**CLEAN DEVELOPMENT MECHANISM**
**PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)**
**As per Version 01 - in effect as of: 1 July 2004**

**CONTENTS**

## SECTION A. Identification of methodology

### A.1. Proposed methodology title:

Avoiding flaring of waste gases from steel manufacturing operations and its utilization for substituting GHG intensive fuel in power generating units and/ or generating power to supply to grid~~generating thermal power to substitute GHG intensive fuel and supply to gridthereby substituting fuel and supplying to grid~~.

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

✓ The project activity is applicable to 'Category 9, metal production', as per sectoral scope. In the absence of an appropriate project category definition, a new project category may be considered titled *"Process waste gas recovery and combustion for electricity generation ~~in grid connected power plants~~"*.

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

The conditions under which this project activity would be applicable include the following:

- the methodology is applicable to steel production plants (existing, newly constructed or both) using basic oxygen furnace (BOF) route where part of the waste gases in the facility is normally[1] used (or would have been used) for internal heating requirements, and the remaining waste gases were being (would have been) flared;
- project activity does not induce diversion of waste gases required for internal usage;
- proposed project activity does not result in integrated process change, except for possible associated changes due to use of waste gases for electricity generationrs;
- there are neither local regulations~~/ programmes~~ to constrain use of GHG intensive fuels (like coal) nor restrict flaring of waste gases~~any regulation making use of waste gases mandatory~~;
- waste gas is supplied to partially replace existing/ planned fuel use in existing/ new power plant or a new power plant facility solely based on use of waste gas or a combination of all the above; and
- there are only two possible alternatives: continued flaring of excess waste gases over and above the internal consumption, or its use for power generation~~; and~~
- ~~project activity results in supply of electricity to local grids that do not have surplus power, unless cost of generation and supply makes exports to other grids attractive~~.

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

**Potential Strengths**

1. The methodology takes into account the availability of data in public/ semi-public domain.
2. The methodology is cost effective and conservative.
3. The methodology accounts for use of waste heat for other associated purposes (e.g., internal heating requirements) and such a scenario is common~~and is required for effective use of waste gases~~.

[1] A project activity considered for CDM applicability must identify and define areas where waste gases are and will be used for meeting internal requirements as standard practice in the steel industry following similar BOF route.

**Potential Weakness**

1. Potential for bias in decision making process pertaining to inclusion/ exclusion of units in the Operating Margin Method.
2. Conservativeness of the methodology shall have to be assessed on a grid-to-grid basis.
3. Representative character of the build margin component in the baseline is uncertain since future developments need not always follow the historical trend based on policy decisions at government level, and the Build Margin for do not capture such uncertainties.
4. Leakage emissions due to use of any GHG intensive fuels that are displaced by the project activity, cannot be calculated, as proof of direct attribution in many cases is difficult.
5. This NMB cannot calculate operating margin in situations where annual dispatch data for operating plants connected to an electricity grid to which the project is connected is not available.
6. There could be lack of adequate data for similar waste gas generating projects[2].

## SECTION B. Overall summary description:

Energy contained in waste gases in a steel manufacturing industry is utilized to generate electricity, thereby avoiding need for flaring the waste gases, replacing more GHG intensive fuel in the thermal power plants connected to an electricity grid. The utilization of heat content in waste gases has been considered to be a credible solution of reducing emissions of GHG (primarily $CO_2$). The proposed methodology establishes the additionality of ~~environmental and sustainable credibility of the~~ CDM project activities that utilize energy content (calorific value) of excess waste gases to generate electricity and determines the baseline emissions and emission reductions.

There are multiple waste gas~~es~~ generating sources in steel manufacturing units~~industry that is~~ based on the COREX or ROMELT or Blast Furnace processes using the BOF route. In such processes, neither the generation of waste gases from any particular source is steady nor the generation, is consistent and in uninterrupted quantity.

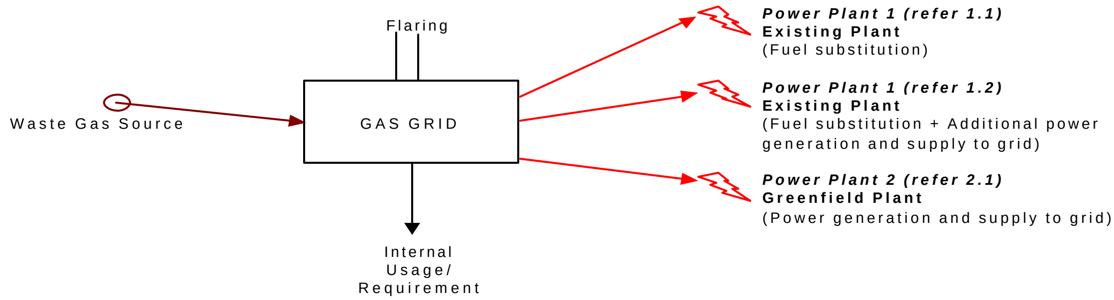
The project activity envisaged ~~in this new baseline~~ is establishment and operation of a gas grid to enable collection of waste gases and enable uninterrupted supply of the excess waste gases to the electricity generators who could use the same for the purpose indicated below:

| Electricity Generation Plant | Use of Waste Gases |
|---|---|
| 1. Existing power plant | 1.1 Partial substitution[3] of existing fuel.<br><br>1.2 Partial substitution of existing fuel + Supply of additional measure of electricity to grid using a fuel mix of existing fuel and waste gases. |
| 2. Greenfield power plant | 2.1 Power generation and supply to grid using waste gases as one of the fuels. |

[2] e.g., there are only three COREX process based steel manufacturing units in the world, in whose activities the proposed new methodology could be applied.

[3] Continued ~~S~~supply of same quantum~~existing measure~~ of electricity to grid using a fuel mix of present~~existing~~ fuel and waste gases.

The gas grid considered under this methodology has the flexibility to collect waste gases from multiple sources to supply to two types of power plants connected to the gas grid. A schematic of the type of gas grid considered is shown below.




Based on the selected gas grid, the proposed CDM project activity involves adding necessary equipment and accessories for collection, cleaning *(if required)* and transportation of waste gases to power plant(s) at steady rate for combustion to generate electricity, and all associated modifications in the existing gas handling system to make the project activity happen.

