BIOMASS COGENERATION PLANT BY SCOUL

Document Prepared By

Enen Green Services Pvt. Ltd.

Email: enengreen@gmail.com

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Prepared By	Enen Green Services Pvt. Ltd.
Contact	Ruchika Sharma Director Enen Green Services Pvt. Ltd. enengreen@gmail.com

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The purpose of the project activity is to utilize available bagasse in SCOUL sugar factory for steam and electricity generation. The project undertaken is a cogeneration plants of capacity 30 MW (with 150 TPH steam generation) located at Lugazi, Uganda. Bagasse based Cogeneration plant will supply steam and electricity to the sugar mill and export the power surplus to the national grid.

The project activity will involve the installation of one module composed of one high-pressure boiler of 150 tonnes of steam per hour at 87 bar and 520 °C and one turbo-generator of 34 MVA corresponding to 30 MWe. The power plant will be fueled with the bagasse left from the sugar mill process.

In the baseline situation, according to the forecast sugar production, the sugar mill continues to generate steam and power demand for onsite process purposes and no surplus of electricity is exported to the national grid. To date, sugar cane production is close to 1400000 tonnes per year and will be progressively increased up to reach 1 650 000 tonnes per year for the sugar season 2025.
By exporting biomass-based electricity surplus to the national grid, the project activity will replace the same amount of electricity otherwise generated in fossil fuel-based plants in the country. In this manner, the project will avoid the emission of 76,321 tCO2e in average per year resulting in 763,215 tCO2e during the 7 years crediting period.

1.2 Sectoral Scope and Project Type

TYPE I – Energy Industries (Renewable/non-renewable sources)

ACM0006: Electricity and heat generation from biomass

The project activity falls under the Sectoral Scope 1: Energy industries (renewable - / non-renewable sources) as per the sectoral scopes defined by the CDM Executive Board.

This is not a grouped project as it does not involve combination of GHG projects or other project categories. It is a single project and there are no other project participants involved.

The purpose of the project activity is to utilize bagasse available in the SCOUL sugar mill for Steam and electricity generation.

1.3 Project Eligibility

This project falls under the "Type I: Renewable energy projects" and "**ACM0006: Electricity and heat generation from biomass**". This project meets all the applicability criteria set under the selected approved large scale CDM methodology and hence the project category is applicable to the VCS project.

As per VCS standard version 4.1 large scale biomass based power generation projects are eligible from LDC countries and Uganda is a LDC country since 1971 as per UN committee for Development Policy dated 24th Nov 2021[1].

1.4 Project Design

☒ *The project includes a single location or installation only*

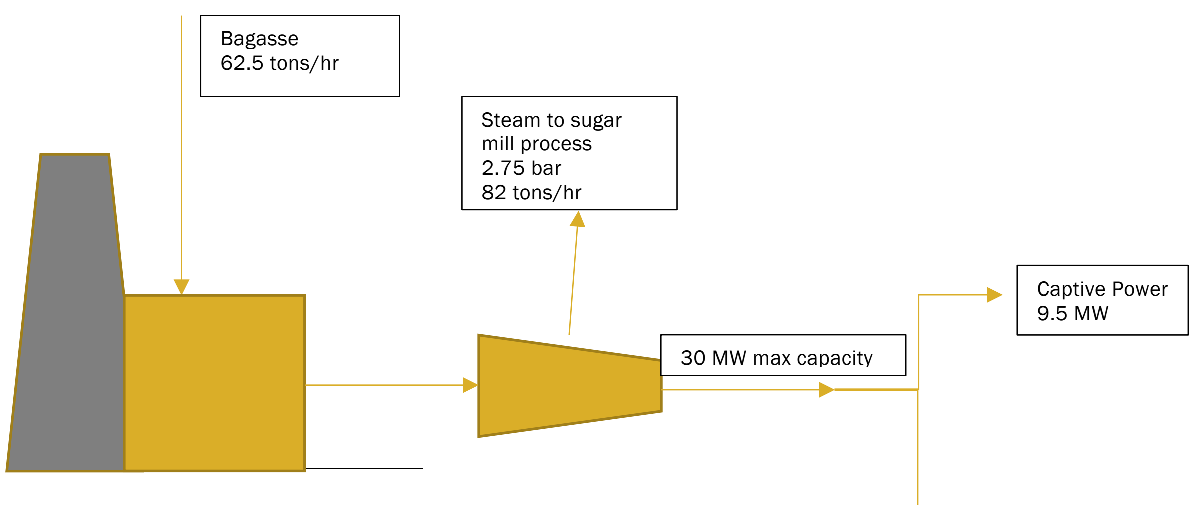
☐ *The project includes multiple locations or project activity instances, but is not being developed as a grouped project*

