## Approved baseline methodology AM0015

## "Bagasse-based cogeneration connected to an electricity grid"

### Source

This methodology is based on the Vale do Rosário Bagasse Cogeneration, Brazil, whose baseline study, monitoring and verification plan and project design document were prepared by Econergy International Corporation on behalf of Vale do Rosário. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0001-rev: "Vale do Rosário Bagasse Cogeneration" on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

### Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable."

### Applicability

This methodology is applicable to bagasse-based cogeneration power plants displacing grid electricity with the following conditions:

- The bagasse to be used as the feedstock for cogeneration shall be supplied from the same facility where the project is implemented;
- Documentation is available supporting that the project activity would not be implemented by the public sector, project participants or other relevant potential developers, notwithstanding of the governmental policies/programs to promote renewables if any, in the absence of the clean development mechanism (CDM);
- The implementation of the project shall not increase the bagasse production in the facility;
- The bagasse at the project facility should not be stored for more than one year.

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0015 ("Bagasse-based cogeneration connected to an electricity grid").

### 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 CDM Executive Board, which is available on the UNFCCC CDM web site*[1].

### Project boundary

Project participants shall account for any net changes in $CO_2$ emissions from fossil fuels due to the project activity. This includes changes in fossil fuel consumption at the project site and, in the baseline, changes in $CO_2$ emissions from displaced electricity generation in fossil fuel fired power plants in the electricity grid. Project participants do not need to account potential methane emissions from the storage of bagasse or $CO_2$ emissions from transport of bagasse, as these are assumed to be very small if bagasse is stored in open piles not longer than one year and if bagasse is only used from the site of the project activity. Other emissions sources (such as methane or nitrous oxide emissions from combustion of fuels) shall not be accounted by project participants.

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

The **spatial extent** of the project boundary includes the project site and all power plants connected physically to the electricity system that the CDM project power plant is connected to.

For the purpose of determining the build margin (BM) and operating margin (OM) emission factor, as described below, a (regional) **project electricity system** is defined by the spatial extent of the power plants that can be dispatched without significant transmission constraints. Similarly, a **connected electricity system,** e.g. national or international, is defined as a (regional) electricity system that is connected by transmission lines to the project electricity system and in which power plants can be dispatched without significant transmission constraints. In determining the project electricity system, project participants should justify their assumptions.

Electricity transfers from connected electricity systems to the project electricity system are defined as **electricity imports** and electricity transfers to connected electricity systems are defined as **electricity exports**.

For the purpose of determining the Build Margin (BM) emission factor, as described below, the spatial extent is limited to the project electricity system, except where recent or likely future additions to transmission capacity enable significant increases in imported electricity. In such cases, the transmission capacity may be considered a build margin source, with the emission factor determined as for the OM imports below.

For the purpose of determining the Operating Margin (OM) emission factor, as described below, use one of the following options to determine the $CO_2$ emission factor(s) for net electricity imports ($COEF_{i,j,imports}$) from a connected electricity system within the same host country(ies):

(a) 0 $tCO_2$/MWh, or
(b) The emission factor(s) of the specific power plant(s) from which electricity is imported, if and only if the specific plants are clearly known, or
(c) The average emission rate of the exporting grid, if and only if net imports do not exceed 20% of total generation in the project electricity system, or
(d) The emission factor of the exporting grid, determined as described in steps 1,2 and 3 below, if net imports exceed 20% of the total generation in the project electricity system.

For imports from connected electricity system located in another country, the emission factor is 0 tons $CO_2$ per MWh.

Electricity exports should not be subtracted from electricity generation data used for calculating and monitoring the baseline emission rate.

**Baseline**

The baseline scenario is that the current practice continues, *i.e.*, the bagasse is not utilized to generate thermal and/or electric energy. Emission reductions may result from the displacement of thermal and/or electric energy generated with fossil fuels.

For project activities that modify or retrofit an existing electricity generation facility, the guidance provided by EB08 shall be taken into account.[2]

[2] "If a proposed CDM project activity seeks to retrofit or otherwise modify an existing facility, the baseline may refer to the characteristics (i.e. emissions) of the existing facility only to the extent that the project activity does not increase the output or lifetime of the existing facility. For any increase of output or lifetime of the facility which is due to the project activity, a different baseline shall apply." (EB08, Annex 1, http://cdm.unfccc.int/EB/Meetings/).

**Baseline emissions due to displacement of electricity**

For the displacement of electricity, the baseline scenario is that electricity would in the absence of the project activity have been generated by the operation of grid-connected power plants and by the addition of new generation sources.

