Draft consolidated baseline methodology ACM00XX

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

Sources

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

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

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

Definitions

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

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

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

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

Indirect CBM to Goaf well methane –coal bed methane extracted from surface drainage wells (vertical or vertical to in-seam) sufficiently close to the planned mining area so that the extraction of gas through this well will contribute to reducing the future concentration of methane that would be released in the future mine.

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

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

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

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

Applicability

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

- Use surface drainage wells to capture CBM to Goaf well methane and Indirect CBM to Goaf well methane;
- Use underground inclined or horizontal boreholes in the mine to capture CMM pre mining;
- Use surface goaf wells, underground inclined or horizontal boreholes, gas drainage galleries or other goaf gas capture techniques, including gas from sealed areas, 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 method to treat the gas captured:

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

The methodology applies to both new and existing mining activities.

The methodology **does <u>not</u> apply** to project activities that:
- Operate in open cast mines; or
- Capture methane from abandoned/decommissioned coalmines.

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

Project boundary

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

- CO_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.

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

- CH_4 emissions as a result of venting and drainage;
- 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 / drainage	CH_4	Included	• Main emission source. However, certain sources of methane may not be included. For classification of venting and drainage, see next table. • Cumulative recovery of methane from unmined coal seams. Will be included for calculation of amount destroyed only when the particular seams are mined through or disturbed by the mining activity. • Recovery of methane from abandoned coalmines will not be included. • 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. • Use of combined margin from ACM0002 is recommended.
	CH_4	Excluded	• Excluded for simplification. This is conservative.
	N_2O	Excluded	• Excluded for simplification. This is conservative.
Captive electricity generation	CO_2	Included	• Only in case where captive power plant already exists or is planned. • Only CO_2 emissions associated to the same quantity of electricity than the electricity generated as a result of the use of methane included as baseline emission will be counted. • Fuel of captive power plant is assumed to be the fuel currently used or planned. • Efficiency of captive power plant is assumed to be the highest historical or catalogue value (this is conservative)
	CH_4	Excluded	• Excluded for simplification. This is conservative.
	N_2O	Excluded	• Excluded for simplification. This is conservative.
Heat generation (including use as vehicle fuel)	CO_2	Included	• Only the CO_2 emissions associated to the heat generated as a result of the use of methane included as baseline emission will be counted. • For specifics, see captive electricity generation.
	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 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% of 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	Included	• Based on standard default factors for pipeline leakage rates.
Accidental methane release	CH_4	Excluded	• Excluded for simplification. This emission source is assumed to be very small.

Identification of baseline scenario

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

Step 1a. Options for CBM and CMM extraction

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

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 CDM project activity not implemented as a CDM project.

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

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

Step 3. Formulate baseline scenario alternatives

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

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

Step 4. Eliminate baseline scenario alternatives that face prohibitive barriers

Sub-step 4a. Identify barriers that would prevent the implementation of type of the proposed project activity:

Establish a complete the list of barriers that would prevent 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.

Sub-step 4 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed CDM project activity):

If any of the baseline scenario alternatives face barriers that would prohibit them from being implemented, then these 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, either chose the most conservative alternative as a baseline scenario and go to step 6, or go to step 5.

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

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

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

Sub-step 5a. Determine appropriate analysis method

Determine whether to apply simple cost analysis or investment comparison analysis. If the project alternatives generate no financial or economic benefits other than CDM related income, then apply the simple cost analysis (Option I). Otherwise, use the investment comparison analysis (Option II).

Sub-step 5b. – 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.

→ If all alternatives do not generate any financial or economic benefits, then the least costly alternative among these alternative pre-selected projects is the baseline.

→ If one or more alternatives generate financial or economic benefits, then the simple cost analysis cannot be used to select the baseline scenario.

Sub-step 5c. – 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).

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[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.

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 pre-selected as a baseline candidate (step 5.d) shall be performed for all projects alternatives that have not been eliminated in step 2.

Sub-step 5d. 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 pre-selected baseline is likely to remain the most financially and/or economically attractive.

In case the sensitivity analysis is not fully conclusive, select the most conservative among the project alternatives that are the most financially and/or economically attractive according to both steps 5.c and the sensitivity analysis in this step 5.d, e.g., if the sensitivity analysis shows that one or more project alternatives compete with the one identified in step 5.c, select the less emitting one.