## SECTION C. Choice of and justification as to why one of the baseline approaches listed in paragraph 48 of CDM modalities and procedures is considered to be the most appropriate:

### C.1. General baseline approach:

- **Existing actual or historical emissions, as applicable;**

- Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

- The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

### C.2. Justification of why the approach chosen in C.1 above is considered the most appropriate:

The existing trend of utilization of waste gases for internal use and flaring would have continued in the absence of the project activity.

In the absence of the project activity, the ~~The baseline scenario considers that~~ electricity would have been otherwise generated by (i) use of existing GHG intensive fuels in the existing power plant(s) and/ or (ii) the operation of other grid-connected power plants and by addition of new power generating sources. Hence, the~~This~~ chosen baseline methodology is in line with the approach marked (highlighted) above under **section C.1**, foreseen in the Marrakesh Agreement: "**Existing actual or historical emissions, as applicable**".

~~The approach, is adopted becauseare based on the following:~~

- ~~in the absence of the project activity, the current fuel mix will be continued in the existing power plants; and~~

- ~~the project activity may impact modification trends in the applicable electricity generation in the applicable gridmatrix (i.e., generating unit for fuel substitution and for additional power generation) in~~ the local electric sector, and the impact that the project's activities may cause to this trend.

## SECTION D. Explanation and justification of the proposed new baseline methodology:

### D.1. Explanation of how the methodology determines the baseline scenario (that is, indicate the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity):

In the absence of the project activity, excess[4] waste gases from steel manufacturing operations[5] will not be dispatched to power plant(s) for generation of electricity and supply to the grid, resulting in the following incidences/ occurrences that are assessed further:

1. flaring of excess waste gases leading to $CO_2$ emissions;
2. use of ~~more~~ GHG intensive fuels for generation of same quantum or additional electricity at the existing power plants ~~leading to emission of GHG~~; and
3. establish new power plants to meet any shortfall of supply in the connected grid~~, with possibility of further GHG emission~~.

The above three incidences could occur without any barriers, whether regulatory, or financial, and represent common or prevailing practice(s). Hence, they represent the baseline scenario, i.e., flaring of the excess waste gases and power generation using GHG intensive fuels in existing or new power plants.

~~The baseline methodology uses existing actual and historical (as available) emission data, of existing power plant(s) due to use of more GHG intensive fuels and those of other suppliers of power to the grid. The baseline methodology can be used for the following two baseline scenarios:~~

Scenario I: project activity results in partial substitution of existing GHG intensive fuel in an existing ~~power plant with waste gases to supply equal measure of electricity which would otherwise have been generated using the GHG intensive fuel; the baseline scenario is therefore 'continued use of the GHG intensive fuel' in the existing power plant; and~~

~~Scenario II: use of waste gases to generate additional[6] power in existing power plant and/ or generate power in new power plant(s) connected to the gas grid; the baseline scenario in this case is 'electricity would have otherwise been generated by the operation of grid-connected power~~ plants and by addition of new generation sources'; the project activity would thus impact at ~~the margin, the supply of additional electricity to the grid by existing operating and build power plants.~~

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[4] After utilizing a portion of total waste gases for meeting the internal heating requirements.

[5] Existing, new or both.

~~[6] Additional power means 'power in excess of what is currently generated using a GHG intensive fuel'.~~

**D.2. Criteria used in developing the proposed baseline methodology:**

~~The baseline methodology is developed on the basis of substitution of higher GHG intensive fuel(s) and combined margins (in operating and build situations) for existing actual and historical emissions.~~

In developing the proposed methodology, option 48(a) of modalities and procedures for a clean development mechanism has been chosen, that details applicability of '**existing actual and historical emissions, as applicable'** for CDM projects.

**D.3. Explanation of how, through the methodology, it can be demonstrated that a project activity is additional and therefore not the baseline scenario (section B.3 of the CDM-PDD):**

A project activity will be additional[7] if anthropogenic emissions of GHGs by its sources are reduced below those that would have occurred in the absence of the registered CDM project activity.

Within the scope of the proposed methodology, additionality needs to be demonstrated through the following six steps, that have been organized using guidance from the CDM Meth Panel recommended guidelines, viz., **"Annex 1: Tool for demonstration and assessment of additionality"**[8].

**Step 0: Preliminary screening based on the starting date of the project activity**

In case the project participant wishes to consider the start date of the crediting period prior to the registration of their project activity, the following evidence need to be provided for verification by the DOE appointed for validation of such project activity:

a) the starting date of the project activity falls between 1 January 2000 and the date of registration of a first CDM project activity, bearing in mind that only CDM project activities submitted for registration before 31 December 2005 may claim for a crediting period starting before the date of registration; and
b) the incentive from the CDM was seriously considered in the decision to proceed with the project activity; this evidence shall be based on (preferably official, legal and/ or other corporate) documentation that was available to third parties at, at prior to, the start of the project activity.

If the project participant can demonstrate the above, then the additionality demonstration may proceed to step 1; else the project activity is not additional for projects where start date of project activity is considered prior to registration.

However, if a project participant does not wish to consider having the crediting period started prior to registration of the project activity, the above demonstration will not be necessary, and the additionality demonstration may proceed to step 1.

**Step 1: Identification of alternatives to the project activity consistent with current laws and regulations**

A set of alternatives to the project activity (refer section D.1) need to be identified, including the project activity, that are consistent with existing national laws and regulations.

[7] As per 17/cp.7.

[8] EB 16 Report

If a project activity has been developed based on legally binding local or national laws and regulations that make "*the project activity equal to what would have happened otherwise*", then such project activity would not be additional.

The list of local or national laws and regulations should not include any national policies that cannot be implemented through legally binding mechanisms.

If it is concluded that the implementation of the project activity is based on binding legal obligations then the project activity is not additional; else the project activity could be additional, and this demonstration may proceed to step 2 or step 3.

**Step 2: Investment Analysis**

A cost comparison between having the project activity (using waste gases for electricity generation) and not having it (flaring waste gases) should be provided. A demonstration should be made to show that investments made on the project activity may not be justifiable in the context of actual returns (or expected) from the supply of waste gas for power generation. In case, the actual returns are attractive, then the project activity is not additional; else it could be additional, and this demonstration may proceed to step 3 or to step 4.