**Calculation of electricity baseline emission factor**

An electricity baseline emission factor ($EF_{electricity,y}$) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (*OM*) and build margin (*BM*) factors according to the following three steps. Calculations for this combined margin must be based on data from an official source (where available)[3] and made publicly available.

**STEP 1. Calculate the Operating Margin emission factor(s) ($EF_{OM,y}$)** based on one of the four following methods:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM.

Each method is described below.

Dispatch data analysis should be the first methodological choice. Where this option is not selected project participants shall justify why and may use the simple OM, the simple adjusted OM or the average emission rate method taking into account the provisions outlined hereafter.

The Simple OM method (a) can only be used where low-cost/must run resources[4] constitute less than 50% of total grid generation in:

[3] Plant emission factors used for the calculation of operating and build margin emission factors should be obtained in the following priority:

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 the relevant host Party authority are used the calculation carried out by the 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.
3. *calculated*, as above, but using estimates such as
   - default IPCC values from the *IPCC 1996 Revised Guidelines* and the *IPCC Good Practice Guidance* for net calorific values and carbon emission factors for fuels instead of plant-specific values (note that the *IPCC Good Practice Guidance* includes some updates from the *IPCC 1996 Revised Guidelines*);
   - 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 is likely to be a conservative estimate, because under actual operating conditions plants usually have lower efficiencies and higher emissions than name plate performance would imply;
   - conservative estimates of power plant efficiencies, based on expert judgments on the basis of the plant's technology, size and commissioning date; or
4. *calculated,* for the simple OM and the average OM, using aggregated generation and fuel consumption data, in cases where more disaggregated data is not available.

[4] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

1) Average of the five most recent years, or
2) Based on long-term normals for hydroelectricity production.

The average emission rate method (d) can only be used

- Where low-cost/must run resources constitute more than 50% of total grid generation and detailed data to apply option (b) is not available, and
- Where detailed data to apply option (c) above is unavailable.

(a) *Simple OM.* The Simple OM emission factor ($EF_{OM,simple,y}$) is calculated as the generation-weighted average emissions per electricity unit ($tCO_2$/MWh) of all generating sources serving the system, not including low-operating cost and must-run power plants:

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}} \quad (1)$$

where

| | |
|---|---|
| $F_{i,j,y}$ | Is the amount of fuel *i* (in a mass or volume unit) consumed by relevant power sources *j* in year(s) *y*. |
| *j* | Refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports[5] from the grid. |
| $COEF_{i,j\,y}$ | Is the $CO_2$ emission coefficient of fuel *i* ($tCO_2$ / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y. |
| $GEN_{j,y}$ | Is the electricity (MWh) delivered to the grid by source *j*. |

The $CO_2$ emission coefficient $COEF_i$ is obtained as

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \quad (2)$$

where

| | |
|---|---|
| $NCV_i$ | Is the net calorific value (energy content) per mass or volume unit of a fuel *i*. |
| $EF_{CO2,i}$ | Is the $CO_2$ emission factor per unit of energy of the fuel *i*. |
| $OXID_i$ | Is the oxidation factor of the fuel (see page 1.29 in the 1996 Revised IPCC Guidelines for default values). |

Where available, local values of $NCV_i$ and $EF_{CO2,i}$ should be used. If no such values are available, country-specific values (see e.g. IPCC Good Practice Guidance) are preferable to IPCC world-wide default values.

The Simple OM emission factor can be calculated using either of the two following data vintages for years(s) *y*:

- A 3-year average, based on the most recent statistics available at the time of PDD submission, or
- The year in which project generation occurs, if $EF_{OM,y}$ is updated based on ex post monitoring.

5 As described above, an import from a connected electricity system should be considered as one power source *j*.

(b) *Simple Adjusted OM.* This emission factor ($EF_{OM,simple\ adjusted,y}$) is a variation on the previous method, where the power sources (including imports) are separated in low-cost/must-run power sources ($k$) and other power sources ($j$):

$$EF_{OM,simple\ adjusted,y} = \left(1-\lambda_y\right)\cdot\frac{\sum_{i,j} F_{i,j,y}\cdot COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y\cdot\frac{\sum_{i,k} F_{i,k,y}\cdot COEF_{i,k}}{\sum_k GEN_{k,y}} \quad (3)$$

where

| | |
|---|---|
| $F_{i,k,y}$, $COEF_{i,k}$ and $GEN_k$ | Are analogous to the variables described for the simple OM method above for plants $k$; the years(s) $y$ can reflect either of the two vintages noted for simple OM above, and |

$$\lambda_y\left(\%\right) = \frac{\text{Number of hours per year for which low - cost/must - run sources are on the margin}}{\text{8760 hours per year}} \quad (4)$$

where lambda ($\lambda_y$) should be calculated as follows (see figure below):

