SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity

Approved monitoring methodology AM0015: "Bagasse-based cogeneration connected to an electricity grid"

D.2. Justification of the choice of the methodology and why it is applicable to the project activity

The chosen methodology is applicable to all bagasse-based cogeneration projects connected to the grid. The monitoring methodology and plan considers monitoring emission reductions generated from cogeneration projects using sugarcane bagasse as fuel.

The main data to be considered in determining the emissions reductions is the electricity exported to the grid. The emissions reduction is reached by applying an emissions factor through the electricity dispatched to the grid, that is verified and monitor by a two party verification: by the power plant that sells the electricity and by the utility company that buys the electricity.

D.2.1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

The project emissions (PE_y) are zero; therefore table D.2.1.1 below is empty.

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived

ID number *(Please use*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or	Recording frequency	Proportion of data to be	How will the data be archived?	Comment

numbers to ease cross-referencing to				estimated (e)		monitored	(Electronic/ paper)	

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_{2e})

The project emissions (PE_y) are zero, therefore no formula for calculation of direct emissions are necessary.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (Electronic/ paper)	Comment
1. EG_y	Electricity supplied to the grid by the project	Readings of the energy metering connected to the grid and Receipt of sales	MWh	(m)	15-minutes-measurement and Monthly recording	100%	Electronic and paper	The electricity delivered to the grid is monitored by the Project as well as by the energy buyer through a double check by receipt of sales.

2. EF_y	Emission Factor	Calculated	tCO_2/MWh	(c)	At the validation	0%	Electronic	Data is available under request. Factors were calculated according to the Approved monitoring methodology AM0015
3. $EF_{om,y}$	Emission factor	Calculated	tCO_2/MWh	(c)	At the validation	0%	Electronic	Data is available under request. Factors were calculated according to the Approved monitoring methodology AM0015
4. $EF_{BM,y}$	Emission factor	Calculated	tCO_2/MWh	(c)	At the validation	0%	Electronic	Data is available under request. Factors were calculated according to the Approved monitoring methodology AM0015
5. λ_y	Fraction of time during which low-cost/must-run sources are on the margin	Calculated	Non dimensional	(c)	At the validation	0%	Electronic	Data is available under request. Factors were calculated according to the Approved monitoring methodology AM0015

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_{2e})

According to the selected approved methodology (AM-0015), the baseline emission factor is calculated as (EF_y) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (OM) and build margin (BM) factors. For the purpose of determining the build margin and the operating margin emission factors, a 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 is defined as an 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.

From AM-0015, a baseline emission factor (EF_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:

- **STEP 1** - Calculate the operating margin emission factor(s), based on one of the following methods
  - Simple operating margin
  - Simple adjusted operating margin
  - Dispatch data analysis operating margin
  - Average operating margin.

The second alternative, simple adjusted operating margin will be used here.

The simple adjusted operating margin emission factor ($EF_{OM,adjusted,y}$ in tCO_2/MWh) is a variation on the simple operating margin, where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*):

$$EF_{OM,simple-adjusted,y} = (1-\lambda_y)\frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y \cdot \frac{\sum F_{i,k,y} \cdot COEF_{i,k}}{\sum_k GEN_{k,y}} \qquad \textbf{Equation 1}$$

Where:

- λ_y is the share of hours in year *y* (in %) for which low-cost/must-run sources are on the margin.
- $\sum_{i,j} F_{i,j,y}$ is the amount of fuel *i* (in mass or volume unit) consumed by relevant power sources *j* (analogous for sources *k*) in year(s) *y*,
- $COEF_{i,j}$ is the CO_{2e} coefficient of fuel *i* (tCO_{2e}/mass or volume unit of the fuel), taking into account the carbon dioxide equivalent emission potential of the fuels used by relevant power sources *j* (analogous for sources *k*) and the percent oxidation of the fuel in year(s) *y* and,

- $\sum_j GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source *j* (analogous for sources *k*),

- **STEP 2** – Calculate the build margin mission factor ($EF_{BM,y}$) as the generation weighted average emission factor (tCO_{2e}/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}}{\sum_m GEN_{m,y}} \qquad \textbf{Equation 2}$$

Where $F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ are analogous to the variables described for the simple OM method (ACM0015, 2004) for plants *m*, based on the most recent information available on plants already built . 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.

