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 not 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:
- CO₂ emissions from the combustion of methane in a flare, engine, power plant or heat generation plant;
- CO₂ emissions from the combustion of non methane hydrocarbons (NMHCs), if they represent more than 1% by volume of the extracted coal mine gas;
- CO₂ 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:
- CH₄ emissions as a result of venting and drainage;
- CO₂ emissions from the destruction of methane in the baseline scenario;
- CO₂ 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”).

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

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1 Please refer to: <http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>.
<table>
<thead>
<tr>
<th>Source</th>
<th>Gas</th>
<th>Justification / Explanation</th>
</tr>
</thead>
</table>
| Emissions of methane as a result of venting / drainage               | CH₄  | • 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 coal mines 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                 | CO₂  | • Considers any flaring or use for heat and power in the baseline scenario.  
                   |      | CH₄ Excluded • Excluded for simplification. This is conservative.  
                   |      | N₂O Excluded • Excluded for simplification. This is conservative. |
| Grid electricity generation (electricity provided to the grid)       | CO₂  | • Only CO₂ 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.  
                   |      | CH₄ Excluded • Excluded for simplification. This is conservative.  
                   |      | N₂O Excluded • Excluded for simplification. This is conservative. |
| Captive electricity generation                                       | CO₂  | • Only in case where captive power plant already exists or is planned.  
                   |      | • Only CO₂ 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) |
                   |      | CH₄ Excluded • Excluded for simplification. This is conservative.  
                   |      | N₂O Excluded • Excluded for simplification. This is conservative. |
| Heat generation (including use as vehicle fuel)                      | CO₂  | • Only the CO₂ 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.  
                   |      | CH₄ Excluded • Excluded for simplification. This is conservative.  
                   |      | N₂O Excluded • Excluded for simplification. This is conservative. |
### Project activity

<table>
<thead>
<tr>
<th>Source</th>
<th>Gas</th>
<th>Justification / Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions of methane as a result of continued venting</td>
<td>CH₄</td>
<td>Excluded • Only the change in CMM emissions release will be taken into account, by monitoring the methane used or destroyed by the project activity.</td>
</tr>
<tr>
<td>On-site fuel consumption due to the project activity, including transport of the gas</td>
<td>CO₂</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>CH₄</td>
<td>Excluded • Excluded for simplification. This emission source is assumed to be very small.</td>
</tr>
<tr>
<td></td>
<td>N₂O</td>
<td>Excluded • Excluded for simplification. This emission source is assumed to be very small.</td>
</tr>
<tr>
<td>Emissions from methane destruction</td>
<td>CO₂</td>
<td>Included • From the combustion of methane in a flare, or heat/power generation.</td>
</tr>
<tr>
<td>Emissions from NMHC destruction</td>
<td>CO₂</td>
<td>Included • From the combustion of NMHC in a flare, or heat/power generation, if NMHC accounts for more than 1% of coal mine gas.</td>
</tr>
<tr>
<td>Fugitive emissions of unburned methane</td>
<td>CH₄</td>
<td>Included • Small amounts of methane will remain unburned in flares or heat/power generation.</td>
</tr>
<tr>
<td>Fugitive methane emissions from on-site equipment</td>
<td>CH₄</td>
<td>Excluded • Excluded for simplification. This emission source is assumed to be very small.</td>
</tr>
<tr>
<td>Fugitive methane emissions from gas supply pipeline or in relation to use in vehicles</td>
<td>CH₄</td>
<td>Included • Based on standard default factors for pipeline leakage rates.</td>
</tr>
<tr>
<td>Accidental methane release</td>
<td>CH₄</td>
<td>Excluded • Excluded for simplification. This emission source is assumed to be very small.</td>
</tr>
</tbody>
</table>

### 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:

1. Venting;
2. Using/destroying ventilation air methane rather than venting it;
3. Flaring of CBM/CMM;
4. Use for additional grid power generation;
5. Use for additional captive power generation;
6. Use for additional heat generation;
7. Feed into gas pipeline (to be used as fuel for vehicles or heat/power generation);
8. 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 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).

\(^2\) 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 Board4.

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

\[ PE_y = PE_{ME} + PE_{MD} + PE_{UM} \]  

where:

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

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 should be included as project emissions.

   \[ PE_{ME} = CONS_{ELEC,PJ} \times CEFELEC + CONS_{HEAT,PJ} \times CEFHEAT \times CONS_{Foss,Fuel,PJ} \times CEF_{Foss,Fuel} \]  

   where:

   - \( PE_{ME} \) Project emissions from energy use to capture and use methane (tCO\textsubscript{2}e)
   - \( CONS_{ELEC,PJ} \) Additional electricity consumption for capture and use of methane, if any (MWh)
   - \( CEFELEC \) Carbon emissions factor of electricity used by coal mine (tCO\textsubscript{2}e/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 (tCO₂e/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.