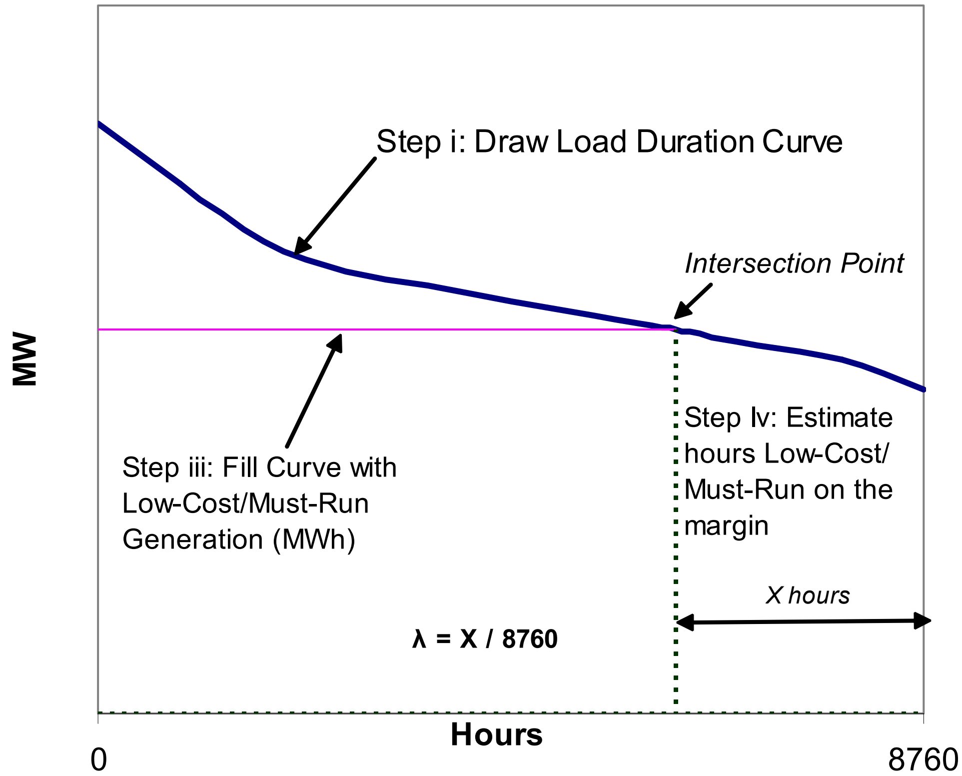
Step i) Plot a Load Duration Curve. Collect chronological load data (typically in MW) for each hour of a year, and sort load data from highest to lowest MW level. Plot MW against 8760 hours in the year, in descending order.

Step ii) Organize Data by Generating Sources. Collect data for, and calculate total annual generation (in MWh) from low-cost/must-run resources (i.e. $\sum_k GEN_{k,y}$).

Step iii) Fill Load Duration Curve. Plot a horizontal line across load duration curve such that the area under the curve (MW times hours) equals the total generation (in MWh) from low-cost/must-run resources (i.e. $\sum_k GEN_{k,y}$).

Step iv) Determine the "Number of hours per year for which low-cost/must-run sources are on the margin". First, locate the intersection of the horizontal line plotted in step (iii) and the load duration curve plotted in step (i). The number of hours (out of the total of 8760 hours) to the right of the intersection is the number of hours for which low-cost/must-run sources are on the margin. If the lines do not intersect, then one may conclude that low-cost/must-run sources do not appear on the margin and $\lambda_y$ is equal to zero. Lambda ($\lambda_y$) is the calculated number of hours divided by 8760.

**Figure 1: Illustration of Lambda Calculation for Simple Adjusted OM Method**




*Note: Step (ii) is not shown in the figure, it deals with organizing data by source.*

(c) *Dispatch Data Analysis OM.* The Dispatch Data OM emission factor ($EF_{OM,Dispatch\ Data,y}$) is summarized as follows:

$$EF_{OM,Dispatch\ Data,y} = \frac{E_{OM,y}}{EG_y} \tag{5}$$

where

$EG_y$ Is the generation of the project (in MWh) in year $y$, and $E_{OM,y}$ are the emissions ($tCO_2$) associated with the operating margin calculated as

$$E_{OM,y} = \sum_h EG_h \cdot EF_{DD,h} \tag{6}$$

where

$EG_h$ Is the generation of the project (in MWh) in each hour $h$.