☐ *The project is a grouped project*

Project activity aims to implement a Greenfield power plant next to sugar mill. The project will use the sugarcane bagasse obtained from the sugar mill and will produce the total energy to cover the sugar factory process. In this manner, the current boilers and turbine will be progressively uninstalled and all the energy generation will be produced by the new project. The project aims also to export a large surplus of electricity into the national grid. A project activity of 34 MVA will be installed in 2020 for an estimated gross power generation of 238 GWh/y. Phase I involved in installation of one high-pressure boiler of 150 tonnes of steam per hour at 87 bar and 525 °C.

The new cogeneration power plant will have an efficiency of around 71.4%, which is similar to that one considered for the new boiler (boiler 3) from the baseline scenario. The new turbo will have an efficiency of 5.1 kg of superheated steam per kilowatt-hour in multi-stage mode (crop season) and 3.6 kg/kWh in condensing mode (off-season). The project will be fueled with the bagasse left from the sugar mill process.

The following figure summarizes the modular configuration of each project activity phase.



[1] https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/ldc_list.pdf

High pressure boiler 87 bars 525 Deg.C 150 t/h

Power to Grid 20.5 MW

This is not a grouped project as it does not involve combination of GHG projects or other project categories. It is a single project and there are no other project participants involved.

Eligibility Criteria

This is not a group project. Therefore, this section is not applicable.

1.5 Project Proponent

Provide contact information for the project proponent(s). Copy and paste the table as needed.

Organization name	Sugar Corporation of Uganda Limited
Contact person	Vijay Dongare
Title	Deputy Chief Executive (Projects)
Address	P.O. Box 1, Lugazi, Uganda
Telephone	Tel : 256 312555500, +256 312555219, Fax : +256 312555248, Mob : +256 703444904
Email	vijaydongare@mehtagroup.com

Organization name	Enen Green Services Private Limited
Role in the project	Project participant
Contact person	Ruchika Sharma
Title	Ms.
Address	506,T4, RPS Savana, sector 88,Faridabad

Telephone	+91-9953935506
Email	enengreen@gmail.com

1.6 Other Entities Involved in the Project

NA

1.7 Ownership

Owner of the project activity is Sugar Corporation of Uganda Limited (SCOUL) and documents showing proof of title and ownership of the emission reductions are as follows:

- Certificate of Incorporation.
- Purchase order of Boilers.
- Power Purchase Agreement

1.8 Project Start Date

19th July 2021 is considered as commissioning date of boiler because on 19th July 2021 project starts supplying power to Uganda Electricity Transmission Company Ltd. (UETCL).

1.9 Project Crediting Period

First crediting period- 19/07/2021 to 18/07/2028

PP has considered seven years, twice renewable for a total of 21 years crediting period

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

☐ <20,000 tCO_2e/year

☒ 20,000 – 100,000 tCO_2e/year

☐ 100,001 – 1,000,000 tCO_2e/year

☐ >1,000,000 tCO_2e/year

Indicate the scale of the project (project or large project) and the estimated annual GHG emission reductions or removals for the project crediting period.

Project Scale	
Project	√
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
19/07/2021 - 31/12/2021	49,567
01/01/2022 - 31/12/2022	108,988
01/01/2023 - 31/12/2023	108,988
01/01/2024 - 31/12/2024	108,988
01/01/2025 - 31/12/2025	108,988
01/01/2026 - 31/12/2026	108,988
01/01/2027 - 31/12/2027	108,988
01/01/2028 - 18/07/2028	59,719
Total estimated ERs	763,215
Total number of crediting years	7
Average annual ERs	76,321

1.11 Description of the Project Activity

Sugar Corporation of Uganda Ltd (SCOUL), Lugazi is operating sugar factory with a rated capacity of 3500 tons cane processing per day. SCOUL is now planning to establish bagasse based cogeneration Project.

At present sugarcane processing at the rate of 200 tch (4600 TCD), the factory has surplus bagasse, which has no local market hence has no economic value. The surplus bagasse is not only costing lot of money for stock piling during season, fire protection etc, but also creating lot of concern on environmental protection. In addition, there is a potential for cane supply of about 1,400,000 tons per year.