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

where:

\[ PE_{MD} \] – Project emissions from CMM/CBM destroyed (tCO₂e)
\[ MD_{FL} \] – Methane destroyed through flaring (tCH₄)
\[ MD_{ELEC} \] – Methane destroyed through power generation (tCH₄)
\[ MD_{HEAT} \] – Methane destroyed through heat generation (tCH₄)
\[ MD_{GAS} \] – Methane destroyed after being supplied to gas grid or for vehicle use (tCH₄)
\[ CEF_{CH4} \] – 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)
\[ r \] – 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.

\[ MD_{FL} = MM_{FL} \times Eff_{FL} \] (4)

where:

\[ MD_{FL} \] – Methane destroyed through flaring (tCH₄)
\[ MM_{FL} \] – Methane measured sent to flare (tCH₄)
\[ Eff_{FL} \] – Efficiency of flare (taken as 98% for conservativeness)

\[ MD_{ELEC} = MM_{ELEC} \times Eff_{ELEC} \] (5)

where:

\[ MD_{ELEC} \] – Methane destroyed through power generation (tCH₄)
\[ MM_{ELEC} \] – Methane measured used for power generation (tCH₄)
\[ Eff_{ELEC} \] – Efficiency of power generation (taken as 85% for conservativeness)

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} = \text{Methane destroyed through power generation (tCH}_4\text{)}

MM_{ELEC} = \text{Methane measured sent to power plant (tCH}_4\text{)}

Eff_{ELEC} = \text{Efficiency of methane destruction/oxidation in power plant (taken as 99.5% from IPCC)}

MD_{HEAT} = MM_{HEAT} \times Eff_{HEAT} \tag{6}

where:

MD_{HEAT} = \text{Methane destroyed through heat generation (tCH}_4\text{)}

MM_{HEAT} = \text{Methane measured sent to heat plant (tCH}_4\text{)}

Eff_{HEAT} = \text{Efficiency of methane destruction/oxidation in heat plant (taken as 99.5% from IPCC)}

MD_{GAS} = MM_{GAS} \times Eff_{GAS} \tag{7}

where:

MD_{GAS} = \text{Methane destroyed after being supplied to gas grid (tCH}_4\text{)}

MM_{GAS} = \text{Methane measured supplied to gas grid for vehicle use or heat/power generation off-site (tCH}_4\text{)}

Eff_{GAS} = \text{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.

\[ PE_{UM} = GWP_{CH_4} \times \sum_i MM_i \times (1 - Eff_i) \] \tag{8}

where:

PE_{UM} = \text{Project emissions from un-combusted methane (tCO}_2\text{e)}

GWP_{CH_4} = \text{Global warming potential of methane (21 tCO}_2\text{e/tCH}_4\text{)}

i = \text{Use of methane (flaring, power generation, heat generation, supply to gas grid to various combustion end uses)}

MM_i = \text{Methane measured sent to use } i \text{ (tCH}_4\text{)}

Eff_i = \text{Efficiency of methane destruction in use } i \text{ (%)}

^6The 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:

\[ BE_y = BE_{MD,y} + BE_{MR,y} + BE_{Use,y} \]  \hspace{1cm} (9)

- \( BE_y \): Baseline emissions in year \( y \) (tCO\(_2\)e)
- \( BE_{MD,y} \): Baseline emissions from destruction of methane in the baseline scenario in year \( y \) (tCO\(_2\)e)
- \( BE_{MR,y} \): Baseline emissions from release of methane into the atmosphere in year \( y \) that is avoided by the project activity (tCO\(_2\)e)
- \( BE_{Use,y} \): Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year \( y \) (tCO\(_2\)e)

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.

\[ BE_{MD,y} = \sum (TH_b + \sigma) \times (CEF_{CH4} + r \times CEF_{NMHC}) \]  \hspace{1cm} (10)

where:
- \( BE_{MD,y} \): Baseline emissions from destruction of methane due to thermal demand in the baseline scenario in year \( y \) (tCO\(_2\)e)
- \( TH_b \): Mean daily baseline CMM demand for thermal energy uses in the baseline (tCH\(_4\))
- \( \sigma \): Standard deviation of daily baseline CMM demand for thermal energy uses (tCH\(_4\))
- \( CEF_{CH4} \): Carbon emission factor for methane (2.75 tCO\(_2\)e/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

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:

\[ TH_b = (TH_y / 365) \times d_i \]  \hspace{1cm} (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 (\( \Sigma d_i = 365 \))

The source of data for mean annual baseline thermal energy demand should be provided on an \textit{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\text{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, $\sigma$, 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 $\sigma$ 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 $\sigma$ 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.

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

\[ + [CBM_{BL,y} + CMM_{BL,y} + PMM_{BL,y} - BE_{MD,y}] \times CEF_{CH4} \]  \hspace{1cm} (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 $y$ (t$CH_4$)
- $PMM_{BL,y}$: 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 $tCO_2e$/t$CH_4$)
- $CEF_{CH4}$: Carbon emission factor for combusted methane (2.75 $tCO2e$/t$CH4$)
- $BE_{MD,y}$: 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.