$EF_{DD,h}$ Is the hourly generation-weighted average emissions per electricity unit ($tCO_2/MWh$) of the set of power plants ($n$) in the top 10% of grid system dispatch order during hour $h$:

$$EF_{DD,h} = \frac{\sum_{i,n} F_{i,n,h} \cdot COEF_{i,n}}{\sum_{n} GEN_{n,h}} \qquad (7)$$

where

| | |
|---|---|
| *F*, *COEF* and *GEN* | Are analogous to the variables described for the simple OM method above, but calculated on an hourly basis for the set of plants (*n*) falling within the top 10% of the system dispatch. |

To determine the set of plants (*n*), obtain from a national dispatch center: a) The grid system dispatch order of operation for each power plant of the system; and b) the amount of power (MWh) that is dispatched from all plants in the system during each hour that the project activity is operating ($GEN_h$). At each hour *h*, stack each plant's generation ($GEN_h$) using the merit order. The set of plants (n) consists of those plants at the top of the stack (i.e., having the least merit), whose combined generation ($\sum GEN_h$) comprises 10% of total generation from all plants during that hour (including imports to the extent they are dispatched).

(d) *Average OM*. The average Operating Margin (OM) emission factor ($EF_{OM,average,y}$) is calculated as the average emission rate of all power plants, using equation (1) above, but including low-operating cost and must-run power plants [except fossil fuel fired power plants if these are a must-run resource]. Either of the two data vintages described for the simple OM (a) may be used.

**STEP 2. Calculate the Build Margin emission factor ($EF_{BM,y}$)** as the generation-weighted average emission factor ($tCO_2$/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,y}} \qquad (8)$$

where

| | |
|---|---|
| $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ | Are analogous to the variables described for the simple OM method above for plants *m*. |

Project participants shall choose between one of the following two options:

*Option 1.* Calculate the Build Margin emission factor $EF_{BM,y}$ *ex ante* based on the most recent information available on plants already built for sample group *m* at the time of PDD submission. The sample group *m* consists of either:

- The five power plants that have been built most recently, or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation.

*Option 2.* For the first crediting period, the Build Margin emission factor $EF_{BM,y}$ must be updated annually *ex post* for the year in which actual project generation and associated emissions reductions occur. For subsequent crediting periods, $EF_{BM,y}$ should be calculated *ex-ante*, as described in option 1 above. The sample group *m* consists of either

- The five power plants that have been built most recently, or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation.

Power plant capacity additions registered as CDM project activities should be excluded from the sample group *m*.

**STEP 3. Calculate the electricity baseline emission factor $EF_{electricity,y}$** as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$EF_{electricity,y} = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y} \tag{9}$$

where the weights $w_{OM}$ and $w_{BM}$, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in $tCO_2$/MWh. Alternative weights can be used, as long as $w_{OM} + w_{BM} = 1$, and appropriate evidence justifying the alternative weights is presented. These justifying elements are to be assessed by the Executive Board.[6]

The weighted average applied by project participants should be fixed for a crediting period and may be revised at the renewal of the crediting period.

<u>**Calculation of baseline emissions due to displacement of electricity**</u>

Baseline emissions due to displacement of electricity are calculated by multiplying the electricity baseline emissions factor ($EF_{electricity,y}$) with the electricity generation of the project activity.

$$BE_{electricity,y} = EF_{electricity,y} \cdot EG_y \tag{10}$$

where

| | |
|---|---|
| $BE_{electricity,y}$ | Are the baseline emissions due to displacement of electricity during the year y in tons of $CO_2$. |
| $EG_y$ | Is the net quantity of electricity generated in the bagasse-based cogeneration plant due to the project activity during the year y in MWh. |
| $EF_{electricity,y}$ | Is the $CO_2$ baseline emission factor for the electricity displaced due to the project activity in during the year y in tons $CO_2$/MWh. |

Where the project activity involves a capacity addition, the net quantity of electricity generated due to the project activity ($EG_y$) should be determined as the difference of the electricity generated by the plant after project implementation and the quantity of electricity that has been generated prior to project implementation, based on the average electricity generation of the last three years before project implementation.

