tCH_4$ | c | calculated monthly | 100% | electronic | Crediting period + 2 yrs | |
| P18 | $MM_{HEAT}$ | Methane sent to boiler | $tCH_4$ | 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/m3 (Revised 1996 IPCC Reference Manual p 1.24 and 1.16) |

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| P19 | $Eff_{HEAT}$ | Efficiency of methane destruction/oxidation in heat plant | - | e | ex ante | | | | set at 99.5%(IPCC) |
| P20 | $MD_{GAS}$ | Methane destroyed by gas grid end-users | $tCH_4$ | c | | 100% | electronic | Crediting period + 2 yrs | |
| P21 | $MM_{GAS}$ | Methane sent to gas grid for end users | $tCH_4$ | 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/m3 (Revised 1996 IPCC Reference Manual p 1.24 and 1.16) |
| P22 | $Eff_{GAS}$ | Overall efficiency of methane destruction / oxidation through gas grid | - | e | ex ante | | | | set at 98.5% (IPCC) |
| P23 | $CEF_{CH4}$ | Carbon emission factor for combusted methane | | | | | | | set at 2.75 $tCO_2e/tCH_4$ |

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| P24 | $CEF_{NMHC}$ | Carbon emission factor for combusted non methane hydrocarbons (various) | | | | | | | To be obtained through periodical analysis of the fractional composition of captured |
| P25 | $PC_{CH4}$ | Concentration of methane in extracted gas | % | m (concentration meters, optical and calorific) | Hourly/Daily | 100% | Electronic | Crediting period + 2 yrs | |
| P26 | $PC_{NMHC}$ | 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 ($PE_{MD}$) can be obtained by the equation

$$PE_{MD} = (MD_{FL} + MD_{ELEC} + MD_{HEAT} + MD_{GAS}) \times (CEF_{CH4} + r \times CEF_{NMHC}) \qquad \textbf{(3)}$$

with :

$$r = PC_{NMHC} / PC_{CH4} \qquad \textbf{(4)}$$

where:[9]

| | |
|---|---|
| $PE_{MD}$ | Project emissions from CMM/CBM destroyed ($tCO_2e$) |
| $MD_{FL}$ | Methane destroyed through flaring ($tCH_4$) |
| $MD_{ELEC}$ | Methane destroyed through power generation ($tCH_4$) |
| $MD_{HEAT}$ | Methane destroyed through heat generation ($tCH_4$) |
| $MD_{GAS}$ | Methane destroyed after being supplied to gas grid or for vehicle use ($tCH_4$) |
| $CEF_{CH4}$ | Carbon emission factor for combusted methane (2.75 $tCO_2e/tCH_4$) |
| $CEF_{NMHC}$ | Carbon emission factor for combusted non methane hydrocarbons (various) ($tCO_2eq/tNMHC$) |
| r | Relative proportion of NMHC compared to methane |
| $Pc_{CH4}$ | 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.

[9] Note that throughout this monitoring 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.

### *11.4 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 | $GWP_{CH4}$ | Global warming potential of methane | - | e | ex ante | | | | set at 21 |
| P29 | $MM_i$ | Methane measured sent to use i | $tCH_4$ | 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 | |

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

$$PE_{UM} = GWP_{CH4} \times \Sigma [MM_i \times (1\text{-}Eff_i)] \quad \textbf{(9)}$$

## 12 2. Baseline emissions

### *12.1 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 | $BE_y$ | Baseline emissions in year y | $tCO_2$ | c | yearly | 100% | electronic | Crediting period + 2 yrs | |
| B2 | $BE_{MD,y}$ | Baseline emissions from destruction of methane in the baseline scenario in year y | $tCO_2$ | c | yearly | 100% | electronic | Crediting period + 2 yrs | |
| B3 | $BE_{MR,y}$ | Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity | $tCO_2$ | c | yearly | 100% | electronic | Crediting period + 2 yrs | |
| B4 | $BE_{Use,y}$ | Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year y | $tCO_2$ | c | yearly | 100% | electronic | Crediting period + 2 yrs | |