<table>
<thead>
<tr>
<th>Well Type</th>
<th>Name Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CBM to Goaf Well</td>
<td>These are wells that intersect the area to be mined and so will be completely drilled through during mining.</td>
</tr>
<tr>
<td>2</td>
<td>Indirect CBM to Goaf well drilled with a zone of influence</td>
<td>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.</td>
</tr>
</tbody>
</table>

*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:

$$R = \left(\frac{V_c}{\pi \times T \times \rho_{\text{coal}} \times g_{\text{coal}}}\right)^{0.5}$$  \hspace{1cm} (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)
- $\rho_{\text{coal}}$ Density of locally mined coal (t/m$^3$) – default value 1.4 t/m$^3$
- $g_{\text{coal}}$ Gas content of the coal (m$^3$ CH$_4$/tonne coal)
(ii) using cumulative flow from a number of wells

\[ R = \left( \frac{n \times V_a}{\pi \times T \times \rho_{\text{coal}} \times g_{\text{coal}}} \right)^{0.5} \]  

(14)

where:

- \( R \): Cumulative radius of zone of influence (m)
- \( n \): Number of days the selected well is operational
- \( V_a \): Average flow per day (m\(^3\)/d)
- \( T \): Total thickness of coal in section accessed by well (m)
- \( \rho_{\text{coal}} \): Density of locally mined coal – default value 1.4 t/m\(^3\)
- \( g_{\text{coal}} \): Gas content of the coal (tCH\(_4\)/tonne coal)

and

\[ V_a = \frac{V_{tc}}{N} \]  

(15)

where:

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

As an example, taking the density of coal as 1.4 tonne per m\(^3\), the gas in coal to be 12 m\(^3\) per tonne, the thickness of the section to be 40 metres and the flow rate to be 2400 m\(^3\)/day, then the radius of zone of influence will increase by 20 m per year. 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.

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

\[ ES_h = \frac{\sum_{w} AO_w}{\sum_{w} AT_w} \]  

(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:

$$ES_v = \frac{t}{T}$$  \hspace{1cm} (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)
- $T$: 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:

$$ES_t = ES_h \times ES_v$$  \hspace{1cm} (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\textsubscript{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\textsubscript{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:

\[
CBM_{i,y} = ESI \times \sum_{w=0}^{y-b} \sum_{i=0}^{w,y} V_{w,y-i}
\]

where:

- \( CBM_{i,y} \): Eligible CBM captured by the project for year \( y \) (tCH₄)
- \( ESI \): total eligible share of CBM (%)
- \( V_{w,y,i} \): Volume of methane captured from well \( w \) in year \( y-i \) (tCH₄)
- \( w \): 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 \( CBM_{i,y} \). 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 \( CMM_{P,i,y} \) and \( PMM_{P,i,y} \) 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**

\[
BE_{Use,y} = GEN_{y} \times EF_{ELEC} + HEAT_{y} \times EF_{HEAT} + VFUEL_{y} \times EF_{V}
\]

\( BE_{Use,y} \): Baseline emissions from the production of power or heat replaced by the project activity in year \( y \) (tCO₂e)

\( GEN_{y} \): Electricity generated by project activity in year \( y \) (MWh), including through the use of CBM
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:

\[
EF_{captive,y} = \frac{EF_{CO2,i} \cdot 44}{Eff_{captive} \cdot 12} \times \frac{3.6TJ}{1000MWh}
\]

where:

- \( EF_{captive,y} \): Emissions factor for captive power generation (tCO2/MWh)
- \( EF_{CO2,i} \): CO2 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.

\[
EF_{ELEC,y} = s_{grid} \cdot EF_{grid,y} + s_{captive} \cdot EF_{captive,y}
\]

- \( EF_y \): CO2 baseline emission factor for the electricity displaced due to the project activity during the year \( y \) (tCO2/MWh).
- \( EF_{grid,y} \): CO2 baseline emission factor for the grid electricity displaced due to the project activity during the year \( y \) (tCO2/MWh).
- \( EF_{captive,y} \): CO2 baseline emission factor for the captive electricity displaced due to the project activity during the year \( y \) (tCO2/MWh).
- \( s_{grid} \): Share of facility electricity demand supplied by grid imports over the last 3 years (%)

\(^7\) 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.
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:

\[
EF_{\text{heat},y} = \frac{EF_{\text{CO2},i}}{Eff_{\text{heat}}} \times \frac{44}{12} \times \frac{1\text{TJ}}{1000\text{GJ}} \tag{23}
\]

where:
- \(EF_{\text{heat},y}\) Emissions factor for heat generation (tCO₂/GJ)
- \(EF_{\text{CO2},i}\) CO₂ emissions factor of fuel used in heat generation (tC/TJ)
- \(Eff_{\text{heat}}\) 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:

\[
EF_{V} = \frac{EF_{\text{CO2},i}}{Eff_{V}} \times \frac{44}{12} \times \frac{1\text{TJ}}{1000\text{GJ}} \tag{24}
\]

where:
- \(EF_{V}\) Emissions factor for vehicle operation replaced by project activity (tCO₂/GJ)
- \(EF_{\text{CO2},i}\) CO₂ 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

\[
LE_y = LE_{d,y} + LE_{o,y}
\]  

(25)

where:

- \(LE_y\) Leakage emissions in year \(y\) (tCO\(_2\)e)
- \(LE_{d,y}\) Leakage emissions due to displacement of other baseline thermal energy uses of methane in year \(y\) (tCO\(_2\)e)
- \(LE_{o,y}\) Leakage emissions due to other uncertainties in year \(y\) (tCO\(_2\)e)

**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:

\[
ME_{\text{total}} - (MM_{\text{FL}} + MM_{\text{ELEC}} + MM_{\text{GAS}} + MM_{\text{HEAT}}) < TH_b
\]  

(26)

where:

- \(ME_{\text{total}}\) Total methane extracted (tCH\(_4\))
- \(MM_{\text{ELEC}}\) Methane measured sent to power plant (tCH\(_4\))
- \(MM_{\text{HEAT}}\) Methane measured sent to heat plant (tCH\(_4\))
- \(MM_{\text{GAS}}\) Methane measured supplied to gas grid for vehicle use or heat/power generation off-site (tCH\(_4\))
- \(MM_{\text{FL}}\) 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:

\[
ED_{th} = (MM_{\text{ELEC}} + CMM_{\text{bl,th}} - ME_{\text{total}}) \times NCV_{\text{CH}_4}
\]  

(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 (tCH₄)
\[ CMM_{bl,th} \] Coal mine methane used for thermal energy in the baseline (tCH₄)
\[ NCV_{CH4} \] Net calorific value for methane (GJ/tCH₄)

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.

\[ Q_{AF} = \frac{ED_{th}}{NCV_{AF}} \]  \hspace{1cm} (28)

where:

\[ Q_{AF} \] Quantity of alternative fuels displaced by the project activity (tonnes or m³)
\[ ED_{th} \] Quantity of thermal energy displaced by the project activity (GJ)
\[ NCV_{AF} \] Net calorific value for alternative fuels (GJ/tonne or m³)

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

\[ LE_{d,y} = Q_{AF} \times NCV_{AF} \times EF_{AF} \times OXID \]  \hspace{1cm} (29)

where:

\[ LE_{d,y} \] Leakage emissions in year y (tCO₂e)
\[ Q_{AF} \] Quantity of alternative fuels displaced by the project activity (tonnes or m³)
\[ NCV_{AF} \] Net calorific value for alternative fuels (GJ/tonne or m³)
\[ EF_{AF} \] Emissions factor for alternative fuel (tCO₂/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.

\[ LE_{o,y} = (BE_{y} - PE_{y}) \times 0.1 \]  \hspace{1cm} (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:

$$ER_y = BE_y - PE_y - LE_y$$  \hspace{1cm} (31)$$

where:

$ER_y$ emissions reductions of the project activity during the year $y$ (tCO$_2$e)
$BE_y$ baseline emissions during the year $y$ (tCO$_2$e)
$PE_y$ project emissions during the year $y$ (tCO$_2$e)
$LE_y$ leakage emissions in year $y$ (tCO$_2$e)

Note that, because emissions reductions from CBM are only credited when the seam is mined through, there could be cases where CBM drainage commenced before the start of the crediting period.
Draft consolidated monitoring methodology ACM00XX

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

Sources

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

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

For more information regarding the proposals and their consideration by the Executive Board please refer to [http://cdm.unfccc.int/methodologies/approved](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

<table>
<thead>
<tr>
<th>ID no.</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m), calculated (c) or estimated (e)</th>
<th>Recording frequency</th>
<th>Proportion of data to be monitored</th>
<th>How will the data be archived? (electronic/paper)</th>
<th>For how long is archived data to be kept?</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>PE_y</td>
<td>Project emissions in year y</td>
<td>tCO₂e</td>
<td>c</td>
<td>monthly</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>PE_ME</td>
<td>Project emissions from energy use to capture and use methane</td>
<td>tCO₂e</td>
<td>c</td>
<td>monthly</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>PE_MD</td>
<td>Project emissions from methane destroyed</td>
<td>tCO₂e</td>
<td>c</td>
<td>monthly</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td>PE_UM</td>
<td>Project emissions from un-combusted methane</td>
<td>tCO₂e</td>
<td>c</td>
<td>monthly</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
</tbody>
</table>

Project emissions are defined by the following equation

\[ PE_y = PE_{ME} + PE_{MD} + PE_{UM} \]  

(1)
## 2. Combustion emissions from additional energy required for CBM/CMM capture and use

<table>
<thead>
<tr>
<th>ID no.</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m), calculated (c) or estimated (e)</th>
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<th>Comment</th>
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<tbody>
<tr>
<td>P5</td>
<td>CONS_ELEC,PJ</td>
<td>Additional electricity consumption by project</td>
<td>MWh</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Credit period + 2 yrs</td>
<td>If any</td>
</tr>
<tr>
<td>P6</td>
<td>CONS_HEAT,PJ</td>
<td>Additional heat consumption by project</td>
<td>GJ</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Credit period + 2 yrs</td>
<td>If any</td>
</tr>
<tr>
<td>P7</td>
<td>CONS_FF,PJ</td>
<td>Additional fossil fuel consumption by project</td>
<td>GJ</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Credit period + 2 yrs</td>
<td>If any</td>
</tr>
<tr>
<td>P8</td>
<td>CEF_ELEC,PJ</td>
<td>Carbon emission factor of CONS_ELEC,PJ</td>
<td>t- CO_2/GJ</td>
<td>m, c or e</td>
<td>ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Credit period + 2 yrs</td>
<td>Use of IPCC default or national values would suffice</td>
</tr>
<tr>
<td>P9</td>
<td>CEF_HEAT,PJ</td>
<td>Carbon emission factor of CONS_HEAT,PJ</td>
<td>t- CO_2/GJ</td>
<td>m, c or e</td>
<td>ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Credit period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>P10</td>
<td>CEF_FF,PJ</td>
<td>Carbon emission factor of CONS_FF,PJ</td>
<td>t- CO_2/GJ</td>
<td>m, c or e</td>
<td>ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Credit period + 2 yrs</td>
<td></td>
</tr>
</tbody>
</table>