Bagasse based co-generation plants are not only eco friendly but also have added advantages of relatively low capital cost as well as short gestation period. With the continuous depletion of fossil fuels, growing population pressures and renewed concern for environment, co-generation in sugar industry has become one of the most convenient and environment friendly way of generating electricity. The world over, co-generation has been recognised as a reliable way of producing additional electricity.

As per the baseline scenario, the same quantity of sugar cane will be processed and consequently, the same amount of bagasse for cogeneration purposes will be available. Concerning the use of fossil fuels, coal and gas could be also used in case of emergency, only in case of lack of biomass. The cogeneration plant has been designed considering these scenarios.

The project activity's technology and know-how is transferred from several sources:

- The consulting expertise is provided by internal resources and by experts with decades of experience in the sugarcane sector as well as the electricity generation sector.
- The equipment's technology comes from British and German manufacturers.
- The installation, operation and maintenance assistance are ensured by a highly qualified international EPC contractor company, assisted by own technical resources.

Installation and operation of the high efficiency cogeneration plant do not pose any environmental hazards. The technology of generating electricity through biomass residues combustion is environmentally safe and sound, as confirmed by the EIA.

The project activity entails the commissioning of a biomass-based Cogeneration Project.

Table 1: The key parameters of the Boiler

Make:	ISGEC Heavy Engineering Limited
Design capacity	150 TPH
Design pressure	87 bar
Steam temperature	525 ± 5 ºC
Thermal Efficiency (%)	71.4%
Fuel used	Bagasse
Purchase date	19/04/2019

Table 2: The key parameters of the Turbine are given below:

Make:	Shin Nippon Machinery Company ltd.
Manufacturer's Model no.	C9-R14-ER
Design capacity	30 MW
Speed (turbine/generator)	4900/1500 rpm
Inlet Steam Temperature:	520°C
Inlet Steam Pressure:	85 bar
Exhaust steam pressure	0.10 bar
Purchase date:	18/04/2019

Bagasse ash contains potash, hence can be used as manure. In most of the sugar factories, it is being mixed with filter cake and is being used as manure in the cane fields.

The project does not involve any transfer of technology.

1.12 Project Location

Mark	Latitude	Longitude
A	0º22'55.70''N	32º56'49.31''E
B	0º22'51.01''N	32º56'50.03''E
C	0º22'50.1''N	32º56'48.77''E
D	0º22'48.31''N	32º56'49.92''E
F	0º22'53.58''N	32º56'58.77''E
G	0º22'56.74''N	32º56'57.44''E

1.13 Conditions Prior to Project Initiation

The electricity demand of sugar mill was met by the grid supply and the steam demand was met by coal fired boilers. Coal was consumed in the pre project scenario for thermal energy generation.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

Regulatory Analysis	Consistency with law and regulations?
As the project activity legal due diligence demonstrates, this alternative scenario complies with all mandatory applicable legal and regulatory requirements.	Yes
Current grid-connected power plants operate under the control and responsibility of the Uganda Electricity Transmission Company Ltd. (UETCL), a Government body in compliance with the law.	Yes
The biomass residues are used for power or heat generation at the project site in plant and left to decay in aerobic conditions in the current sugarcane plantations: As the current sugar mill operation permits demonstrate, this alternative scenario complies with all mandatory applicable legal and regulatory requirements.	Yes

Project activity received EIA approval from The National Environment Management Authority (NEMA) on 19th May 2016 for establishment of co-generation plant and 33 kV power evacuation line from cogeneration plant to switch yard. EIA approval clarifies that co-generation power plant is meeting all requirements of EIA regulation 1998.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

Project activity not registered under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

The project is not rejected under any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project is not included in any emission trading program or any other mechanism that includes GHG allowance trading and include details about any such programs or mechanisms.

Does the project reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading?

☐ Yes ☒ No

1.16.2 Other Forms of Environmental Credit

The Project has not created another form of environment credit till date.

Has the project sought or received another form of GHG-related credit, including renewable energy certificates?