For this methodology, it is assumed that transmission and distribution losses in the electricity grid are not influenced significantly by the project activity. They are therefore neglected.

[6] More analysis on other possible weightings may be necessary and this methodology could be revised based on this analysis. There might be a need to propose different weightings for different situations.

**Baseline emissions due to displacement of thermal energy**

The thermal energy generated by the bagasse cogeneration plant may displace thermal energy generation by fossil fuels in the absence of the project activity. In such cases, baseline emissions are calculated by multiplying the savings of fossil fuels with the emission factor of these fuels. Savings of fossil fuels are determined by dividing the generated thermal energy by the net calorific value of the fuel and the efficiency of the boiler that would be used in the absence of the project activity.

$$BE_{thermal,y} = \frac{Q_y}{\varepsilon \cdot NCV_i} \cdot COEF_i \qquad (11)$$

where

| | |
|---|---|
| $BE_{thermal,y}$ | Are the baseline emissions due to displacement of thermal energy during the year y in tons of $CO_2$. |
| $Q_y$ | Is the quantity of thermal energy generated in the bagasse-based cogeneration plant during the year y in GJ. |
| $\varepsilon_{boiler}$ | Is the energy efficiency of the boiler. |
| $NCV_i$ | Is the net calorific value of the fuel type *i* displaced due to the project activity in GJ per volume or mass unit. |
| $COEF_i$ | Is the $CO_2$ emission factor of the fossil fuel type *i* fired in the boiler in the absence of the project activity in tons $CO_2$ / mass or volume unit of the fuel. |

To estimate boiler efficiency, the highest value among the following three values should be used as a conservative approach:

1. Measured efficiency prior to project implementation;
2. Measured efficiency during monitoring;
3. Manufacturer's information on the boiler efficiency.

In determining the $CO_2$ emission factors (COEF) of fuels, reliable local or national data should be used if available. Where such data is not available, IPCC default emission factors (country-specific, if available) should be chosen in a conservative manner.

Where the project activity involves a capacity addition, the net quantity of thermal energy generated due to the project activity ($Q_y$) should be determined as the difference of the thermal energy generated by the plant after project implementation and the quantity of thermal energy that has been generated prior to project implementation, based on the average thermal energy generation of the last three years before project implementation.

**Project Activity**

As part of project emissions, project participants shall account $CO_2$ emissions from the combustion of any fossil fuels due to the project activity. Where applicable, such emissions are calculated by multiplying the fuel quantities (mass or volume) with the appropriate net calorific values and $CO_2$ emission factors:

$$PE_y = \sum_i FF_{i,y} \cdot COEF_i \qquad (12)$$

where

| | |
|---|---|
| $PE_y$ | Are the project emissions during the year *y* in tons of $CO_2$. |
| $FF_{i,y}$ | Is the quantity of fuel type i combusted due to the project activity during the year *y* in a volume or mass unit. |
| $COEF_i$ | Is the $CO_2$ emission factor of the fossil fuel type *i* fired in the boiler in the absence of the project activity in tons $CO_2$ / mass or volume unit of the fuel. |

The net increase of $CO_2$ emissions associated with the transport of bagasse fuel is regarded as negligible because of its short distance (within the area).

**Leakage**

Project participants should account for any increase of fossil fuels outside the project boundary which may result from the project activity. Any decrease of bagasse availability outside of the boundary due to implementation of the project may result in fossil fuel usage at the point where bagasse was originally used. In such cases, such leakage effects are given by

$$L_y = BG_{sold\ before} \cdot \frac{\varepsilon_{i,before}}{\varepsilon_{i,after}} \cdot \frac{NCV_{bagasse}}{NCV_i} \cdot COEF_i \tag{13}$$

where

| | |
|---|---|
| $L_y$ | Are the leakage emissions during the year y in tons of $CO_2$. |
| $BG_{sold\ before}$ | Is the quantity of bagasse sold to former bagasse buyer(s), measured as the latest three-year average before implementation of the project, in mass unit. |
| $\varepsilon_{i,before}$ | Is the energy efficiency of the plant which switches from bagasse to fossil fuel i before implementation of the project activity. |
| $\varepsilon_{i,after}$ | Is the energy efficiency of the plant which switches from bagasse to fossil fuel i after implementation of the project activity. |
| $NCV_{bagasse}$ | Is the net calorific value of bagasse in GJ per volume or mass unit. |
| $NCV_i$ | Is the net calorific value of the fuel type *i* in GJ per volume or mass unit. |
| $COEF_i$ | Is the $CO_2$ emission factor of the fossil fuel type i fired in the plant after the implementation of the project activity in tons $CO_2$/mass or volume unit of the fuel. |

If former buyers are plural, summation over such buyers is needed.