Project emissions from energy use to capture and use methane (PE\_ME) is obtained by the equation

$$PE_{ME} = CONS_{ELEC,PJ} \times CEF_{ELEC} + CONS_{HEAT,PJ} \times CEF_{HEAT} \times CONS_{Fossil Fuel,PJ} \times CEF_{FF}$$
### 3. Combustion emissions from use of captured methane

<table>
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<tr>
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<th>Symbol</th>
<th>Data variable</th>
<th>Measured (m), calculated (c) or estimated (e)</th>
<th>Recording frequency</th>
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<th>For how long is archived data to be kept?</th>
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<tr>
<td>P11</td>
<td>MD&lt;sub&gt;FL&lt;/sub&gt;</td>
<td>Methane destroyed by flare</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>calculated</td>
<td>monthly</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
</tr>
<tr>
<td>P12</td>
<td>MM&lt;sub&gt;FL&lt;/sub&gt;</td>
<td>Methane sent to flare</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
</tr>
<tr>
<td>P13</td>
<td>Eff&lt;sub&gt;FL&lt;/sub&gt;</td>
<td>Efficiency of flare</td>
<td>-</td>
<td>e</td>
<td>ex ante</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>P14</td>
<td>MD&lt;sub&gt;ELEC&lt;/sub&gt;</td>
<td>Methane destroyed by power generation</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>calculated</td>
<td>monthly</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
</tr>
<tr>
<td>P15</td>
<td>MM&lt;sub&gt;ELEC&lt;/sub&gt;</td>
<td>Methane sent to power plant</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
</tr>
<tr>
<td>P16</td>
<td>Eff&lt;sub&gt;ELEC&lt;/sub&gt;</td>
<td>Efficiency of methane destruction/oxidation in power plant</td>
<td>-</td>
<td>e</td>
<td>ex ante</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P17</td>
<td>MD&lt;sub&gt;HEAT&lt;/sub&gt;</td>
<td>Methane destroyed by heat generation</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>calculated</td>
<td>monthly</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
</tr>
<tr>
<td>P18</td>
<td>MM&lt;sub&gt;HEAT&lt;/sub&gt;</td>
<td>Methane sent to boiler</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
</tr>
<tr>
<td>ID no.</td>
<td>Symbol</td>
<td>Data variable</td>
<td>Data unit</td>
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</tr>
<tr>
<td>P19</td>
<td>Eff\textsubscript{HEAT}</td>
<td>Efficiency of methane destruction/oxidation in heat plant</td>
<td>-</td>
<td>e</td>
<td>ex ante</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P20</td>
<td>MD\textsubscript{GAS}</td>
<td>Methane destroyed by gas grid end-users</td>
<td>tCH\textsubscript{4}</td>
<td>c</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>P21</td>
<td>MM\textsubscript{GAS}</td>
<td>Methane sent to gas grid for end users</td>
<td>tCH\textsubscript{4}</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
</tr>
<tr>
<td>P22</td>
<td>Eff\textsubscript{GAS}</td>
<td>Overall efficiency of methane destruction / oxidation through gas grid</td>
<td>-</td>
<td>e</td>
<td>ex ante</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P23</td>
<td>CEF\textsubscript{CH4}</td>
<td>Carbon emission factor for combusted methane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P24</td>
<td>CEF\textsubscript{NMHC}</td>
<td>Carbon emission factor for combusted non methane hydrocarbons (various)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P25</td>
<td>r</td>
<td>Relative proportion of NMHC compared to methane</td>
<td>%</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
</tbody>
</table>
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:

- **PE$_{MD}$**: Project emissions from CMM/CBM destroyed (tCO$_2$e)
- **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$_2$e/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

<table>
<thead>
<tr>
<th>ID no.</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m), calculated (c) or estimated (e)</th>
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<th>Comment</th>
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</thead>
<tbody>
<tr>
<td>P26</td>
<td>GWP$_{CH_4}$</td>
<td>Global warming potential of methane</td>
<td>-</td>
<td>e</td>
<td>ex ante</td>
<td></td>
<td></td>
<td></td>
<td>set at 21</td>
</tr>
<tr>
<td>P27</td>
<td>MM$_i$</td>
<td>Methane measured sent to use i</td>
<td>tCH$_4$</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Flow meters will record gas volumes, pressure and temperature</td>
</tr>
<tr>
<td>P28</td>
<td>Eff$_i$</td>
<td>Efficiency of methane destruction / oxidation through use i</td>
<td>-</td>
<td>m, c, or e</td>
<td>ex ante or ex post</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Project-by-project basis</td>
</tr>
</tbody>
</table>

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

$$PE_{UM} = GWP_{CH_4} \times MM_i \times \Sigma (1 - EFF_i)$$
2. Baseline emissions