Step 6. Common practice analysis

An analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region. This test is a credibility check to complement the above steps to determine the baseline scenario. Identify and discuss the existing common practice through the following sub-steps:

Sub-step 6a. Analyze other activities similar to the proposed CDM project activity:

Provide an analysis of any other activities implemented previously or currently underway that are similar to the proposed project activity. Projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. Other CDM project activities are not to be included in this analysis. Provide quantitative information where relevant.

In case the pre-selected baseline emits less emissions than similar activities widely observed and commonly carried out, or is one of them, the pre-selected baseline scenario can be adopted as the baseline scenario.

If similar activities are widely observed and commonly carried out and are different from the baseline scenario pre-selected and are emitting less emissions, it calls into question the claim that the considered alternative to the project activity does not face barriers or mandatory regulation or is financially the most attractive. Therefore, if similar activities are identified above, then it is necessary to demonstrate why the existence of these activities does not contradict the claim that the pre-selected baseline scenario is economically or financially the most attractive or is not subject to barriers. This can be done by comparing the pre-selected baseline to the other similar activities, and pointing out and explaining essential distinctions between them that explain why the similar activities enjoyed certain benefits that rendered it financially more attractive (e.g., subsidies or other financial flows) or why the pre-selected baseline faced barriers that have since be removed.

Essential distinctions may include a serious change in circumstances under which the pre-selected baseline would be implemented when compared to circumstances under which similar projects where carried out. For example, some barriers may have been removed, or promotional policies may have been implemented, leading to a situation in which the pre-selected baseline would be implemented in the absence of the CDM. The change must be fundamental and verifiable.

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 0 and 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 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 more or less economically and/or financially attractive than the CDM project activity if not registered as a CDM project.

Project Emissions

Project emissions are defined by the following equation

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

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)

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.

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

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)

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

$CONS_{HEAT,PJ}$ 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)
$CONS_{FF,PJ}$ Additional fossil fuel consumption for capture and use of methane, if any (GJ)
CEF_{FF} Carbon emissions factor of fossil fuel used by coal mine (tCO2e/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 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 fuel used are the basis of the emissions factor.

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% of the coalmine gas, combustion emission from these gases should also be included.

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

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 (various. to be obtained through periodical analysis of captured methane)
r Relative proportion of NMHC compared to methane

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

$$MD_{FL} = MM_{FL} \text{ x } Eff_{FL} \qquad \textbf{(4)}$$

where:

MD_{FL} Methane destroyed through flaring (tCH_4)
MM_{FL} Methane measured sent to flare (tCH_4)
Eff_{FL} Efficiency of flare (taken as 98% for conservativeness)

$$MD_{ELEC} = MM_{ELEC} \text{ x } Eff_{ELEC} \qquad \textbf{(5)}$$

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_{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)

$$MD_{HEAT} = MM_{HEAT} \text{ x } Eff_{HEAT} \quad \textbf{(6)}$$

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)

$$MD_{GAS} = MM_{GAS} \text{ x } Eff_{GAS} \quad \textbf{(7)}$$

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 grid and combustion efficiency at end user (taken as 98.5% from IPCC)[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.

$$PE_{UM} = GWP_{CH4} \times \sum_{i} MM_i \times \left(1 - Eff_i\right) \quad \textbf{(8)}$$

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 (%)

[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% * 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.

Baseline Emissions

Baseline emissions are given by the following equation:

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

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)

1. Methane destruction due to thermal demand in the baseline

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

$$BE_{MD,y} = \Sigma(TH_b + \sigma) \text{ x } (CEF_{CH4} + r \text{ x } CEF_{NMHC}) \quad \textbf{(10)}$$

where:

$BE_{MD,y}$	Baseline emissions from destruction of methane due to thermal demand in the baseline scenario in year y (tCO_2e)
TH_b	Mean daily baseline CMM demand for thermal energy uses in the baseline(tCH_4)
σ	Standard deviation of daily baseline CMM demand for thermal energy uses (tCH_4)
CEF_{CH4}	Carbon emission factor for 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)
r	Relative proportion of NMHC compared to methane