**Emission Reductions**

The total net emission reductions due to the project activity result during a given year *y* as

$$ER_y = BE_{thermal,y} + BE_{electricity,y} - PE_y - L_y \tag{14}$$

where

| | |
|---|---|
| $ER_y$ | Are the emissions reductions of the project activity during the year y in tons of $CO_2$. |
| $BE_{electricity,y}$ | Are the baseline emissions due to displacement of electricity during the year y in tons of $CO_2$. |
| $BE_{thermal,y}$ | Are the baseline emissions due to displacement of thermal energy during the year y in tons of $CO_2$. |
| $PE_y$ | Are the project emissions during the year y in tons of $CO_2$. |
| $L_y$ | Are the leakage emissions during the year y in tons of $CO_2$... |

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### Source

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### Applicability

This methodology is applicable to bagasse-based cogeneration power plants displacing grid electricity with the following conditions:

- The bagasse to be used as the feedstock for cogeneration shall be supplied from the same facility where the project is implemented;
- Documentation is available supporting that the project activity would not be implemented by the public sector, project participants or other relevant potential developers, notwithstanding of the governmental policies/programs to promote renewables if any, in the absence of the clean development mechanism (CDM);
- The implementation of the project shall not increase the bagasse production in the facility;
- The bagasse at the project facility should not be stored for more than one year.

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM0015 ("Bagasse-based cogeneration connected to an electricity grid").

### Monitoring Methodology

The monitoring methodology involves monitoring of the following:

- Electricity generation from the proposed project activity;
- Data needed to recalculate the operating margin emission factor, if needed, based on the choice of the method to determine the operating margin (OM), consistent with the "Bagasse-based cogeneration connected to an electricity grid" (AM0015) baseline methodology;
- Data needed to recalculate the build margin emission factor, if needed, consistent with the "Bagasse-based cogeneration connected to an electricity grid" (AM0015) baseline methodology;
- Data needed to calculate baseline emissions due to the displacement of thermal energy at the project site (where relevant);
- Data required to calculate $CO_2$ emissions from fossil fuels combusted due to the project activity at the project site (where relevant);
- Data required to calculate leakage effects due to fuel switch from bagasse to other fuels outside the project boundary.

***Baseline Emission Parameters***
The 6th column indicates which monitoring elements are required depending on which method is used to determine the operating margin (OM) in step 1 of the baseline methodology AM0015 "Simple OM" is defined in step 1a; "Simple Adjusted OM" in 1b; "Dispatch Data OM" in 1c; and "Average OM" in step 1d. Items required for "BM" are for the Build Margin defined in step 2. Note that for the "Simple OM", "Simple Adjusted OM" and the "Average OM" as well as the "BM, where project participants choose, consistent with baseline methodology AM0015, a data vintage based on ex ante monitoring, at least $EG_y$ shall be monitored, and all parameters will be required to recalculate the combined margin at any renewal of a crediting period, using steps 1-3 in the baseline methodology.

| ID number | Data type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | For which baseline method(s) must this element be included | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. $EG_y$ ($EG_h$ if dispatch data OM is used) | Electricity quantity | Electricity supplied to the grid by the project | MWh | Directly measured | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM*<br>*BM* | hourly measure-ment and monthly recording | 100% | electronic | During the crediting period and two years after | Electricity supplied by the project activity to the grid. In case of retrofit projects, only the net increase in electricity supplied shall be accounted. Double check by receipt of sales. |
| 2. $EF_y$ | Emission factor | $CO_2$ emission factor of the grid | $tCO_2$ / MWh | c | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM*<br>*BM* | yearly | 100% | electronic | During the crediting period and two years after | Calculated as a weighted sum of the OM and BM emission factors |
| 3. $EF_{OM,y}$ | Emission factor | $CO_2$ Operating Margin emission factor of the | $tCO_2$ / MWh | c | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM* | yearly | 100% | electronic | During the crediting period and two years after | Calculated as indicated in the relevant OM baseline method above |