Baseline emissions are given by the following equation:

$$BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y} \quad \textbf{(10)}$$

### *12.2 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 | $CBM_{BL,i,y}$ | CBM that would have been captured, used and destroyed by use *i* in the baseline scenario in year y | $tCH_4$ | e | estimated ex-ante at start of project | 100% | electronic | crediting period + 2 yrs | |
| B6 | $CMM_{BL,i}$ | CMM that would have been captured, used and destroyed by use *i* in the baseline scenario in year y | $tCH_4$ | e | estimated ex-ante at start of project | 100% | electronic | crediting period + 2 yrs | |
| B7 | $PMM_{BL,i}$ | PMM that would have been captured, used and destroyed by use *i* in the baseline scenario in year y | $tCH_4$ | e | estimated ex-ante at start of project | 100% | electronic | crediting period + 2 yrs | |
| B9 | $TH_{BL,y}$ | Projected annual baseline CMM / CBM demand for thermal energy uses | $tCH_4$ | e | ex-ante | 100% | electronic | Crediting period + 2yrs | estimated by procedure defined in the corresponding baseline methodology |
| B10 | $CEF_{CH4}$ | Carbon emission factor for methane | $tCO_2e/tCH_4$ | e | ex-ante | 100% | | | 2.75 $tCO_2e/tCH_4$ |
| B11 | $d_k^{max}$ | scalar adjustment factor for day k, based on the seasonal load shape ($\Sigma\ d_k^{max} > 365$) | - | c | ex-ante | 100% | electronic | crediting period+2yrs | |

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

$$BE_{MRy} = (CEF_{CH4} + r \times CEF_{NMHC}) \times \sum_{i} (CBM_{BLi,y} + CMM_{BLi,y} + PMM_{BLi,y}) \quad \textbf{(11)}$$

where:

| | |
|---|---|
| $BE_{MD},_{y}$ | Baseline emissions from destruction of methane in the baseline scenario in year y ($tCO_2e$) |
| 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 $tCH_4$) |
| $CMM_{BL,i,y}$ | Pre-mining CMM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year y (expressed in $tCH_4$) |
| $PMM_{BLi,,y}$ | post-mining CMM that would have been captured, sent to and destroyed by use *i* in the baseline scenario in year y ($tCH_4$) |
| $CEF_{CH4}$ | Carbon emission factor for combusted methane (2.75 tCO2e/tCH4) |
| $CEF_{NMHC}$ | Carbon emission factor for combusted non methane hydrocarbons (various. To be obtained through periodical analysis of captured methane) (tCO2eq/tNMHC) |
| r | Relative proportion of NMHC compared to methane |

with :
$r = PC_{NMHC} / PC_{CH4}$

| | |
|---|---|
| $PC_{CH4}$ | Concentration (in mass) of methane in extracted gas (%) |
| $PC_{NMHC}$ | NMHC concentration (in mass) in extracted gas (%) |

Where thermal demand is present in the baseline scenario, baseline thermal demand is estimated using the following variables.

$$(CBM_{BL,th,y} + CMM_{BL,th,y} + PMM_{BL,th,y}) = \sum_{k=1}^{365} TH_{BL,k} \quad \textbf{(12)}$$

$$TH_{BL,k} = \frac{TH_{BL,y}}{365} \times d_k^{\max} \quad \textbf{(13)}$$

where:

| | |
|---|---|
| $CBM_{BL,th,,y}$ | CBM that would have been captured and destroyed by thermal demand in the baseline scenario ($tCH_4$) |
| $CMM_{BL,th,y}$ | Pre-mining CMM that would have been captured and destroyed by thermal demand in the baseline scenario ($tCH_4$) |
| $PMM_{BLth,,y}$ | post-mining CMM that would have been captured and destroyed by thermal demand in the baseline scenario ($tCH_4$) |
| $TH_{BL,k}$ | Methane used to serve estimated thermal energy demand in the baseline for day k in year y ($tCH_4$) |
| $TH_{BL,y}$ | Projected annual baseline thermal demand for year y ($tCH_4$) |
| $d_k$ | scalar adjustment factor for day k to reflect seasonal variations, such that $\Sigma d_k=365$ |
| $d^{max}{}_k$ | maximum scalar adjustment factor for day k over the 5 years prior to the start of the project activity (i.e. $\Sigma d^{max}{}_k>365$) |