☐ Yes ☒ No

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

This section will update later

1.17.2 Sustainable Development Contributions Activity Monitoring

This section will update later

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
Sequential row number	*SDG Target number*	*Number and text of SDG indicator or, if no official SDG indicator is applicable, user-defined indicator*	*Indicate the project's contribution to the SDG Indicator (implemented activities to increase or decrease)*	*Brief description of the quantifiable impact of the project's activities related to the SDG indicator, during the monitoring period.*	*Brief description of the cumulative quantifiable impact of the project's activities related to the SDG indicator, over the project lifetime.*
1)	1.1	1.1.1 Proportion of population below the international poverty line	Implemented activities to decrease	No further changes this monitoring period	The project has increased the 65 participants' total daily income from 1.20 USD/day to 2.57 USD/day, bringing them above the international poverty line
2)	3.2	3.3.3 Malaria incidence per 1,000 population	Implemented activities to decrease	Lowered the malaria incidence per 1,000 to 98 by distributing 200 additional bed nets and conducted malaria prevention workshops.	Lowered the malaria incidence per 1,000 from 157 to 98
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	By conserving 400 ha of tropical rainforest, Project X has prevented the release of 250 thousand tonnes of carbon into the atmosphere during the monitoring period	Prevented the release of 750 thousand tonnes of carbon into the atmosphere

4)	6.1	Proportion of the rural population who have easy access to a safe water supply	Implemented activities to increase	Completed construction of 4 additional improved wells to provide potable water to 230 people	Provided at least 10 liters of potable water per day to 1,200 people, a 40% increase in the catchment area, over the project lifetime by constructing improved wells

1.18 Additional Information Relevant to the Project

Leakage Management

Scenarios for the use of biomass residues, as per the methodological tool “Project and leakage emissions form biomass” (Version 04.0):

B1	**The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields;**	**Yes**	**B1 is a likely baseline scenario since biomass residues are used for cogeneration purposes and the remaining share is left to decay in aerobic conditions in the current sugarcane plantations.**
B2	The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to landfills which are deeper than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields;	No	Not applicable as the biomass residues are used for cogeneration purposes and the remaining share left to decay in the current sugarcane plantations.
B3	The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes;	No	Not applicable as the biomass residues are used for cogeneration purposes and the remaining share left to decay in aerobic conditions in the current sugarcane plantations.
B4	The biomass residues are used for energy or non-energy applications, or the primary source of the biomass residues and/or their fate cannot be clearly identified. For example, this scenario can be used if biomass residues are purchased from biomass processing plants which are not included in the project boundary.	No	Not applicable as the biomass residues are not purchased from any market, or the primary source of the biomass residues and/or their fate in the absence of the project activity cannot be clearly identified.
B5	**The biomass residues are used for power or heat generation at the project site in new and/or existing plants;**	**Yes**	**B5 is a likely baseline scenario since bagasse residue are mainly used to cover the plant energy needs. This is usually the prevailing practice in similar**

			countries and industries. **At the time of PDD elaboration no other category of biomass residues is considered in the baseline.**

Leakage emissions due to diversion of biomass residues from other applications shall be calculated according to the methodological tool “Project and leakage emissions from biomass”.

➔ Leakage emissions due to shift of pre-project activities shall be calculated according to the methodological tool “Project and leakage emissions from biomass”. No biomass scenarios for biomass residues used in the Project activity are subject to leakage, therefore **LE_y = 0**.

Commercially Sensitive Information

All relevant information for the purpose of Project description is included in VCS PD. None of the information disclosed to the validator was withheld from the public version of the report.

Sustainable Development

The contributions of proposed project activity towards sustainable development are explained with indicators like social, economic, environmental and technological well-being, as follows:

- Environmental well-being: The project activity will conserve decay of bagasse and help to mitigate emission of GHG (CH_4) also project is reducing use of grid power.
- Social well-being: The project activity will pave the way for development and increases the social status and living conditions and the prevailing living standard in the vicinity of the project activity and thus results in empowering the nearby population (supplier of the major amount of workforce for construction of the project activity).Also it will Contribute to a small increase in the local employment by employing skilled and un-skilled personnel for operation and maintenance of the equipment. This Proposed Project Activity will result in reduced migration of the local population.
- Economic well-being: The project has created a business opportunity during construction phase for local stakeholders such as suppliers, contractors, bankers etc. contributing to economic well-being aspects. Further, the project also influences creation of employment opportunities for local people, which would enhance their social status. Also, it Saves the coal and HSD and thus allows it to be diverted to other needy sections of the economy.
- Technological well-being: The project activity utilizes biomass as fuel to generate steam and electricity. It is an advanced and sustainable technology for long term benefits. The project activity is expected to increase awareness and interest among the industry players to make investments in similar areas.