| ID number | Data type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | For which baseline method(s) must this element be included | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | | grid | | | | | | | | |
| 4. $EF_{BM,y}$ | Emission factor | $CO_2$ Build Margin emission factor of the grid | $tCO_2$ / MWh | c | BM | yearly | 100% | electronic | During the crediting period and two years after | Calculated as $[\sum_i F_{i,y}*COEF_i]$ / $[\sum_m GEN_{m,y}]$ over recently built power plants defined in the baseline methodology |
| 5. $F_{i,y}$ | Fuel quantity | Amount of each fossil fuel consumed by each power source / plant | Mass or volume | m | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM*<br>*BM* | yearly | 100% | electronic | During the crediting period and two years after | Obtained from the power producers, dispatch centers or latest local statistics. |
| 6. $COEF_i$ | Emission factor coefficient | $CO_2$ emission coefficient of each fuel type *i* | $tCO_2$ / mass or volum e unit | m | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM*<br>*BM*<br><br>Baseline emissions due to the displacement of thermal energy | yearly | 100% | electronic | During the crediting period and two years after | Plant or country-specific values to calculate COEF are preferred to IPCC default values. |
| 7. $GEN_{j/k/n,,y}$ | Electricity quantity | Electricity generation of each power source / plant | MWh/ a | m | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM*<br>*BM* | yearly | 100% | electronic | During the crediting period and two years after | Obtained from the power producers, dispatch centers or latest local statistics. |

| ID number | Data type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | For which baseline method(s) must this element be included | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | | j, k or n | | | | | | | | |
| 8. | Plant name | Identification of power source / plant for the OM | Text | e | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM* | yearly | 100% of set of plants | electronic | During the crediting period and two years after | Identification of plants (j, k, or n) to calculate Operating Margin emission factors |
| 9. | Plant name | Identification of power source / plant for the BM | Text | e | BM | yearly | 100% of set of plants | electronic | During the crediting period and two years after | Identification of plants (m) to calculate Build Margin emission factors |
| 10. $\lambda_y$ | Parameter | Fraction of time during which low-cost/must-run sources are on the margin | Number | c | *Simple Adjusted OM* | yearly | 100% | electronic | During the crediting period and two years after | Factor accounting for number of hours per year during which low-cost/must-run sources are on the margin |
| 11. | Merit order | The merit order in which power plants are dispatched by documented evidence | Text | m | *Dispatch Data OM* | yearly | 100% | paper for original documents, else electronic | During the crediting period and two years after | Required to stack the plants in the dispatch data analysis. |

| ID number | Data type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | For which baseline method(s) must this element be included | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 11a. $GEN_{j/k/ll,y}$ *IMPORTS* | Electricity quantity | Electricity imports to the project electricity system | kWh | c | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM*<br>*BM* | yearly | 100% | electronic | During the crediting period and two years after | Obtained from the latest local statistics. If local statistics are not available, IEA statistics are used to determine imports. |
| 11b. $COEF_{i,j\ y}$ IMPORTS | Emission factor coefficient | $CO_2$ emission coefficient of fuels used in connected electricity systems (if imports occur) | $tCO_2$ / mass or volume unit | c | *Simple OM*<br>*Simple Adjusted OM*<br>*Dispatch Data OM*<br>*Average OM*<br>*BM* | yearly | 100% | electronic | During the crediting period and two years after | Obtained from the latest local statistics. If local statistics are not available, IPCC default values are used to calculate. |
| 12. $Q_y$ | Energy quantity | Quantity of thermal energy generated by the cogeneration plant of the project activity | GJ/year | m | Baseline emissions due to the displacement of thermal energy | continuous measure-ment and monthly recording | 100% | electronic | During the crediting period and two years thereafter | Thermal energy supplied by the project activity to the grid. In case of retrofit projects, only the net increase in thermal energy supplied shall be accounted. |

| ID number | Data type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | For which baseline method(s) must this element be included | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| 13. ε | Efficiency | Efficiency of boilers where thermal energy is generated in the absence of the project by combustion of fossil fuels | % | m or e | Baseline emissions due to the displacement of thermal energy | Once at the beginning of the crediting period (if estimated) or regularly (if measured) | 100% | electronic | During the crediting period and two years thereafter | Efficiency may be measured or estimated conservatively (e.g. using manufacturers information on maximum efficiency). Measurements are to be conducted according to internationally recognised standards such as BS 845, ASME PTC, etc |
| 14. $NCV_i$ | Calorific enthalpy | Net calorific value of the fossil fuel i | GJ per mass or volume unit | c | Baseline emissions due to the displacement of thermal energy | Once at the beginning of a crediting period | 100% | electronic | During the crediting period and two years thereafter | Local data are preferable than default value applied to wider area. IPCC Guidelines/Good Practice Guidance provide for default values where local data is not available. |