1. Overall

<table>
<thead>
<tr>
<th>ID no.</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m)</th>
<th>calculated (c)</th>
<th>estimated (e)</th>
<th>Recording frequency</th>
<th>Proportion of data monitored</th>
<th>How will data be archived? (electronic/paper)</th>
<th>For how long is archived data kept?</th>
<th>Comment</th>
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</thead>
<tbody>
<tr>
<td>B1</td>
<td>BE_y</td>
<td>Baseline emissions in year y</td>
<td>tCO_2</td>
<td>m</td>
<td>continuous</td>
<td></td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>BE_MD_y</td>
<td>Baseline emissions from destruction of methane in the baseline scenario in year y</td>
<td>tCO_2</td>
<td>c</td>
<td>yearly</td>
<td></td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>BE_MR_y</td>
<td>Baseline emissions from release of methane into the atmosphere in year y that is avoided by the project activity</td>
<td>tCO_2</td>
<td>c</td>
<td>yearly</td>
<td></td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>BE_Use_y</td>
<td>Baseline emissions from the production of power, heat or supply to gas grid replaced by the project activity in year y</td>
<td>tCO_2</td>
<td>c</td>
<td>yearly</td>
<td></td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>ID no.</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m) calculated (c) estimated (e)</th>
<th>Recording frequency</th>
<th>Proportion of data monitored</th>
<th>How will data be archived? (electronic/paper)</th>
<th>For how long is archived data kept?</th>
<th>Comment</th>
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<tbody>
<tr>
<td>B5</td>
<td>THₜₜ</td>
<td>Mean daily baseline CMM demand for thermal energy uses in the baseline</td>
<td>tCH₄</td>
<td>c</td>
<td>daily</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2yrs</td>
<td>As per NM0066</td>
</tr>
<tr>
<td>B6</td>
<td>σ</td>
<td>Standard deviation of daily baseline CMM demand for thermal energy uses</td>
<td>-</td>
<td>c</td>
<td>annual</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2yrs</td>
<td>As per NM0066</td>
</tr>
<tr>
<td>B7</td>
<td>CEFₜₜₐₜ₄</td>
<td>Carbon emission factor for methane</td>
<td>-</td>
<td>e</td>
<td></td>
<td></td>
<td></td>
<td>2.75 tCO₂e/tCH₄</td>
<td></td>
</tr>
<tr>
<td>B9</td>
<td>THₜᵧ</td>
<td>Mean baseline CMM demand for year y (tCH₄)</td>
<td>tCH₄</td>
<td>c</td>
<td>daily</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2yrs</td>
<td>As per NM0066</td>
</tr>
<tr>
<td>B10</td>
<td>dᵢ</td>
<td>Scalar adjustment factor for day I, based on the seasonal load shape (Σ dᵢ = 365)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>As per NM0066</td>
<td></td>
</tr>
</tbody>
</table>

Methane destruction due to thermal demand in the baseline (BEₑₑₜₜₜₜ), is obtained by the equation:

\[
BEₑₑₜₜₜₜ,ᵧ = \Sigma (THₜₜ + σ) \times (CEFₜₜₐₜ₄ + CEFₜₜₜₜₐₜ₄)
\]

where:

- \( BEₑₑₜₜₜₜ,ᵧ \) Baseline emissions from destruction of methane in the baseline scenario in year \( y \) (tCO₂e)
- \( THₜₜ \) Mean daily baseline CMM demand for thermal energy uses in (tCH₄)
- \( σ \) Standard deviation of daily baseline CMM demand for thermal energy uses (tCH₄)
- \( CEFₜₜₐₜ₄ \) Carbon emission factor for methane (2.75 tCO₂e/tCH₄)
3. Baseline emissions from methane released into the atmosphere

i. Overall

<table>
<thead>
<tr>
<th>ID number</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m) calculated (c) estimated (e)</th>
<th>Recording frequency</th>
<th>Proportion of data monitored</th>
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<th>Comment</th>
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</thead>
<tbody>
<tr>
<td>B11</td>
<td>CBM&lt;sub&gt;e,y&lt;/sub&gt;</td>
<td>Eligible CBM captured and destroyed by the project for year y</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B12</td>
<td>CBM&lt;sub&gt;BL,y&lt;/sub&gt;</td>
<td>CBM that would have been captured and destroyed in the baseline scenario</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>c,e</td>
<td>ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B13</td>
<td>CMM&lt;sub&gt;PJ,y&lt;/sub&gt;</td>
<td>Pre-mining CMM captured and destroyed by the project activity in year y</td>
<td>tCH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>ID number</td>
<td>Symbol</td>
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<tr>
<td>B14</td>
<td>CMM_{BL,y}</td>
<td>Pre-mining CMM that would have been captured and destroyed in the baseline scenario in year y</td>
<td>tCH₄</td>
<td>c,e</td>
<td>ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
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<tr>
<td>B15</td>
<td>PMM_{PJ,y}</td>
<td>post-mining CMM captured and destroyed by the project activity in year y</td>
<td>tCH₄</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B16</td>
<td>PMM_{BL,y}</td>
<td>post-mining CMM that would have been captured and destroyed in the baseline scenario in year y</td>
<td>tCH₄</td>
<td>c,e</td>
<td>ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B17</td>
<td>GWP_{CH₄}</td>
<td>Global warming potential of methane</td>
<td></td>
<td></td>
<td></td>
<td>21 tCO₂e/tCH₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID number</td>
<td>Symbol</td>
<td>Data variable</td>
<td>Data unit</td>
<td>Measured (m) calculated (c) estimated (e)</td>
<td>Recording frequency</td>
<td>Proportion of data monitored</td>
<td>How will data be archived? (electronic/paper)</td>
<td>For how long is archived data kept?</td>
<td>Comment</td>
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</tr>
<tr>
<td>B18</td>
<td>CEF&lt;sub&gt;CH4&lt;/sub&gt;</td>
<td>Carbon emission factor for combusted methane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>44/16 = 2.75 tCO2e/tCH&lt;sub&gt;4&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