***12.3 Baseline emissions from methane released into the atmosphere***

***i. Overall***

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| B12 | $CBMe_{i,.y}$ | Eligible CBM captured, sent to and destroyed by use *i* in the project for year y | $tCH_4$ | c | yearly | 100% | electronic | Crediting period + 2 yrs | |
| B13 | $CBM_{BL,i,y}$ | CBM that would have been captured , sent to and destroyed by use *i* in the baseline scenario | $tCH_4$ | c,e | ex ante | 100% | electronic | Crediting period + 2 yrs | |
| B14 | $CMM_{PJ,\ i,y}$ | Pre-mining CMM captured, sent to and destroyed by use *i* in the project activity in year y | $tCH_4$ | m | continuous | 100% | electronic | 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 |
|---|---|---|---|---|---|---|---|---|---|
| B15 | $CMM_{BL, i,y}$ | Pre-mining CMM that would have been captured , sent to and destroyed by use *i* in the baseline scenario in year y | $tCH_4$ | c,e | ex ante | 100% | electronic | Crediting period + 2 yrs | |
| B16 | $PMM_{PJ, i,y}$ | post-mining CMM captured, sent to and destroyed by use *i* in the project activity in year y | $tCH_4$ | m | continuous | 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 |
|---|---|---|---|---|---|---|---|---|---|
| B17 | $PMM_{BL, i,y}$ | post-mining CMM that would have been captured , sent to and destroyed by use *i* in the baseline scenario in year y | $tCH_4$ | c,e | ex ante | 100% | electronic | Crediting period + 2 yrs | |
| B18 | $GWP_{CH4}$ | Global warming potential of methane | $tCO_2e/tCH_4$ | e | ex ante | | | | 21 $tCO_2e/tCH_4$ |
| B19 | $CEF_{CH4}$ | Carbon emission factor for combusted methane | tCO2e/ $tCH_4$ | e | ex ante | | | | 44/16 = 2.75 tCO2e/$tCH_4$ |

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

$$BE_{MR,y} = [(CBM_{e,y} – CBM_{BL,y})+ (CMM_{PJ,y} - CMM_{BL,y})+ (PMM_{PJ,y} - PMM_{BL,y})] \times GWP_{CH4} \quad \textbf{(14)}$$

*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 |
|---|---|---|---|---|---|---|---|---|---|
| B20 | R | Cumulative radius of zone of influence | m | c | annually | 100% | electronic | Crediting period + 2 yrs | |
| B21 | $V_w$ | Cumulative flow at well | $m^3$ | m/c | | 100% | Electronic & Paper | Crediting period + 2 yrs | Monitoring at each well should record gas flow, methane concentration, pressure, and temperature |
| B22 | T | Thickness of all coal accessed by wells | m coal | m | annually | 100% | Paper/Electronic | Crediting period + 2 yrs | Depth of fractures into respective seams and casing used should be recorded at time of drilling |
| B23 | $\rho_{coal}$ | density of locally mined coal | $t/m^3$ | m | at start of each crediting period | sample | Electronic & Paper | Crediting period + 2 yrs | default value is 1.4 |
| B24 | $g_{coal}$ | gas content of coal | $m^3CH_4$ /t coal | m | at start of each crediting period | sample | Electronic & Paper | Crediting period + 2 yrs | |
| B25 | n | number of days the selected well is operational | days | m | | | 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 | $V_a$ | Average flow per day | $m^3$/day | c | | 100% | Electronic & Paper | Crediting period + 2 yrs | |
| B27 | $V_c$ | Cumulative flow from all wells | $m^3$/day | 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 |
| B28 | N | sum of days all wells operational | days | c | | | Electronic & Paper | Crediting period + 2 yrs | |
| B29 | | Position of wells relative to mining plan | coordi-nates | m | annually | 100% | Paper/ Electronic | Crediting period + 2 yrs | Recorded in PDD ex-ante. New drawing produced each year. |
| B30 | | Well profile | coordi-nates | m | annually | 100% | Paper/ Electronic | Crediting period + 2 yrs | Shows each well and zone of influence against latest mining plan |
| B31 | | Well depth | m | m | at time of drilling | 100% | Paper/ Electronic | Crediting period + 2 yrs | Based on actual drilling records |