**Step 3: Barrier Analysis**

A demonstration needs to be presented justifying that the project activity crosses any of the following three barriers in sub-steps 3 (a, b or c) to proceed to further additionality checks under step 4. If the project activity cannot cross at least one of these barriers, then it is not additional. It has to be also shown that the barrier(s) that could prevent implementation of the project activity are either non-existent or would not prevent implementation of an alternative (refer section D.1) to the project activity.

*Part (3a): Financial or economic barriers.*

The project activity needs to demonstrate that the investments on it are not attractive in relation to prevalent benchmark practices in the sector or corporate body. Non-attractiveness could be due to barriers such as non-availability of debt funding due to use of any non-reliable or uncommon technology, or perceived risks by the lenders/ investors to the project activity.

*Part (3b): Technological barriers.*

The project activity needs to demonstrate that the technology/ process adopted in the project activity has/ have uncertainties and these have to be overcome by pilot runs/ experiments or by other means.

*Part (3c): Barriers due to prevailing practice.*

There could barriers in the context of a project activity in that in the sector or region or country of its implementation, there is little willingness or familiarity for implementation of similar project activity by steel manufacturers' using the BOF route.

If the project activity crosses any one or more of the above three barriers, and there is transparent documentary evidence[9] on the same, the project activity could be additional and this demonstration may proceed to step 4. If such is not the case, the project activity is not additional, unless it is already crossed step 2.

[9] That can be verified during a DOE during validation of a project activity.

**Step 4:** **Common Practice Analysis**

The credibility of a project activity as 'additional' needs to be demonstrated to show that under comparable environmental and socio-economic situation and circumstances, no similar project activities have been implemented without a CDM incentive(s).

In case, similar project activities have been and/ or are being implemented under comparable environmental and socio-economic situation without a CDM incentive, a project activity can still be uncommon if there are major changes in its circumstances of implementation that have given rise to new or additional barriers to investment and/ or implementation, that the CDM revenues could eliminate or alleviate. Such change in circumstances should constitute any fundamental and verifiable paradigm shift, making the project activity 'not a common practice'.

If the above analysis indicates that the project activity is 'not a common practice', then it could be 'additional' and this demonstration could proceed to step 5; else the project activity is not additional.

**Step 5: Impact of CDM Registration**

The benefits due to the registration of the project activity and realization of the associated CDM revenue could induce one or more of the following:

- ✓ reduce GHG emissions to the atmosphere;
- ✓ encourage other similar steel industries to undertake GHG avoiding/ reduction project activities;
- ✓ encourage development of national/ regional/ sectoral policies for use of waste gases in steel industries to generate electricity;
- ✓ provide reliability and credibility in the technology used for power generation from waste gases; and
- ✓ provide confidence to investors.

If at least one of the above impacts is not foreseen, the project activity is not additional.

**D.4. How national and/or sectoral policies and circumstances can been taken into account by the methodology:**

~~The methodology considers that at the time of start of project activity, the national and sectoral policies may not support the use of waste gases for electricity generation. However, the project activity where this methodology would be applied may demonstrate that circumstances such as power deficit and/or fuel deficit and/or sustainable development needs could encourage development of national and/or sectoral policies that would support electricity generation utilizing waste gases. However, if current national and/or sectoral policies require utilization of waste gases for power generation, the baseline provided under this methodology is not applicable.~~

The methodology is applicable to national and/ or sectoral policies and circumstances wherein:

- ✓ utilization of excess (after internal use) waste gases to generate power is not mandatory and flaring is permitted;

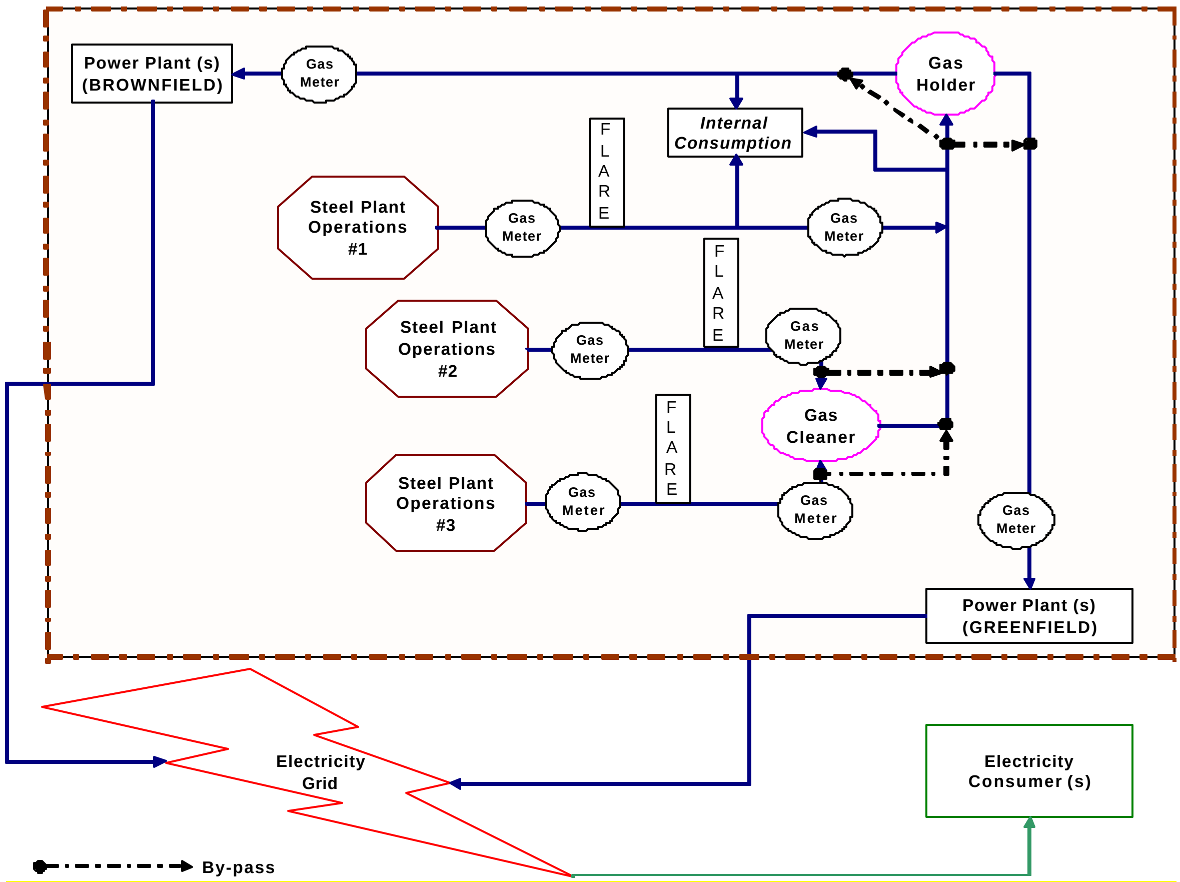
- ✓ utilization of such waste gases for power generation is permitted; and

- ✓ the power grid system exists and operates.