1.1. Daily baseline thermal energy demand for CMM

The quantity TH_b should be determined for each day of the annual reporting period based on a historical seasonal load shape for thermal energy demand. For each day, i, in a standard year the formula is:

$$TH_b = (TH_y / 365) \text{ x } d_i \quad \textbf{(11)}$$

where:

TH_b	Mean daily baseline CMM demand for thermal energy uses in the baseline(tCH_4)
TH_y	Mean baseline CMM demand for year y (tCH_4)
d_i	scalar adjustment factor for day I, based on the seasonal load shape (Σ d_i = 365)

The source of data for mean annual baseline thermal energy demand should be provided on an *ex ante* basis by local CMM distribution system operators, supported by a detailed description of the drivers of, and constraints on, future CMM thermal energy demand. The project participants will use the following methods to project thermal energy demand:

- *Engineering/economic study of thermal energy demand*. Ideally, projections should be based on a detailed description of the existing CMM 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 thermal energy system;
  - The cost/benefits of expanding the CMM delivery system to additional end users;
  - The type and cost of alternative fuels for potential or existing CMM thermal energy customers, compared to the cost of delivering CMM;
  - Any other variables relevant to the particular thermal energy CMM distribution system associated with the project.

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

- *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 availability and thermal energy CMM 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.

- *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 that could be delivered to end users through existing pipelines. To be conservative, this approach should assume that thermal energy demand for CMM in all future years will be equal to the maximum amount of CMM that can be delivered. Maximum throughput estimates should be based on a detailed engineering description of the existing pipeline infrastructure. This analysis may also inform the analysis for (a) and (b), above.

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

1.2. Adjustment to account for volatility in baseline thermal energy demand

This methodology prescribes a conservative approach to account for how fluctuations in CMM extraction and thermal energy demand will affect actual emission reductions relative to the baseline.

To account for fluctuations in thermal energy demand, project proponents must quantify the following:
- How much annual (year-to-year) fluctuation is likely to occur in thermal energy demand for CMM relative to baseline projections, based on historical data or engineering models?
- How much day-to-day fluctuation is likely to occur in thermal energy demand for CMM relative to baseline projections, based on historical data or engineering models?

- How much seasonal variation is likely to occur in thermal energy demand for CMM, based on historical data or engineering models?

The level of these fluctuations should be statistically estimated and a variance calculated for daily thermal energy demand. The standard deviation, σ, should be calculated and added to TH_b to obtain baseline thermal energy CMM usage.

Many potential project sites will have existing storage tanks to buffer CMM flows used to provide thermal energy. The impact of day-to-day fluctuations in CMM extraction and thermal demand can be mitigated if sufficient storage capacity is available to absorb such fluctuations and provide a steady flow of CMM to both project generation equipment and the thermal energy distribution system. If storage is available, and project proponents can demonstrate that it is large enough to provide a sufficient buffer against day-to-day fluctuations in CMM flows (both into and out of the gas storage tanks), then σ may be omitted for the purpose of calculating baseline emissions. The showing that storage capacity is large enough must be backed by statistical and/or engineering estimates of project-case usable CMM flow rates and volatility.

Finally, inclusion of σ is not necessary if project proponents can demonstrate that expected future CMM extraction will be more than 2.5 standard deviations above total thermal energy demand for CMM plus project demand for CMM to generate electricity.

2. Methane released into the atmosphere

Depending on the nature of the project activity, CBM/CMM can be removed at three different stages – (1) as coal bed methane from a CBM to goaf wells prior to mining, or from underground pre-mining CMM drainage; (2) during the mining process using surface or underground post mining CMM drainage techniques, or (3) after the mining process by drainage from sealed goafs but before the mine is closed. This methane would have been emitted to the atmosphere in the baseline scenario, unless some capture and use activities form part of the baseline.

$$BE_{MR,y} = [(CBM_{e,y} – CBM_{BL,y}) + (CMM_{PJ,y} - CMM_{BL,y}) + (PMM_{PJ,y} - PMM_{BL,y})] \times GWP_{CH4} + [CBM_{BL,y} + CMM_{BL,y} + PMM_{BL,y} - BE_{MD,y}] \times CEF_{CH4} \quad \textbf{(12)}$$

where:

$BE_{MR,y}$	Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity (tCO_2e)
$CBM_{e.y}$	Eligible CBM captured and destroyed by the project for year y (expressed in tCH_4)
$CBM_{BL,y}$	CBM that would have been captured and destroyed in the baseline scenario (expressed in tCH_4)
$CMM_{PJ,y}$	Pre-mining CMM captured and destroyed by the project activity in year y (expressed in tCH_4)
$CMM_{BL,y}$	Pre-mining CMM that would have been captured and destroyed in the baseline scenario in year y (expressed in tCH_4)
$PMM_{PJ,y}$	post-mining CMM captured and destroyed by the project activity in year y (tCH_4)
$PMM_{BL,y}$	post-mining CMM that would have been captured and destroyed 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)
BEMD,y	Baseline emissions from destruction of methane due to thermal demand in the baseline scenario in year y (tCO2e)

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

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

2.1. Eligible CBM

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

Step 1: Classification of wells

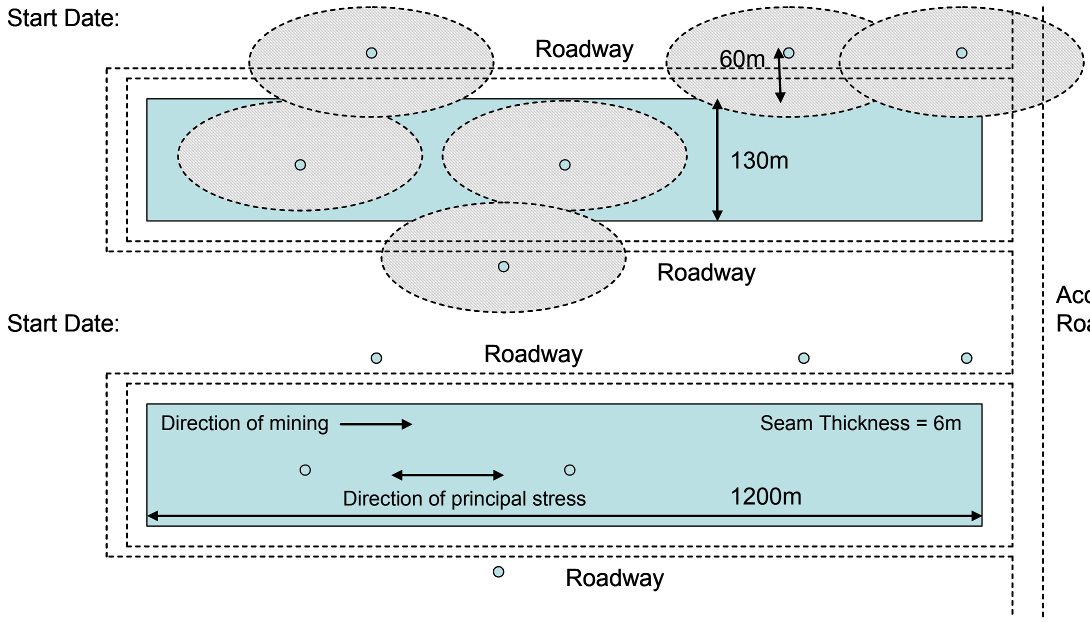
The first step is to identify the drilling plan and classification of the wells as follows:

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

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

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

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



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

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

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

(i) Using cumulative flow at the well:

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

where:

R	Cumulative radius of zone of influence per year (m/year)
V_c	Cumulative flow measured at the well (m^3/d)
T	Total thickness of coal in section accessed by well (m)
ρ_{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

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

where:

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

and

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

where:

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

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

Area of Overlap

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

<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:

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

where:

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

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

Vertical plane: The de-stressing zone typically extends upwards 140 m and downwards 40 metres. If cased boreholes are used and the seams are 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:

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

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_p	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.

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

$$ES_t = ES_h \times ES_v \quad \textbf{(18)}$$

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

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

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

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

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

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

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

where:

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

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

2.2. 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.