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| B32 | t | Total thickness of coal in longwall emission zone | m | m | at start of each crediting period | | Paper/ Electronic | Crediting period + 2 yrs | From geology report and drilling records |
| B33 | $ES_t$ | total eligible share of CBM | % | c | annually | 100%? | Electronic | Crediting period +2yrs | |
| B34 | $ES_h$ | eligible share of CBM based on the horizontal plane overlap | % | c | annually | 100%? | Electronic | Crediting period +2yrs | |
| B35 | $ES_v$ | eligible share of CBM based on the vertical plane overlap | % | c | annually | 100%? | Electronic | Crediting period +2yrs | |
| B36 | $AO_w$ | Area of overlap with longwall panel | $m^2$ | e | annually | 100%? | Electronic & Paper | Crediting period + 2 yrs | |
| B37 | $AT_w$ | Total zone of influence | $m^2$ | c | annually | 100%? | Electronic & Paper | Crediting period + 2 yrs | |
| B38 | w | wells | | | | | | | |

*12.4 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 |
|---|---|---|---|---|---|---|---|---|---|
| B39 | $ED_{CBMw,y}$ | Avoided emissions related to CBM wells intersected by mine in year y | $tCO_2$ | c | annually | 100% | electronic | Crediting period + 2 yrs | |
| B40 | $ED_{CBMz,y}$ | Avoided emissions related to CBM wells intersected before year y | $tCO_2$ | c | annually | 100% | electronic | Crediting period + 2 yrs | |
| B41 | $ED_{CPMM,y}$ | Avoided emissions related to CMM and PMM | $tCO_2$ | c | annually | 100% | electronic | Crediting period + 2 yrs | |
| B42 | $CBM_{w,y}$ | CBM captured from well intersected in yr y | $tCH_4$ | m | continuous | 100% | electronic | Crediting period + 2 yrs | Monitor each well separately |
| B43 | $CBM_{z,y}$ | CBM captured from well intersected before year y | $tCH_4$ | m | continuous | 100% | electronic | Crediting period + 2 yrs | Monitor each well separately |
| B44 | $CBM_{x,y}$ | CBM captured from well not yet intersected in yr y | $tCH_4$ | m | continuous | 100% | electronic | Crediting period + 2 yrs | Monitor each well separately |

| 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 | $PBE_{Use,y}$ | Potential baseline emissions from displacement fuels | $tCO_2e$ | c | annually | 100% | electronic | Crediting period + 2 yrs | |
| B46 | $GEN_y$ | Electricity generation by project | MWh | m | continuous | 100% | electronic | Crediting period + 2 yrs | |
| B47 | $HEAT_y$ | Heat generation by project | GJ | m | continuous | 100% | electronic | Crediting period + 2 yrs | |
| B48 | $VFUEL_y$ | Vehicle power supplied by project | GJ | m | continuous | 100% | electronic | Crediting period + 2 yrs | |
| B49 | $EF_{ELEC}$ | $CO_2$ emission factor of the grid | $tCO_2$ /MWh | c | annually | 100% | electronic | Crediting period + 2 yrs | Calculated as per ACM0002 |
| B50 | $EF_{OM,y}$ | $CO_2$ Operating Margin emission factor of the grid | $tCO_2$ /MWh | c | annually or ex ante | 100% | electronic | Crediting period + 2 yrs | Calculated as per ACM0002 |
| B51 | $EF_{BM,y}$ | $CO_2$ Build Margin emission factor of the grid | $tCO_2$ /MWh | c | annually or ex ante | 100% | electronic | Crediting period + 2 yrs | Calculated as per ACM0002 |
| B52 | $F_{i,j,y}$ | Amount of each fossil fuel consumed by each power source / plant | t or $m_3$/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 |
|---|---|---|---|---|---|---|---|---|---|
| B53 | $COEF_{i,k}$ | $CO_2$ emission coefficient of each fuel type and each power source / plant | $tCO_2$ / t or $m^3$ | 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 $EF_{OM}$ ex post.. |
| B54 | $GEN_{j,y}$ | 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.. |
| B55 | $EF_{CO2,i}$ | $CO_2$ 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 |
| B56 | $Eff_{captive}$ | 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 |
| B57 | $Eff_{heat}$ | Energy efficiency of heat plant | % | m | annually | 100% | electronic | Crediting period + 2 yrs | |
| B58 | $Eff_V$ | Efficiency of vehicle engine | % | m, e | annually | 100% | electronic | Crediting period + 2 yrs | |