## D.5. Project boundary (gases and sources included, physical delineation):

The physical project boundary begins from the generation of waste gases and its internal use in the steel manufacturing operations and flaring, and collection and transportation of the excess gases to the power plant(s) through a gas handling network/ grid including all associated equipment for the project activity that are under control of the project proponent(s). The associated equipment may include, amongst other equipment, gas-holder(s) for gas pressure and flow stabilisation, and gas cleaner(s); the use of one or more of such associated equipment is optional in the project activity. Any emissions due to generation of

**Schematic of Project Boundary**




electricity using waste gases only are also included within the project boundary. The physical delineations within the project boundary are shown below.

The GHG emissions within the project boundary include $CO_2$ only.

The sources of such emissions are:

- combustion of waste gases in power plants connected to the gas grid, and
- combustion of GHG intensive fuels in these power plants, and for any internal heating requirements in the steel industry unit operations.

**D.6. Elaborate and justify formulae/algorithms used to determine the baseline scenario. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):**

The baseline comprises of the following two components:

(1) identification of areas in a steel industry where the waste gases are normally used for internal heating requirements, and establishing normal usage quantity in such areas (actual monitoring of such quantity will be checked in the NMM); and

(2) estimating quantum of excess waste gases that a project activity will obtain, from associated up-stream steel manufacturing operations, for generating electricity.

While determining the quantity of waste gases required for meeting the internal heating requirements, as in point number (1), the practices followed prior to start of the project activity should be used as benchmark for estimating internal requirements at existing steel operations; for new or proposed steel operations, design values or common practice, whichever is lower, should be used.

Based on point number (2) above, the baseline methodology calculates the baseline emission factors. It uses existing actual and historical (as available) emission data of existing power plant(s) that consumes more GHG intensive fuels and those of other suppliers of power to the grid, to calculate the baseline emissions. The baseline methodology can be used for the following two baseline scenarios:

Scenario I: project activity results in partial substitution of existing GHG intensive fuel in an existing power plant with waste gases to supply equal measure of electricity which would otherwise have been generated using the GHG intensive fuel; the baseline scenario is therefore 'continued use of the GHG intensive fuel' in the existing power plant; and

Scenario II: use of waste gases to generate additional[10] power in existing power plant and/ or generate power in new power plant(s) connected to the gas grid; the baseline scenario in this case is 'electricity would have otherwise been generated by the operation of grid-connected power plants and by addition of new generation sources'; the project activity would thus impact at the margin, the supply of additional electricity to the grid by existing operating and build power plants.

The baseline emission would comprise of either individual baseline scenarios (i.e., Scenario I or Scenario II) or a combination, based on the use of the available excess waste gases in a specific project situation. Thus, the proposed methodology comprises two baseline components (Baseline I and Baseline II) for determining the baseline emissions, which would be applied as per appropriate baseline scenario(s). For example, the application of the two baseline components could occur to the situations such as mentioned below:

1. only Baseline I will be applicable for use of waste gases in an existing power plant that would result in partial substitution of existing use of GHGs;

2. only Baseline II will be applicable in case of power generation in a new power plant solely using waste gases; and

[10] Additional power means 'power in excess of what is currently generated using a GHG intensive fuel'.

3. both Baseline I and II will be applicable if there is substitution of existing use of a GHG intensive fuel and generation of additional power supplied to the connected grid.

**Baseline I: Choice of replacement fuel and determination of GHG intensity of existing power plant**

The choice of the waste gases as replacement fuel is not automatic but on the basis of research and partial substitution of existing GHG intensive fuel with waste gases from one area of existing steel manufacturing process operations, and planning of logistics for its uninterrupted availability for power generation. Based on such research and partial substitution of the existing fuel with waste gases, it would have been established that the latent heat content of waste gases is significant enough to allow its use as a viable alternative fuel. It could be also understood and established that minimal logistics would be required for storing and transportation of these gases from another neighbouring waste gas generating source within the same steel manufacturing industry, thus allowing uninterrupted supply of the waste gases to the power generating stations.

A mix of fuels, comprising GHG fuels (including those used for auxiliary needs such as start-up operations) and waste gases from already existing plant, determines the carbon intensity in choice of fuel, for which available historical data on fuel quantity used (at least 3 years or total operation period, which ever is less) need to be analysed. The methodology describes ways of determining GHG intensity of power generation in the power plant, based on available emission factors for existing fuels as per Intergovernmental Panel for Climate Change (IPCC - current version). The emission factors are reported in terms of $tCO_{2equ}$/GWh.

**Baseline II: Determination of GHG intensity of the grid[11]**

The mix of power plants supplying electricity to the grid determines its GHG intensity. A combined margin (CM) methodology incorporating elements of operating margin (OM) and build margin (BM) has been suggested in this case for determining the carbon intensity of the selected grid.

**Operating Margin:** The operating margin of the applicable baseline grid will comprise a mix of 'worst performing' power plants. An weighted average emission factor (in $tCO_{2equ}$/GWh) of such plants have been calculated to capture the effect of the project activity on a dynamic basis due to the operation of power plants connected to the grid system to which the project activity is (would be) connected. The calculation of operating margin thus involves an analysis of actual dispatch data, thereby bringing more realistic approach to estimate actual annual emission rate in the operating margin component of the baseline. Hence, the methodology suggests sorting the operating power plants on least[12] merit order basis based on actual annual dispatch data, to identify the set of plants in the operating margin with lowest performance measure covering 10% of the total grid generation.

**Build Margin:** The weighted average emission (in $tCO_{2equ}$/GWh) of recent capacity additions to the system, defined as the greater of the power additions from the top of most recent 20% of the plants built or the five most recent plants, is proposed as the BM.