3. Emissions from power/heat generation and vehicle fuel replaced by project

$$BE_{Use,y} = GEN_{,y} \text{ x } EF_{ELEC} + HEAT_y \text{ x } EF_{HEAT} + VFUEL_y \text{ x } EF_V \qquad \textbf{(20)}$$

$BE_{Use,y}$	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)

3.1. 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.

3.2. 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:

$$EF_{captive,y} = \frac{EF_{CO2,i}}{Eff_{captive}} \times \frac{44}{12} \times \frac{3.6TJ}{1000MWh} \qquad \textbf{(21)}$$

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

3.3. 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.

$$EF_{ELEC,y} = s_{grid} \cdot EF_{grid,y} + s_{captive} \cdot EF_{captive,y} \qquad \textbf{(22)}$$

EF_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]

[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.

$s_{captive}$	Share of facility electricity demand supplied by captive power over the last 3 years (%)[2]

3.4. 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:

$$EF_{heat,y} = \frac{EF_{CO2,i}}{Eff_{heat}} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \qquad \textbf{(23)}$$

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:

Option A

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

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

Option B

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

3.5. 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:

$$EF_{V} = \frac{EF_{CO2,i}}{Eff_{V}} \times \frac{44}{12} \times \frac{1TJ}{1000GJ} \qquad \textbf{(24)}$$

where:

EFV	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.

Leakage

The formula for leakage is given as follows

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

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)

1. Displacement of other thermal energy uses

Leakage for this type of project may occur if the project activity prevents CMM from being used to meet baseline thermal energy demand, whether as a result of physical constraints on delivery, or price changes. If this occurs, the project activity may cause increased emissions outside the project boundary associated with meeting thermal energy demand with other fuels. The test for whether this form of leakage must be calculated is:

$$ME_{total} - (MM_{FL} + MM_{ELEC} + MM_{GAS} + MM_{HEAT}) < TH_b \quad \textbf{(26)}$$

where:

ME_{total}	Total methane extracted (tCH4)
MM_{ELEC}	Methane measured sent to power plant (tCH_4)
MM_{HEAT}	Methane measured sent to heat plant (tCH_4)
MM_{GAS}	Methane measured supplied to gas grid for vehicle use or heat/power generation off-site (tCH_4)
MM_{FL}	Methane measured sent to flare (tCH_4)
TH_b	Methane used for thermal energy in the baseline (tCH_4)

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

The amount of thermal energy CMM foregone in the project case should be calculated as:

$$ED_{th} = (MM_{ELEC} + CMM_{bl,th} - ME_{total}) \times NCV_{CH4} \quad \textbf{(27)}$$

where:

ED_{th}	Quantity of thermal energy displaced by the project activity (GJ)
ME_{total}	Total methane extracted (tCH4)
MM_{ELEC}	Methane measured sent to power plant (tCH_4)
$CMM_{bl,th}$	Coal mine methane used for thermal energy in the baseline (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.

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

where:

Q_{AF}	Quantity of alternative fuels displaced by the project activity (tonnes or m^3)
ED_{th}	Quantity of thermal energy displaced by the project activity (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:

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

where:

$LE_{d,y}$	Leakage emissions in year y (tCO_2e)
Q_{AF}	Quantity of alternative fuels displaced by the project activity (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

2. Other issues

There are a range of other uncertainties associated with the evolution of the baseline and project scenarios for these project types. For example, for a new mine it may be difficult to assess whether and what type of CBM/CMM drainage system would have been implemented without the CDM project activity. CBM drainage wells can also 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. There are also uncertainties regarding potential economic influence of the CERs on (i) the release of certain constraints that currently limit mining operations and (ii) the new net cost and price of the coal, which could theoretically eventually induce an increase of coal production and consumption (rebound effect).

For these reasons, in order to mitigate the risk of excessive CERS issuance and ensure minimum conservativeness of the methodology, a generic discount of 10% of emissions reductions is included. Such a conservative measure may be revised later on the light of reliable quantification of such effects**.**

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

Emission Reductions

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

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

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.

Draft consolidated monitoring methodology ACM00XX

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

Sources

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

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

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

Applicability

This methodology applies to project activities that:

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

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

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

The methodology applies to both new and existing mining activities.