The baseline emissions from release of methane into the atmosphere in the year y (BE<sub>MR,y</sub>) is obtained by the following equation:

\[
BE_{MR,y} = [(CB_{M,y} - CB_{BL,y}) + (CMM_{P1,y} - CMM_{BL,y}) + (PMM_{P1,y} - PMM_{BL,y})] \times GWP_{CH4} \\
+ [CB_{BL,y} + CMM_{BL,y} + PMM_{BL,y} - BE_{MD,y}] \times CEF_{CH4}
\]
### ii. Estimation of eligible CBM

<table>
<thead>
<tr>
<th>ID number</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m) calculated (c) estimated (e)</th>
<th>Recording frequency</th>
<th>Proportion of data monitored</th>
<th>How will data be archived? (electronic/paper)</th>
<th>For how long is archived data kept?</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>B19</td>
<td>R</td>
<td>Cumulative radius of zone of influence</td>
<td>m</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B20</td>
<td>Vc</td>
<td>Cumulative flow at well</td>
<td>m³</td>
<td>c</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B21</td>
<td>T</td>
<td>Thickness of all coal accessed by wells</td>
<td>m coal</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Depth of fractures into respective seams and casing used should be recorded at time of drilling</td>
</tr>
<tr>
<td>B22</td>
<td>ρcoal</td>
<td>density of locally mined coal</td>
<td>t/m³</td>
<td>m</td>
<td>at start of each crediting period</td>
<td>sample</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>default value is 1.4</td>
</tr>
<tr>
<td>B23</td>
<td>gcoal</td>
<td>gas content of coal</td>
<td>m³</td>
<td>CH₄/t coal</td>
<td>at start of each crediting period</td>
<td>sample</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B24</td>
<td>n</td>
<td>number of days the selected well is operational</td>
<td>days</td>
<td>m</td>
<td></td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B25</td>
<td>Va</td>
<td>Average flow per day</td>
<td>m³</td>
<td>c</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td></td>
<td></td>
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<tr>
<td>ID number</td>
<td>Symbol</td>
<td>Data variable</td>
<td>Data unit</td>
<td>Measured (m) calculated (c) estimated (e)</td>
<td>Recording frequency</td>
<td>Proportion of data monitored</td>
<td>How will data be archived? (electronic/paper)</td>
<td>For how long is archived data kept?</td>
<td>Comment</td>
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<td>----------------</td>
</tr>
<tr>
<td>B26</td>
<td>V_w</td>
<td>Cumulative flow from all wells</td>
<td>m³</td>
<td>m</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Total flow from all boreholes measured at collection manifold using automatic remote monitoring of gas flow, methane concentration, pressure and temperature</td>
<td></td>
</tr>
<tr>
<td>B27</td>
<td>N</td>
<td>sum of days all wells operational</td>
<td>days</td>
<td>c</td>
<td></td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Recorded in PDD ex-ante. New drawing produced each year.</td>
<td></td>
</tr>
<tr>
<td>B28</td>
<td></td>
<td>Position of wells relative to mining plan</td>
<td>coordinates</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Shows each well and zone of influence against latest mining plan</td>
</tr>
<tr>
<td>B29</td>
<td></td>
<td>Well profile</td>
<td>coordinates</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Shows each well and zone of influence against latest mining plan</td>
</tr>
<tr>
<td>B30</td>
<td></td>
<td>Well depth</td>
<td>m</td>
<td>m</td>
<td>at time of drilling</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Based on actual drilling records</td>
</tr>
<tr>
<td>B31</td>
<td>V_w</td>
<td>Annual flow at well</td>
<td>m³</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Monitoring at each well should record gas flow, methane concentration, pressure, and temperature</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>ID number</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data variable</th>
<th>Measured (m)</th>
<th>Calculated (c)</th>
<th>Estimated (e)</th>
<th>Recording frequency</th>
<th>Proportion of data monitored</th>
<th>How will data be archived? (electronic/paper)</th>
<th>For how long is archived data kept?</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>B32</td>
<td>t</td>
<td>Total thickness of coal in longwall emission zone</td>
<td>m, m</td>
<td>at start of each crediting period</td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>From geology report and drilling records</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B33</td>
<td>ES\textsubscript{t}</td>
<td>total eligible share of CBM</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B34</td>
<td>ES\textsubscript{h}</td>
<td>eligible share of CBM based on the horizontal plane overlap</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B35</td>
<td>ES\textsubscript{v}</td>
<td>eligible share of CBM based on the vertical plane overlap</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>B36</td>
<td>AO\textsubscript{w}</td>
<td>Area of overlap with longwall panel</td>
<td>m\textsuperscript{2}, e</td>
<td></td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Only relevant for type 2 wells.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>B37</td>
<td>AT\textsubscript{w}</td>
<td>Total zone of influence</td>
<td>m\textsuperscript{2}, e</td>
<td></td>
<td>Electronic &amp; Paper</td>
<td>Crediting period + 2 yrs</td>
<td>Only relevant for type 2 wells.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>B38</td>
<td>w</td>
<td>wells classified as Type 2 wells</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</table>
### 4. Baseline emissions from power/heat generation and vehicle replaced by project