[11] Applicable to power generation by use of waste gases, either as additional power in existing power plant and/ or in new power plant(s) connected to the gas grid. This baseline scenario (Baseline II), thus, accounts for electricity generation by the operation existing of grid-connected power plants and by addition of new generation sources to the grid, thereby impacting the operating and build margins.

[12] Since the worst performing power plants would be affected in a preferential power dispatch sequence to the connected grid.

~~In the event that there is an energy deficit in the local grid forcing the grid to purchase power from other grids/ states with surplus power, the power availability scenario in the local grid may be improved at a higher cost.~~

~~The project activity, may impact the total power dispatched from the build power plants serving the grid and also to some extent new or proposed capacity additions to the grid. In light of these facts, the project can impact the nature and timing of new facilities that may be proposed. Hence, "Build Margin Methodology" also has relevance for assessing impact of the project activity.~~

The BM effect shall pertain to projects commissioned immediately preceding the project activity and those following it. The BM so developed would be a current margin using a "cohort" of most recent 5 projects and 20% of the most recent projects from all projects added to the system in the last 5 years.

**Combined Margin** has been considered to the most suitable representation of the baseline scenario, as per discussions provided above, particularly if the low-cost/ must-run resources are in excess of 50% of the total grid generation.

As explained earlier under *D.1*, based on any specific project scenario, either Baseline I or Baseline II or combination of both the baselines will be applicable to estimate the baseline emission $\mathbf{BE_y}$ (in $tCO_{2equ}$) during any year 'y'.

In a situation where a power generator receives excess waste gases from more than one steel manufacturing unit operation, the contribution of scenarios I and II components to the 'baseline estimation' by each of such waste gas source will be calculated based on the contribution to normal electricity generation by individual waste gas sources in terms of total annual heat supplied by excess waste gases from such sources.

The formulae/ algorithm used for determining the emissions in the baseline scenarios *(i.e., Baseline I and Baseline II)* are elaborated below.

**Baseline I Emissions: Replacing GHG intensive fuel with waste gases**

The baseline emission will depend on quantities of waste gases combusted at the power plant(s) as substitution of GHG intensive fuel. The methodology for calculation of baseline emissions for fuel substitution scenario will be as per the following algorithm.

$$\textit{Baseline I} = S\ (BL\_IPCC_p) \quad \ldots\ldots (1)$$

where, $BL\_IPCC_p$ is calculated as follows:

$$BL\_IPCC_p = (F_{x,p,y} * COEF_x) \quad \ldots\ldots (1.1)$$

$$COEF_x = NCV_x * CEF_x * OXID_x * (44/12) \quad \ldots\ldots (1.2)$$

where:

| | |
|---|---|
| BL_IPCC$_p$ | $CO_2$ emission at power plant 'p' using GHG intensive fuel 'x' as per IPCC guidelines[13] (in $tCO_2$), and calculated as per equations 1.1 and 1.2 above |
| $F_{x,p,y}$ | Amount of existing GHG intensive fuel 'x' (in tonnes) consumed by power plant 'p' |
| COEF$_x$ | $CO_2$ emission co-efficient (in $tCO_2$/ tonnes of fuel) for existing GHG intensive fuel 'x', based on its net calorific value, emission factor and oxidation factor |
| CEF$_x$ | Carbon Emission Factor (in tonnes of C / TJ) for existing GHG intensive fuel 'x', *as per Table 1-2 of IPCC guidelines (refer footnote 13)* |
| NCV$_x$ | Net Calorific Value (in TJ/$10^3$ tonnes) for existing GHG intensive fuel 'x', *as per Table 1-3 of IPCC guidelines (refer footnote 13) and Table 2.4 of IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* |
| OXID$_x$ | Oxidation Factor for existing GHG intensive fuel 'x', i.e., fraction of carbon oxidised during combustion for power generation, *as per Table 1-4 of IPCC guidelines (refer footnote 13)* |
| Baseline I | Total $CO_2$ emission (in $tCO_{2equ}$) due to combustion of fuel 'x during any year 'y' in all power plants connected to the relevant gas grid where waste gases substitute the existing fuel, in the preceding year to start of the project activity. |

**Baseline II Emissions: Replace/ avoid/ delay equivalent amount of electricity supplied to the grid**

~~**'Average Operation Margin' calculations**~~

**'Least Merit Order' Operating Margin calculations (based on performance ratio)**

The OM emission factor **(**$EF_{OM,y}$**)** is calculated as per the following procedure. The OM emission factor will be dynamic, i.e., can change annually for every crediting year.

All the generating units contributing to the selected grid will be identified and data on their installed capacities, actual annual generation/ delivery to the grid and representative plant load factors (PLF) (average for previous 3 years prior to the project activity) will be obtained from published available data sources. Utilizing these data, the performance ratio of each plant will be calculated by applying following formula:

*Performance Ratio (PR) = (Actual Generation - AG) / (Installed Capacity – IC * PLF)……(2.1)*

The PRs for all plants in the operating margin are analyzed to select the worst performers[14] (low performance ratio) who contributed about 10% of the total power generated in the grid in the operating year. The total power contributed by these plants will be $S\ GEN_j$ (in GWh).

To calculate $CO_2$ emission factor[15] from each of these power plants, their annual power dispatch ($GEN_j$) is multiplied by the individual emission factor(s). The summation of $CO_2$ contributed by all plants provides

[13] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook (Volume 2) – Energy.

[14] Ranked in order (0 – 1, including fractional values).

[15] Plant emission factors used for the calculation of operating and build margin emission factors should be obtained in the following priority, as per availability of data:

1. *acquired directly* from the dispatch center or power producers, if available; or
2. *calculated,* if data on fuel type, fuel emission factor, fuel input and power output can be obtained for each plant; if confidential data available from relevant host party authority are used, the calculation carried out by the

the total $CO_2$ contributed by all the plants in the operating margin given as following, from which the operating margin is calculated.