Further Information

- Legislative: The Project Proponent has obtained all the relevant approvals required for the establishment and operation of the project activity.

2 SAFEGUARDS

2.1 No Net Harm

No negative environmental and socio-economic impacts was created on the environment. Thus, no net harm caused.

2.2 Local Stakeholder Consultation

Stakeholder consultation meeting not yet planned due to COVID.

Ongoing communication with stakeholders and interested parties is maintained through an open invitation of feedback and criticism. At the gate of SCOUL, a complaint and feedback register are kept for comments of stakeholders and to inform them back for action taken on the comments. A display is maintained to inform the purpose of the register and to encourage any feedback from stakeholders that they may like to convey to SCOUL. Up to the date of preparation of this report, there are no adverse comments from stakeholders regarding implementation of the project.

2.3 Environmental Impact

Project activity received EIA approval from The National Environment Management Authority (NEMA) on 19th May 2016 for establishment of co-generation plant and 33 kV power evacuation line from cogeneration plant to switch yard. EIA approval clarifies that co-generation power plant is meeting all requirements of EIA regulation 1998.

2.4 Public Comments

Ongoing communication with stakeholders and interested parties is maintained through an open invitation of feedback and criticism. At the gate of plant, a complaint and feedback register are kept for comments of stakeholders and to inform them back for action taken on the comments. A display is maintained to inform the purpose of the register and to encourage any feedback from stakeholders that they may like to convey to Sugar Corporation of Uganda Limited. Up to the date of preparation of this report, there are no adverse comments from stakeholders regarding implementation of the project.

2.5 AFOLU-Specific Safeguards

This is a non-AFOLU project. Perhaps, this section is not applicable.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The approved baseline and monitoring methodology applied in the proposed project activity is ACM0006 "Consolidated methodology for electricity and heat generation from biomass residues" Version 15.0.

In line with the application of the ACM0006 methodology, the project refers to the following tools:

- Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)
- Tool to calculate the emission factor for an electricity system (Version 07.0)
- Project and leakage emissions from biomass (Version 04.0)

3.2 Applicability of Methodology

The approved consolidated baseline and monitoring methodology ACM0006 version 15.0 is applicable to biomass-residue (co-) fired power-and heat plants. The project activity includes: The installation of new plants at a site where currently power or heat generation occurs. The new plant replaces or is operated next to existing plants (capacity expansion projects).

S. No.	Applicability condition	Justification for project activity
1	Biomass used by the project facility is limited to biomass residues, biogas, RDF and/or biomass from dedicated plantations;	The project plant will use bagasse (by-product of sugar production), which is a biomass residue. No dedicated plantation activity involved in project activity.
2	Fossil fuels may be co-fired in the project plant. However, the amount of fossil fuels co-fired does not exceed 80% of the total fuel fired on energy basis;	No fossil use in project activity. The use of fossil fuel (coal or natural gas) has been envisaged only in case of emergency in case of lack of biomass.
3	For projects that use biomass residues from a production process (e.g. production of sugar or wood panel boards), the implementation of the project does not result in an increase of the processing capacity of raw input (e.g. sugar, rice, logs, etc.) or in other substantial changes (e.g. product change) in this process;	The implementation of the project does not result in an increase of the processing capacity of raw input or in other substantial change (identical volumes of resulting sugar production).
4	The biomass used by the project facility is not stored for more than one year;	The sugar cane bagasse will not be stored longer than a few months (minor volumes during off-season), this in order to guarantee enough bagasse to start the milling process the year after.

5	The biomass used by the project facility is not obtained from chemically or biologically (e.g. through esterification, fermentation, hydrolysis, pyrolysis, bio-or chemical degradation etc) prior to combustion. Thermal degradation, drying and mechanical processing, such as shredding and pelletisation are allowed.	No chemical process is involved in the biomass preparation prior to combustion. It is directly fed from the crushing mills exit to the boilers. .
6	In the case of fuel switch project activities, the use of biomass residues or the increase in the use of biomass residues as compared to the baseline scenario is technically not possible at the project site without a capital investment in: • The retrofit or replacement of existing heat generators/boilers; or • The installation of new heat generators/boilers; or • A new dedicated biomass supply chain established for the purpose of the project (e.g. collecting and cleaning contaminated new sources of biomass residues that could otherwise not be used for energy purposes); or • Equipment for preparation and feeding of biomass residues.	Not applicable as no fuel switch is at stake.
7	If biogas is used for power and/or heat generation, the biogas must be generated by anaerobic digestion of wastewater, and: • If the wastewater generation source is registered as a CDM project activity, the details of the wastewater project shall be included in the PDD and emissions reductions from biogas energy generation are claimed using this methodology; • If the wastewater source is not a CDM project, the amount of biogas does not exceed 50% of the total fuel fired on energy basis.	Not applicable as no biogas is recovered for power or heat generation.
8	In the case biomass from dedicated plantations are used the applicability conditions of the methodology tool "project and leakage emissions from biomass" apply.	No dedicated plantation involved in project activity as PP is using bagasse waste from sugar industry.