$BE_{Use,y} = ED_{CBMw,y} + ED_{CBMz,y} + ED_{CPMM,y}$ **(22)**

| | |
|---|---|
| $BE_{Use,y}$ | Total baseline emissions from the production of power or heat replaced by the project activity in year y ($tCO_2$) |
| $ED_{CBMw,y}$ | Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersected the zone of influence in year y ($tCO_2$) |
| $ED_{CBMz,y}$ | Emissions from displacement of end uses by use of coal bed methane captured from wells where the mining area intersected the zone of influence prior to year y ($tCO_2$) |
| $ED_{CPMM,y}$ | Emissions from displacement of end uses by use of coal mine methane and post-mining methane ($tCO_2$) |

The total methane captured during year y can be described as follows:

$CBMM_{tot,y} = CBM_{w,y} + CBM_{z,y} + CBM_{x,y} + CMM_{PJ,y} + PMM_{PJ,y}$ **(23)**

| | |
|---|---|
| $CBMM_{tot,y}$ | Total CBM and CMM captured and utilised by the project activity ($tCH_4$) |
| $CBM_{w,.y}$ | CBM captured from wells where the mining area intersected the zone of influence in year y ($tCH_4$) |
| $CBM_{z,.y}$ | CBM captured from wells where the mining area intersected the zone of influence prior to year y ($tCH_4$) |
| $CBM_{x,.y}$ | CBM captured from wells where the mining area has not yet intersected the zone of influence in year y ($tCH_4$) |
| $CMM_{PJ,i,y}$ | Pre-mining CMM captured by the project activity in year y ($tCH_4$) |
| $PMM_{PJ,i,y}$ | Post-mining CMM captured by the project activity in year y ($tCH_4$) |

The total potential emissions reductions from displacement of power/heat generation and vehicle fuels are given by the following equation:

$PBE_{Use,y} = GEN_{,y} \text{ x } EF_{ELEC} + HEAT_y \text{ x } EF_{HEAT} + VFUEL_y \text{ x } EF_V$ **(24)**

Where,

| | |
|---|---|
| $PBE_{Use,y}$ | Potential total baseline emissions from the production of power or heat replaced by the project activity in year y ($tCO_2e$) |
| $GEN_y$ | 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 ($tCO_2/MWh$) |
| $HEAT_y$ | 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 ($tCO_2/GJ$) |
| $VFUEL_y$ | 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 ($tCO_2/GJ$) |

### *12.5 Leakage emissions from displacement of baseline thermal energy uses*

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| L1 | $ME_k$ | Methane extracted on day k | $tCH_4$ | m | daily/continuous? | 100% | electronic | Crediting period + 2 yrs | |
| L2 | $MM_{ELEC,k}$ | Methane measured for power generation on day k | $tCH_4$ | m | daily/continuous? | 100% | electronic | Crediting period + 2 yrs | |
| L3 | $MM_{HEAT,k}$ | Methane measured for new heat generation on day k | $tCH_4$ | m | daily/continuous? | 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 |
|---|---|---|---|---|---|---|---|---|---|
| L4 | $MM_{FL,k}$ | Methane measured sent flare on day k | $tCH_4$ | m | daily/contin uous? | 100% | electronic | Crediting period + 2 yrs | |

The other factors used for calculating baseline thermal demand are described under B9 and B11.