The methodology does not apply to project activities that:

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

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

1. Project Emissions

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

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

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 $CONS_{ELEC\_PJ}$	t-CO_2/GJ	m, c or e	ex ante	100%	electronic	Crediting period + 2 yrs	Use of IPCC default or national values would suffice
P9	CEF_{HEAT_PJ}	Carbon emission factor of $CONS_{HEAT\_PJ}$	t-CO_2/GJ	m, c or e	ex ante	100%	electronic	Crediting period + 2 yrs	
P10	CEF_{FF_PJ}	Carbon emission factor of $CONS_{FF\_PJ}$	t-CO_2/GJ	m, c or e	ex ante	100%	electronic	Crediting period + 2 yrs	

Project emissions from energy use to capture and use methane ($PE_{ME,}$) is obtained by the equation
$PE_{ME} = CONS_{ELEC,PJ}$ x CEF_{ELEC} + $CONS_{HEAT,PJ}$ x CEF_{HEAT} $CONS_{Foss\ Fuel,PJ}$ x $CEF_{Foss\ Fuel}$

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
P13	Eff_{FL}	Efficiency of flare	-	e	ex ante				set at 98% for conservativeness
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
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

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
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
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	r	Relative proportion of NMHC compared to methane	%	m	annually	100%		Crediting period + 2 yrs	Used to check if more than 1% of emissions

Project emissions from methane destroyed (PE_{MD}) can be obtained by the equation

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

where:[8]

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)
r	Relative proportion of NMHC compared to methane

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

[8] 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.

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
P26	GWP_{CH4}	Global warming potential of methane	-	e	ex ante				set at 21
P27	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
P28	Eff_i	Efficiency of methane destruction / oxidation through use i	-	m, c, or e	ex ante or ex post	100%	electronic	Crediting period + 2 yrs	Project-by-project basis

Uncombusted methane from flaring and end uses (PE_{UM}) can be obtained through the equation:
$PE_{UM} = GWP_{CH4} * MM_i * \Sigma(1-EFF_i)$

2. Baseline emissions

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

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	TH_b	Mean daily baseline CMM demand for thermal energy uses in the baseline	tCH_4	c	daily	100%	electronic	Crediting period + 2yrs	As per NM0066
B6	σ	Standard deviation of daily baseline CMM demand for thermal energy uses	-	c	annual	100%	electronic	Crediting period + 2yrs	As per NM0066
B7	CEF_{CH4}	Carbon emission factor for methane	-	e					2.75 tCO2e/tCH4
B9	TH_y	Mean baseline CMM demand for year y (tCH_4)	tCH_4	c	daily	100%	electronic	Crediting period + 2yrs	As per NM0066
B10	d_i	scalar adjustment factor for day I, based on the seasonal load shape ($\Sigma\ d_i = 365$)	-						As per NM0066

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

$BE_{MD,y} = \Sigma(TH_b + \sigma)\ \text{x}\ (CEF_{CH4} + CEF_{NMHC})$

where:

$BE_{MD,y}$	Baseline emissions from destruction of methane in the baseline scenario in year y (tCO_2e)
TH_b	Mean daily baseline CMM demand for thermal energy uses in (tCH_4)
σ	Standard deviation of daily baseline CMM demand for thermal energy uses (tCH_4)
CEF_{CH4}	Carbon emission factor for methane (2.75 tCO2e/tCH4)

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
B11	$CBM_{e.y}$	Eligible CBM captured and destroyed by the project for year y	tCH_4	m	continuous	100%	electronic	Crediting period + 2 yrs	
B12	$CBM_{BL,y}$	CBM that would have been captured and destroyed in the baseline scenario	tCH_4	c,e	ex ante	100%	electronic	Crediting period + 2 yrs	
B13	$CMM_{PJ,y}$	Pre-mining CMM captured and destroyed by 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
B14	$CMM_{BL,y}$	Pre-miing CMM that would have been captured and destroyed in the baseline scenario in year y	tCH_4	c,e	ex ante	100%	electronic	Crediting period + 2 yrs	
B15	$PMM_{PJ,y}$	post-mining CMM captured and destroyed by the project activity in year y	tCH_4	m	continuous	100%	electronic & Paper	Crediting period + 2 yrs	
B16	$PMM_{BL,y}$	post-mining CMM that would have been captured and destroyed in the baseline scenario in year y	tCH_4	c,e	ex ante	100%	electronic	Crediting period + 2 yrs	
B17	GWP_{CH4}	Global warming potential of methane							21 tCO_2e/tCH_4