$EF_{OM,y} = S\ (F_{i,j} * COEF_i) / S\ GEN_j$ ………………………………………………(2.2)

and

$COEF_i = NCV_i * CEF_i * OXID_i * (44/12)$ …………………………………………………(2.3)

where,

| | |
|---|---|
| $EF_{OM,y}$ | OM $CO_2$ emission factor per unit of energy ($tCO_2$/GWh) of 'worst performing' generating sources in the operating margin of the grid. |
| $GEN_j$ | Electricity (GWh) delivered to the grid by power plant 'j' in the operating margin. |
| $F_{i,j}$ | Amount of existing GHG intensive fuel 'i' (in tonnes) consumed by power plant 'j' |
| $COEF_i$ | $CO_2$ emission co-efficient (in $tCO_2$/ tonnes of fuel) for existing GHG intensive fuel 'i', based on its net calorific value, emission factor and oxidation factor |
| $CEF_i$ | Carbon Emission Factor (in tonnes of C / TJ) for existing GHG intensive fuel 'i', as per Table 1-2 of IPCC guidelines *(refer footnote 13)* |
| $NCV_i$ | Net Calorific Value (in TJ/$10^3$ tonnes) for existing GHG intensive fuel 'i', as per Table 1-3 of IPCC guidelines *(refer footnote 13) and Table 2.4 of IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* |
| $OXID_i$ | Oxidation Factor for existing GHG intensive fuel 'i', i.e., fraction of carbon oxidised during combustion for power generation, as per Table 1-4 of IPCC guidelines *(refer footnote 13)*. |

**Build Margin calculations**
This is calculated as the capacity addition-weighted average emission factor ($tCO_2$/GWh) of a sample of power plants recently added to the grid, as per the following algorithm:

$EF_{BM,,y} = S\ (3.6 * GEN_{m\%} * EF_m / PLF_m)$ ……………………………………………………………(2.4)

$EF_m = CEF_m * OXID_m * (44/12)$ ……………………………………………………………………(2.5)

$GEM_{m\%} = GEN_m * 100 / S\ GEN_m$ ………………………………………………………………(2.6)

where,

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project participants shall be verified by the DOE and the CDM-PDD may only show the resultant carbon emission factor and the corresponding list of plants; and

3. *calculated*, as above, but using estimates such as,

- default IPCC values from the *IPCC 1996 Revised Guidelines* and the *IPCC Good Practice Guidance*;
- technology provider's name plate power plant efficiency or the anticipated energy efficiency documented in official sources (instead of calculating it from fuel consumption and power output); this will be conservative estimate than actual operating values; and
- conservative estimates of power plant efficiencies, based on expert judgements on the basis of the plant's technology, size anad commissioning date.

| | |
|---|---|
| $EF_{BM,y}$ | Average BM $CO_2$ emission factor per unit of energy ($tCO_2$/GWh) for sample group of recent power plants added to the grid. The sample group consists either of the two groups, based on whichever group comprises the larger annual power generation:<br>• five power plants that have been built most recently [including plants under construction], or<br>• power plants capacity additions in the electricity system that comprise 20% of the system generation (in *GWh*) and that have been built most recently [including plants under construction]. |
| $GEN_m$ | Installed capacity (MW) addition to the grid by each project/ fuel type [16] 'm' added to the grid. |
| $\Sigma\ GEN_m$ | Total installed capacity (MW) addition to the grid by all project/ fuel types added to the grid. |
| $GEM_{m\%}$ | Share (in %) of installed capacity addition by each project/ fuel type 'm' added to the grid. |
| $PLF_m$ | Typical plant load factors (in %) or electricity generation efficiency for each project/ fuel type 'm' as per local country based publicly available data. |
| $EF_m$ | $CO_2$ emission factor (in $tCO_2$/ TJ of fuel) for fuel type 'm', based on carbon emission factor and oxidation factor *(as per IPCC – refer footnote 13)* |
| $CEF_m$ | Carbon Emission Factor (in tonnes of C / TJ) for fuel type 'm', as per Table 1-2 of IPCC guidelines *(refer footnote 13)* |
| $OXID_m$ | Oxidation Factor for fuel type 'm', i.e., fraction of carbon oxidised during combustion for power generation, as per Table 1-4 of IPCC guidelines *(refer footnote 13)*. |

The baseline emission factor in CM ($EF\_BL_{CM,y}$) during any year y, is calculated as,

$$EF\_BL_{CM,y} = (w_{OM} * EF_{OM,y} + w_{BM} * EF_{BM,y}) / (w_{OM} + w_{BM}) \quad \ldots\ldots(2.7)$$

where, $w_{OM}$ and $w_{BM}$ are the weightages in the operating and build margins, and $w_{OM} + w_{BM} = 1$.

A straight average [17] of the OM and BM has been taken to develop the CM.

***Baseline II* (in $tCO_{2equ}$)**
***= $EF\_BL_{CM,y}$ * Annual net electricity ($NPO_y$) generated by project activity ………………(2)***

$NPO_y$ value to be considered for calculating Baseline II in equation (2) will be lower of the following:

(i) monitored value at the power plant(s); and

(ii) calculated value as per equations (3.3) and (3) below.

**Calculation of Annual Net Electricity generated by Project Activity**

The annual measure of net electricity generated at any power plant using excess waste gases will be calculated as per the following algorithm.

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[16] 'm' types could be coal, natural gas, diesel, lignite, hydro, nuclear, etc., based capacity additions to the grid.

[17] Equal weightage have been provided to OM and BM, as default, in line with approved methodology ACM0002. Alternative weights can also be used, with appropriate justification.

$MPO_{p,y} = W_{p,y} * GCV / HR_{p,y}$ ……………………………………………………………………….(3.1)

$W = S\ W_{p,y}$ …………………………………………………………………………………….(3.2)

$NPO_{p,y} = MPO_{p,y} * (1 – AUX/100)$ …………………………………………………………….(3.3)

$NPO_y = S\ NPO_{p,y}$ ………………………………………………………………………….(3)

where:

| | |
|---|---|
| $W_{p,y}$ | Annual quantity of waste gas available/ provided (in SCM) for power generation at power plant 'p' during year 'y' |
| GCV | Annual 'Gross Calorific Value[18]' for waste gas (in kCal/ SCM) |
| $HR_{p,y}$<br>$MPO_{p,y}$ | Annual 'Heat Rate' (in kCal/MWh) for power plant 'p' during year 'y'<br>Annual 'Power generated/ output by waste gases' (in GWh, after converting MWh to GWh) during year 'y' |
| W | Annual quantity of waste gas available/ provided (in SCM) for power generation at all power plants connected to the gas grid in the project activity during year 'y' |
| AUX | Percent auxiliary consumption at power plant |
| $NPO_{p,y}$<br>$NPO_y$ | Annual 'Net electricity generated by waste gases' (in GWh) at power plant 'p' during year 'y'.<br>Annual 'Net electricity generated by waste gases' (in GWh) at all power plants connected to the gas grid in the project activity during year 'y'. |