As per methodology

- For power generation: Scenarios P1, P5 and P7.
- For heat generation: Scenarios H1 and H5.
- For biomass residue use: Scenarios B1 and B5.

It is worth to mention that the project activity does not include the generation of mechanical power through steam turbines, or the use of biogas from on-site wastewater, thus, scenarios M1 to M5 and BG1 to BG5 do not apply.

Finally, the project activity complies with all the applicability criteria of the tools referred in the ACM0006 methodology.

Conclusion: the proposed project activity meets all the applicability conditions of the version 15.0 of ACM0006 methodology.

Sr No.	**Tool**	**Applicability with Project activity**
1.	Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)	According to ACM0006 methodology, the selection of the baseline scenario should be conducted by applying the "Combined tool to identify the baseline scenario and demonstrate additionality", thus PP has demonstrated applicability of tool in section 3.4 below.
2.	Tool to calculate the emission factor for an electricity system (Version 07.0)	Project activity has adopted UNFCCC standardised baseline for grid emission factor calculation[2].
3.	Project and leakage emissions from biomass (Version 04.0)	No dedicated plantation involved in project activity as PP is using bagasse waste from sugar industry. Therefore this tool will not be applicable.

3.3 Project Boundary

According to methodology ACM0006, the spatial extent of the project boundary encompasses:

- All plants generating power and/or heat located at the project site, whether fired with biomass residues, fossil fuels or a combination of both;
- All power plants connected physically to the electricity system (grid) that the project plant is connected to;
- If applicable, all off-site heat sources that supply heat to the site where the project activity is located (either directly or via a district heating system);
- The means of transportation of biomass residues to the project site;

[2] https://cdm.unfccc.int/methodologies/standard_base/2015/sb45.html

- If the feedstock is biomass residues, the site where the biomass residues would have been left for decay or dumped;
- If the feedstock is biomass produced in dedicated plantations, the geographic boundaries of the dedicated plantations;
- The wastewater treatment facilities used to treat the wastewater produced from the treatment of biomass residues.
- If biogas is included, the site of the anaerobic digester.

Note that the project boundary encompasses not only the plants generating power and/or heat that are directly affected by the project activity (e.g. retrofitted or installed) but also all other plants generating power and/or heat located at the same site as the project activity, whether fired with biomass residues, fossil fuels or a combination of both. Thus power and heat generation, grid power and heat imports/exports should be considered for the whole site where the project activity is located and all facilities are to be included in the power and heat balances.

As shown in the following table, the emissions sources and the GHG involved in the project activity solely encompass the carbon dioxide (CO_2) saved from displaced fossil fuel consumption for electricity generation. Methane (CH_4) or Nitrous Oxide (N_2O) emissions not considered as there is no dedicated plantation.

Source		Gas	Included?	Justification/Explanation
Baseline	Electricity and heat generation	CO_2	Included	Main Emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
		Other	Excluded	-
	Uncontrolled burning or decay of surplus biomass residues	CO_2	Excluded	It is assumed that CO2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector
		CH_4	Excluded	For conservativeness reasons, project participants decided not to include this emission source.
		N_2O	Excluded	Excluded for simplification. This is conservative. Note also that emissions from natural decay of biomass are not included in GHG inventories as anthropogenic sources
		Other	Excluded	-
Project	On site fossil fuel and electricity consumption	CO_2	Included	The emission due to onsite fossil fuel consumption attributable to the project activity has been included in the project activity