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
B18	CEF_{CH4}	Carbon emission factor for combusted methane							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:

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

ii. Estimation of eligible CBM

ID number	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
B19	R	Cumulative radius of zone of influence	m	m	annually	100%	electronic	Crediting period + 2 yrs	
B20	V_c	Cumulative flow at well	m^3	c		100%	Electronic & Paper	Crediting period + 2 yrs	
B21	T	Thickness of all coal accessed by wells	m coal	m	annually	100%	Electronic & Paper	Crediting period + 2 yrs	Depth of fractures into respective seams and casing used should be recorded at time of drilling
B22	ρ_{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
B23	g_{coal}	gas content of coal	m^3 CH_4/t coal	m	at start of each crediting period	sample	Electronic & Paper	Crediting period + 2 yrs	
B24	n	number of days the selected well is operational	days	m			Electronic & Paper	Crediting period + 2 yrs	
B25	V_a	Average flow per day	m^3	c		100%	Electronic & Paper	Crediting period + 2 yrs	

ID number	Symbol	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
B26	V_{tc}	Cumulative flow from all wells	m^3	m		100%	Electronic & Paper	Crediting period + 2 yrs	Total flow from all boreholes measured at collection manifold using automatic remote monitoring of gas flow, methane concentration, pressure and temperature
B27	N	sum of days all wells operational	days	c			Electronic & Paper	Crediting period + 2 yrs	
B28		Position of wells relative to mining plan	coordi-nates	m	annually	100%	Electronic & Paper	Crediting period + 2 yrs	Recorded in PDD ex-ante. New drawing produced each year.
B29		Well profile	coordi-nates	m	annually	100%	Electronic & Paper	Crediting period + 2 yrs	Shows each well and zone of influence against latest mining plan
B30		Well depth	m	m	at time of drilling	100%	Electronic & Paper	Crediting period + 2 yrs	Based on actual drilling records
B31	V_w	Annual flow at well	m^3	m	continuous	100%	Electronic & Paper	Crediting period + 2 yrs	Monitoring at each well should record gas flow, methane concentration, pressure, and temperature

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		Electronic & Paper	Crediting period + 2 yrs	From geology report and drilling records
B33	ES_t	total eligible share of CBM	%						
B34	ES_h	eligible share of CBM based on the horizontal plane overlap	%						
B35	ES_v	eligible share of CBM based on the vertical plane overlap	%						
B36	AO_w	Area of overlap with longwall panel	m^2	e			Electronic & Paper	Crediting period + 2 yrs	Only relevant for type 2 wells.
B37	AT_w	Total zone of influence	m^2	c			Electronic & Paper	Crediting period + 2 yrs	Only relevant for type 2 wells.
B38	w	wells classified as Type 2 wells							

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

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	GEN_y	Electricity generation by project	MWh	m	continuous	100%	electronic	Crediting period + 2 yrs	
B40	$HEAT_y$	Heat generation by project	GJ	m	continuous	100%	electronic	Crediting period + 2 yrs	
B41	$VFUEL_y$	Vehicle power supplied by project	GJ	m	continuous	100%	electronic	Crediting period + 2 yrs	
B42	EF_{ELEC}	CO_2 emission factor of the grid	tCO_2 /MWh	c	annually	100%	electronic	Crediting period + 2 yrs	Calculated as per ACM0002
B43	$EF_{OM,y}$	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
B44	$EF_{BM,y}$	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
B45	$F_{i,j,y}$	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
B46	$COEF_{i,k}$	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..
B47	$GEN_{j,y}$	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..
B48	$EF_{CO2,i}$	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
B49	$Eff_{captive}$	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
B50	Eff_{heat}	Energy efficiency of heat plant	%	m	annually	100%	electronic	Crediting period + 2 yrs	
B51	Eff_V	Efficiency of vehicle engine	%	m, e	annually	100%	electronic	Crediting period + 2 yrs	

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

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

where:

$BE_{Use,y}$	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)