In case, there are more than one contributing sources of excess waste gases to a power generator, then the contribution of scenarios I and II components to the 'baseline estimation' relevant to each of such waste gas source would be computed using the following algorithm:

$\mathbf{BEC_1 = (W_{p1,y} * GCV_{p1}) / S\ (W_{p1,y} * GCV_{p1})}$ ………………………………………………….(4)

where:

Heat supplied by individual waste gas generator to any power plant 'p' = $(W_{p1,y} * GCV_{p1})$ …(4.1)

| | |
|---|---|
| $BEC_1$ | Contribution of scenarios I and II components to the 'baseline estimation' by waste gas source '1' contributing to power plant 'p' during any year 'y', where, there would be several such waste gas generators, 1, 2, 3,………, and annual quantity of waste gas available at power generator 'p' will be: $W_{p,y} = S\ W_{p1,y}$ |
| $W_{p1,y}$ | Annual quantity of waste gas available from/ provided by (in SCM) the waste gas generator '1' during year 'y', to power generator 'p' |
| $GCV_{p1}$ | Average annual 'Gross Calorific Value' for waste gas (in kCal/ SCM) provided by the waste gas generator '1', based on average values. |

In case, there is only one stream of excess waste gases to a power generator, the value of $BEC_1$ will be 1.

[18] In case multiple waste gas sources supply to a power generator, GCV will be the combined average value for all contributing sources.

**D.7. Elaborate and justify formulae/algorithms used to determine the emissions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):**

The project activity will not result in any additional emissions due to burning of excess waste gases compared to emissions that were occurring during flaring of the same quantity of waste gases in the baseline scenario. ~~results in combustion of a quantity of excess waste gases in one or more power plants (existing and/or greenfield) instead of flaring. This means that the project activity does not normally cause any additional GHG emissions from combustion of excess waste gases than those already occurring in its absence, but causes a physical relocation of the emitting point(s).~~

Hence, the project emission '**$PE_y$** (in $tCO_{2equ}$)' from combustion of excess waste gases in the power plant(s) during any year 'y' will be zero.

**D.8. Description of how the baseline methodology addresses any potential leakage of the project activity:**

- ✓ Leakages could occur[19] due to use of displacement of any GHG intensive fuel ~~d hydrocarbon fuel~~ by other power generators (e.g., other smaller power generators who currently use renewables like biomass or a larger power generator using same hydrocarbon or proposing use of it).

  If used by a smaller generator, it would require replacement and retrofitting of existing power generating equipment, which may not be feasible for such a generator.

  Leakage emissions can occur, if and only if, such displaced fuels is used by a larger generator. Any leakage emissions due to use of such displaced fuel needs to be directly attributable to the project. If such a situation is identified, then leakage emissions will be calculated as per equation (5) below.

- ✓ Potential leakages could also occur if the project participant creates a situation where the normal use of waste gases for internal requirements in the steel operations is minimised/ reduced/ avoided through use of any other substituting GHG intensive fuel(s), and the avoided waste gases due to such use of substituting GHG intensive fuel(s) are then diverted for additional electricity generation. The methodology addresses such type of leakage potential by identifying and defining areas where waste gases are required for normal internal use, and if any alternate GHG intensive fuel(s) is(are) used in these areas, the equivalent $CO_2$ emissions (**$LE_y$** in $tCO_2$) will be calculated as per algorithms below to estimate such leakages due to the project activity:

  $$LE_y = Q_{ALT,y} * NCV_{ALT} * CEF_{ALT} * OXID_{ALT} * (44/12) \quad (5)$$

  where:

| | |
|---|---|
| $Q_{ALT,y}$ | Amount of alternate GHG intensive fuel(s) used (in tonnes) for internal requirements in steel manufacturing operation, replacing normal use of waste gases |
| $CEF_{ALT}$ | Carbon Emission Factor (in tonnes of C / TJ) for alternate GHG intensive fuel(s), *as per Table 1-2 of IPCC guidelines (refer footnote 13)* |
| $NCV_{ALT}$ | Net Calorific Value (in $TJ/10^3$ tonnes) for alternate GHG intensive fuel(s), *as per* |

[19] In the form of additional emissions on account of the project activity.

| | |
|---|---|
| | *Table 1-3 of IPCC guidelines (refer footnote 13) and Table 2.4 of IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* |
| $OXID_{ALT}$ | Oxidation Factor for alternate GHG intensive fuel(s), i.e., fraction of carbon oxidised during combustion for power generation, *as per Table 1-4 of IPCC guidelines (refer footnote 13)*. |

If any alternate fuel are used, then emissions due to use of such fuels will be included under lekage emission calculations, using equation (5).

✓ Potential leakages in the form of an increase in waste gas generation *(in Nm³/ MT of steel produced)* may also occur under the following situations:

- by efficiency improvement in internal heat utilization process at historical steel production levels, and not through any other means such as using additional[20] GHG intensive raw material in steel manufacturing process *(as mentioned earlier under this section)*; or/ and

- through an increase in the scale of steel production using the BOF route, by retrofitting the existing steel operations or adding a new one to the gas grid.

The methodology does not restrict CDM benefits due to the later two situations where additional excess waste gases could be available for electricity generation.

**D.9. Elaborate and justify formulae/algorithms used to determine the emissions reductions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):**

The following emission reduction components could arise under the different baseline scenarios described in this methodology. The emission reductions will be calculated based on the use of excess waste gases as mentioned earlier under section B. Based on the usage pattern of the available excess waste gases, the total annual emission reductions would constitute one or more of the three components, as applicable to a project activity per details below.

**Component 1: Emission reduction during any year 'y' in existing power plant where only fuel substitution occurs**

$$ER_y(1) = Baseline\ I * BEC_1 - PE_y - LE_{HC,y} - LE_y \quad (6)$$

**Component 2: Emission reduction in existing power plant during any year 'y' where fuel substitution occurs alongwith additional power generation**

$$ER_y(2) = (Baseline\ I + Baseline\ II) * BEC_1 - PE_y - LE_{HC,y} - LE_y \quad (7)$$

**Component 3: Emission reduction in a greenfield power plant during any year 'y' connected to the grid or approximate emission reduction in an existing power plant where fuel**

[20] Compared to data on GHG intensive raw material *(such as coal)* for last 3 years of operation or any other smaller duration in case of recently stabilized manufacturing operations.