- **STEP 3** – Calculate the baseline emission factor EF_y, as the weighted average of the operating margin factor ($EF_{OM,y}$) and the build margin factor ($EF_{BM,y}$):

$$EF_y = w_{OM} \cdot EF_{OM,y} + w_{BM} \cdot EF_{BM,y} \qquad \textbf{Equation 3}$$

Where the weights are by w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{OM} = 0.5$). Alternative weights can be used, as long as $w_{OM} + w_{BM} = 1$, and appropriate evidence justifying the alternative weights is presented.

D.2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E)

Not applicable.

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived

Not applicable.

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (Electronic/paper)	Comment

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_{2e})

Not applicable.

D.2.3. Treatment of leakage in the monitoring plan

The main emissions giving rise due to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction, transportation of materials, fuel handling (extraction, processing and transport) and other upstream activities. Project participants do no need to consider these emissions these emission sources as leakage in applying this methodology. Nevertheless project's lifetime upstream emissions from the wells drilling and maintenance will be estimated to assure that they are effectively their negligible.

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease crossreferencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (Electronic/ paper)	Comment

No sources of emissions were identified, and therefore no data will be collected and archived. There are no entries in the table D.2.3.1 above.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_{2e})

Leakage is not applicable to the projects activity approved methodology

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equivalent)

The project activity mainly reduces carbon dioxide through substitution of grid electricity generation with fossil fuel fired power plants by renewable electricity. The emission reduction by the project activity (ER_y) during a given year (y) is the difference between the baseline emissions (BE_y, in tCO_2), project emissions (PE_y, in tCO_2e) and due to leakage (L_y, in tCO_2e), as follows:

$$ER_y = BE_y - PE_y - L_y \quad \textbf{Equation 4}$$

Where the baseline emissions are the product of the the electricity supplied by the project to the grid (EG_y in MWh) times the baseline emission factor (EF_y in tCO_2e/MWh), as follows:

$$BE_y = EG_y \cdot EF_y \quad \textbf{Equation 5}$$

Project emissions are the sum of the fugitive carbon dioxide and methane emissions due to the release of non-condensable gases from the produced steam (PES_y, *in* tCO_2) and carbon dioxide emissions from fossil fuel combustion ($PEFF_y$, *in* tCO_2), as follows:

$$PE_y = PES_y + PEFF_y \quad \textbf{Equation 6}$$

The main emissions giving rise due to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction, fuel handling (extraction, processing and transport). Project participants do no need to consider these emissions these emission sources as leakage in applying this methodology. Therefore:

$$L_y = 0 \quad \textbf{Equation 7}$$

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data *(Indicate table and ID number e.g. 3.1; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1	Low	These data will be used for calculate the emission reductions. Two energy meters are used to measure the electricity delivered to the grid (main meter and backup meter). Equipments used to measure the electricity delivered to the grid are calibrated each 2 years following the National Electric System Operator (from the Portuguese *Operador Nacional do Sistema Elétrico – ONS*) recommendations and procedures[1].
2	Low	Data acquired from ONS and ANEEL and does not need to be monitored.
3	Low	Data acquired from ONS and ANEEL and does not need to be monitored.
4	Low	Data acquired from ONS and ANEEL and does not need to be monitored.
5	Low	Data acquired from ONS and ANEEL and does not need to be monitored.

D.4. Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

As the project is neither associated with leakage effects nor with new emissions of pollutants and all other pertinent data is necessary to be analyzed and presented only at the validation phase of the project, the only data that has to be monitored going forward during the life of the contract is the electricity supplied to the grid by the project (EG_y).

This data is monitored through a spreadsheet that has to collect by meters installed in the exit of the mill and entrance of the transmission lines and by the sales receipts issued by the electricity utility to the mill.

[1] Sub-módulo 12.3. Metering System Maintenance for Invoicing (in a free translation from the Portuguese *Manutenção do Sistema de Medição para Faturamento*).

D.5.	Name of person/entity determining the monitoring methodology

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Annex 4

MONITORING PLAN

As per the procedures set by the Approved monitoring methodology AM0015: "Monitoring methodology for emissions reductions from grid connected bagasse cogeneration projects"

CERPA will proceed with the necessary measures for the power control and monitoring. Together with the information produced by both ANEEL and ONS, it will be possible to monitor the power generation of the project and the grid power mix.