*Project Emission Parameters*

| ID number | Data Type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 15. $FF_{i,y}$ | Physical quantity | Quantity of fossil fuel i used at the project site due to the project activity | (mass unit)/yr or (volume unit)/yr | m | yearly | 100% | electronic | During the crediting period and two years thereafter | Fossil fuel used in the boundary measured in mass or volume unit. |
| 16. $NCV_i$ | Calorific enthalpy | Net calorific value of the fossil fuel i | GJ per mass or volume unit | c | Once at the beginning of a crediting period | 100% | electronic | During the crediting period and two years thereafter | Local data are preferable than default value applied to wider area. IPCC Guidelines/Good Practice Guidance provide for default values where local data is not available. |
| 17. $COEF_i$ | $CO_2$ emission coefficie nt | $CO_2$ emission factor of the fossil fuel i | $tCO_2$ / mass or volume unit | c | Once at the beginning of a crediting period | 100% | electronic | During the crediting period and two years thereafter | Local data are preferable than default value applied to wider area. IPCC Guidelines/Good Practice Guidance provide for default values where local data is not available. |

***Leakage***

| ID number | Data Type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 18. $BG_{sold\ before}$ | Physical quantity (e.g., mass) | Quantity of bagasse sold before project implementation | (mass unit)/yr or (volume unit)/yr | m | Once before implementation of the project | 100% | electronic | During the crediting period and two years thereafter | Quantity of bagasse sold to the former bagasse buyer(s), measured as the latest 3-year average before implementation of the project, backed by business receipt. |
| 19. $\varepsilon_{i,before}$ | Energy efficiency | Energy efficiency of the plant which switched fuel from bagasse to fossil fuel before implementation of the project | % | m | Once before implementation of the project | 100% | electronic | During the crediting period and two years thereafter | Energy efficiency of the plant which switched the fuel from bagasse to fossil fuel i before implementation of the project. The data is to be provided by the former bagasse buyer. The data is that of typical load factor. |

| ID number | Data Type | Data variable | Data unit | Measured (m) calculated (c) estimated (e) | Recording frequency | Proportion of data monitored | How will data be archived? (electronic/ paper) | For how long is archived data kept? | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 20. $\varepsilon_{i,after}$ | Energy efficiency | Energy efficiency of the plant which switched fuel from bagasse to fossil fuel after implementation of the project | % | m | Once after implementation of the project | 100% | electronic | During the crediting period and two years thereafter | Energy efficiency of the plant which switched the fuel from bagasse to fossil fuel i after implementation of the project. The data is to be provided by the former bagasse buyer. The efficiency may be measured or estimated conservatively. |

***Quality Control (QC) and Quality Assurance (QA) Procedures***

All variables used to calculate project and baseline emissions are directly measured or are publicly available official data. To ensure the quality of the data, in particular those that are measured, the data are double-checked against commercial data. The quality control and quality assurance measures planned for the Project are outlined in the following table.

| **Data** | **Uncertainty Level of Data (High/Medium/Low)** | **Are QA/QC procedures planned for these data?** | **Outline explanation how QA/QC procedures are planned** |
|---|---|---|---|
| 1, 12, 13, 15 | Low | Yes | These data will be directly used for calculation of emission reductions. Sales record and other records are used to ensure the consistency. |
| others | Low | Yes | Default data (for emission factors) and IEA statistics (for energy data) are used to check the local data. |

**Baseline Data**

Load Duration Curve Data is to be provided by the grid operator. The load duration curve provides data of the aggregated operating hours by type of power plant annually. The calculation method is provided in the baseline methodology.

For default emission factors, IPCC 1996 Guidelines on GHG Inventory (The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, IPCC) and Good Practice Guidance Report (Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, IPCC) are to be referred not only for their default values but also for their monitoring methodology as well as uncertainty management to ensure data credibility. These documents are downloadable from http://www.ipcc-nggip.iges.or.jp/. The latter document is a new supplementary document of the former.

1996 Guidelines:
Vol. 2, Module 1 (Energy) for methodology,
Vol. 3, Module 1 (Energy) for application (including default values)

2000 Good Practice Guidance on GHG Inventory and Uncertainty Management
Chapter 2: Energy
Chapter 6: Uncertainty

IEA (Yearly Statistics)
$CO_2$ Emissions from Fuel Combustion
Energy Statistics of Non-OECD Countries