**substitution has not yet started (i.e., tentative emission calculations prior to start of project activity)**

***$ER_y(3)$ = Baseline II * $BEC_1$ - $PE_y$ - $LE_{HC,y}$ - $LE_y$ …………………….……………………..(8)***

In the event that the project activity results in more than one of the above components occurring, by distributing the available excess waste gases to multiple power plants during any year 'y', the total emission reductions will be summation of appropriate components as described above.

**SECTION E. Data sources and assumptions:**

**E.1. Describe parameters and or assumptions (including emission factors and activity le vels):**

- Emission factor for all power plants using GHG intensive fuels will be calculated as per the IPCC recommended values *(refer section D.6)*.
- Project will not add any additional GHG emission than added during normal flaring in the absence of the project activity, and hence the net emissions from project are zero.
- The project activity will not result in diversion of waste gases normally required for internal heating requirements to a power generator.
- This NMB calculates OM for situations where annual dis patch data for operating plants in the electricity grid to which the project activity is connected is available.
- Any additional waste gases available due to efficiency improvements in internal heat utilization process improvements in the steel plant during crediting period will be considered for accrual of CDM benefits.
- If additional waste gases are produced due to use of more of GHG intensive raw materials in steel production, such additional gas will not be considered for CDM benefits.

**E.2. List of data used indicating sources (e.g. official statistics, expert judgement, proprietary data, IPCC, commercial and scientific literature) and precise references and justify the appropriateness of the choice of such data:**

| Type of data | Source(s) |
|---|---|
| Quantity of waste gas available/ provided for power generation | Proprietary data of steel operations/ power plant(s). |
| Gross calorific value of various waste gas streams | Proprietary data of steel operations/ power plant(s). |
| Amount of existing GHG intensive fuel 'x' consumed by power plant 'p' during year 'y'<br>Carbon Emission Factors for various GHG intensive fuels | Proprietary data of power generator(s) where fuel is replaced.<br>Table 1-2 of IPCC guidelines *(refer footnote 13)*. |
| Net Calorific Value for various GHG intensive fuels | Table 1-3 of IPCC guidelines *(refer footnote 13)* and Table 2.4 of IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. |
| Oxidation Factor for various GHG intensive fuels, i.e., fraction of carbon oxidised during combustion for power generation | Table 1-4 of IPCC guidelines *(refer footnote 13)*. |
| Electricity delivered to the grid by source 'j' | National/ regional level publicly available database. |

| Type of data | Source(s) |
|---|---|
| Amount of existing GHG intensive fuel 'i' consumed by power plant 'j' | National/ regional level publicly available database. |
| Carbon Emission Factor for existing GHG intensive fuel 'i' | Table 1-2 of IPCC guidelines *(refer footnote 13).* |
| Net Calorific Value for existing GHG intensive fuel 'i' | Table 1-3 of IPCC guidelines *(refer footnote 13).* |
| Oxidation Factor for existing GHG intensive fuel 'i' | Table 1-4 of IPCC guidelines *(refer footnote 13).* |
| Quantity of GHG intensive raw material used in the steel manufacturing operations | Proprietary data of steel operations. |
| Quantity of metal produced | Proprietary data of steel operations. |
| Quantity of any GHG intensive material used for internal requirements in place of waste gases | Proprietary data of steel operations. |

**E.3. Vintage of data (e.g. relative to starting date of the project activity):**

All historical data at local level ~~data~~ *(refer section E.4)* will be 3 years old or of lesser vintage (in case of recently stabilized steel manufacturing units and/or power plants; the currency of the vintage period is from the start date of project activity). This is necessary since project related data for similar project activity is expected to be limited due to uncommon nature of the project activity. All regional level data will be of 5 years vintage, except for power generation data for operating margin power plants.

**E.4. Spatial level of data (local, regional, national):**

The data required for the application of the proposed methodology will have the following spatial levels:

| | |
|---|---|
| **Local:** | • All data from the project including waste gas generation, utilization for internal heating requirements, flaring and consumption at power plant(s), as mentioned earlier under section E.2. |
| **Regional and National:** | • As mentioned earlier under section D.6.<br>• Plants synchronized to the grid in the recent 5 years.<br>• Thermal Power (from fossil fuels) and hydropower generation for grid connected sources.<br>• Most recent 5 capacity additions synchronized to the grid.<br>• Most recent 20% of capacity additions synchronized to the grid. |
| **Global** | • IPCC default values on carbon emission factor, net calorific values and oxidation factor. |

**SECTION F. Assessment of uncertainties (sensitivity to key factors and assumptions):**

The uncertainties need to be analysed based on project specific assumptions. The types of uncertainties involved in this methodology are as follows:

| Assumption/ Key Factors | Uncertainties |
|---|---|
| The power generators having opted for using waste gases will continue to use the same as fuel during the entire crediting period | ✓ The power plants may decide not to use waste gases for power generation based on unfamiliarity with the new technology, under performance in power generation etc.<br><br>✓ One or more of the greenfield power generators could shift to more GHG intensive fuel thereby making it necessary to flare more of waste gases. |
| The steel industry in the project activity continues with same production technology over the crediting period | ✓ The steel industry may decide to improve its existing technology thereby producing more waste gases, or utilizing less waste gases for internal heating requirements. |

**SECTION G. Explanation of how the baseline methodology allows for the development of baselines in a transparent and conservative manner:**

**Transparency**

1. The data to be used for application of the methodology should be able to demonstrate reliability on the basis of availability in the public/ published sources or from the books/ logs/ registers available *(for validator and verifier)* with the project proponent/ sponsor/ participant.

**Conservatism**

1. All values of the parameter to be used for computation of emissions should be taken as maximum, minimum or 95% of special and temporal values (as applicable to specific parameters) in a way that demonstrates that the emission reduction value is conservative and not overstated/ doubly accounted (anywhere).

2. It is important that the potential impact of these uncertainties on the project baseline, be at least qualitatively (such as economic factors) understood, and an appropriate decision in the interest of conservatism be taken in application of the methodology.

3. To prevent the possibility that waste gases are not diverted from pre-project activity usages, the methodology sets limits on waste gas availability to the power plants *(refer section D.8 on potential leakages)*.

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