<table>
<thead>
<tr>
<th>ID no.</th>
<th>Symbol</th>
<th>Data variable</th>
<th>Data unit</th>
<th>Measured (m) calculated (c) estimated (e)</th>
<th>Recording frequency</th>
<th>Proportion of data monitored</th>
<th>How will data be archived? (electronic/paper)</th>
<th>For how long is archived data kept?</th>
<th>Comment</th>
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</thead>
<tbody>
<tr>
<td>B39</td>
<td>GEN&lt;sub&gt;y&lt;/sub&gt;</td>
<td>Electricity generation by project</td>
<td>MWh</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B40</td>
<td>HEAT&lt;sub&gt;y&lt;/sub&gt;</td>
<td>Heat generation by project</td>
<td>GJ</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B41</td>
<td>VFUEL&lt;sub&gt;y&lt;/sub&gt;</td>
<td>Vehicle power supplied by project</td>
<td>GJ</td>
<td>m</td>
<td>continuous</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B42</td>
<td>EF&lt;sub&gt;ELEC&lt;/sub&gt;</td>
<td>CO₂ emission factor of the grid</td>
<td>tCO₂ /MWh</td>
<td>c</td>
<td>annually</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Calculated as per ACM0002</td>
</tr>
<tr>
<td>B43</td>
<td>EF&lt;sub&gt;OM,y&lt;/sub&gt;</td>
<td>CO₂ Operating Margin emission factor of the grid</td>
<td>tCO₂ /MWh</td>
<td>c</td>
<td>annually or ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Calculated as per ACM0002</td>
</tr>
<tr>
<td>B44</td>
<td>EF&lt;sub&gt;BM,y&lt;/sub&gt;</td>
<td>CO₂ Build Margin emission factor of the grid</td>
<td>tCO₂ /MWh</td>
<td>c</td>
<td>annually or ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Calculated as per ACM0002</td>
</tr>
<tr>
<td>B45</td>
<td>F&lt;sub&gt;i,j,y&lt;/sub&gt;</td>
<td>Amount of each fossil fuel consumed by each power source / plant</td>
<td>t or m&lt;sub&gt;j&lt;/sub&gt;/yr</td>
<td>m</td>
<td>annually or ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Obtained from the power producers, dispatch centers or latest local statistics,</td>
</tr>
<tr>
<td>ID no.</td>
<td>Symbol</td>
<td>Data variable</td>
<td>Data unit</td>
<td>Measured (m), calculated (c), estimated (e)</td>
<td>Recording frequency</td>
<td>Proportion of data monitored</td>
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<tr>
<td>B46</td>
<td>COEF&lt;sub&gt;ijk&lt;/sub&gt;</td>
<td>CO&lt;sub&gt;2&lt;/sub&gt; emission coefficient of each fuel type and each power source/plant</td>
<td>tCO&lt;sub&gt;2&lt;/sub&gt;/ m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Plant or country-specific values to calculate COEF are preferred to IPCC default values, in case of obtaining EFOM ex post..</td>
</tr>
<tr>
<td>B47</td>
<td>GEN&lt;sub&gt;ijy&lt;/sub&gt;</td>
<td>Electricity generation of each power source/plant</td>
<td>MWh/yr</td>
<td>m</td>
<td>annually or ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Obtained from the power producers, dispatch centers or latest local statistics..</td>
</tr>
<tr>
<td>B48</td>
<td>EF&lt;sub&gt;CO2,i&lt;/sub&gt;</td>
<td>CO&lt;sub&gt;2&lt;/sub&gt; emission factor of fuel used for captive power or heat</td>
<td>tC/TJ</td>
<td>e</td>
<td>annually or ex ante</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>National sources or IPCC defaults</td>
</tr>
<tr>
<td>B49</td>
<td>Eff&lt;sub&gt;captive&lt;/sub&gt;</td>
<td>Energy efficiency of captive power plant</td>
<td>%</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td>Depending on option chosen in baseline, measured before or after project implementation</td>
</tr>
<tr>
<td>B50</td>
<td>Eff&lt;sub&gt;heat&lt;/sub&gt;</td>
<td>Energy efficiency of heat plant</td>
<td>%</td>
<td>m</td>
<td>annually</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
<td></td>
</tr>
<tr>
<td>B51</td>
<td>Eff&lt;sub&gt;v&lt;/sub&gt;</td>
<td>Efficiency of vehicle engine</td>
<td>%</td>
<td>m, e</td>
<td>annually</td>
<td>100%</td>
<td>electronic</td>
<td>Crediting period + 2 yrs</td>
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</table>
Emissions from power/heat generation and vehicle fuel replaced by project ($BE_{use,y}$) can be obtained by:

$$BE_{use,y} = GEN_y \times EF_{ELEC} + HEAT_y \times EF_{HEAT} + VFUEL_y \times EF_V$$  \hspace{1cm} (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 ($tCO_2/GJ$)