Source		Gas	Included?	Justification/Explanation
	due to the project activity (stationary or mobile)	CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
		Other	Excluded	-
	Grid electricity generation	CO_2	Included	Main Emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Off site Transportation of biomass residues	CO_2	Excluded	Excluded for simplification. This is conservative.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Combustion of biomass residues for electricity and/or heat generation	CO_2	Excluded	Does not apply to the project activity as there is no uncontrolled burning or decay of biomass residues that would lead to GHG emissions
		CH_4	Excluded	
		N_2O	Excluded	
		Other	Excluded	
	Storage of biomass residues	CO_2	Excluded	Does not apply to the project activity as the biomass residues storage period is less than one year.
		CH_4	Excluded	
		N_2O	Excluded	

Identifying GHG sources, sinks and reservoirs for the baseline scenario and for the project:

3.4 Baseline Scenario

According to ACM0006 methodology, the selection of the baseline scenario should be conducted by applying the “Combined tool to identify the baseline scenario and demonstrate additionality”, thus the following steps are applied:

Step 1: Identification of alternative scenarios

This step serves to identify all alternative scenarios to the proposed project activity(s) that can be the baseline scenario through the following sub-steps:

Step 1a: Definition of alternatives scenarios to the proposed project activity

Identify realistic alternative scenarios that are available to the project participants and that provide outputs or services with comparable quality, properties and application areas as the proposed project activity, i.e. heat and power production for the sugar mill facilities.

The project activity does not include the generation of mechanical power through steam turbines, or the use of biogas from on-site wastewater, thus, these scenarios have not been considered.

Alternative scenarios for electric power:

Description of alternative scenarios		**Plausible and credible alternative?**	**Rationale**
P1	**The proposed project activity not undertaken as a CDM project activity.**	**Yes**	**Project activity is feasible although not likely to occur without carbon financing.**
P2	If applicable, the continuation of power generation in existing power plants at the project site; The existing plants would operate at the same conditions (e.g. installed capacities, average load factors, or average energy efficiencies, fuel mixes, and equipment configuration) as those observed in the most recent three years prior to the starting date of the project activity;	No	P2 is not plausible baseline scenario, as the old turbine of 9.5 MW (6+3.5 MW) would be replaced by a new one of 30 MW, which will cover the onsite power demand. Indeed, the continuation of power generation in the existing turbine at the project site is not a realistic scenario as its power capacity is not enough to meet the onsite power requirements based on the forecast sugar cane production.
P3	If applicable, the continuation of power generation in existing power plants at the project site. *The existing plants would operate with different conditions from those observed in the most recent three years prior to the starting date of the project activity;*	No	P3 is not plausible baseline scenario, as the old turbine of 9.5 MW (6+3.5 MW) would be replaced by a new one of 30 MW, which will cover the onsite power demand. Indeed, the continuation of power generation in the existing turbine at the project site is not a realistic scenario as its power capacity is not

			enough to meet the onsite power requirements based on the forecast sugar cane production.
P4	If applicable, the retrofitting of existing power plants at the project site; *The retrofitting may or may not include a change in fuel mix;*	No	The retrofitting of the 9.5 MW (6+3.5 MW) turbine is not a realistic scenario since in the baseline the electricity demand exceeds installed capacity. As per stated above, during the baseline this unit is replaced by a new one of 30 MW which covers the onsite power demand.
P5	**The installation of new power plants at the project site different from those installed under the project activity;**	**Yes**	**P5 is a plausible baseline scenario as a new turbine of 30 MW would be installed in order to replace the current one and meet the onsite power requirements according to the forecast sugar cane production.**
P6	The generation of power in specific off-site plants, excluding the power grid;	No	Not credible as there are no off-site plants neither existing nor planned to be built near the project site.
P7	**The generation of power in the power grid.**	**Yes**	**Feasible considering that the Sugar mill is connected to the national grid although in the baseline situation the factory entirely covers its power demand.** **In the absence of the project activity, no electricity is exported into the grid and consequently other plants which are mainly based on fossil fuel would have generated the same power into the grid.**

Alternative scenarios for heat:

Description of alternative scenarios		Plausible and credible alternative?	Rationale
H1	**The proposed project activity not undertaken as a CDM project activity.**	**Yes**	**Project activity is feasible although not likely to occur without carbon financing.**
H2	If applicable, the continuation of heat generation in existing plants at the project site; *The existing plants would operate at the same conditions (e.g. installed capacities, average load factors, or average energy efficiencies, fuel mixes, and equipment configuration) as those observed in the most recent three years prior to the starting date of the project activity;*	No	H2 is not a plausible baseline scenario, since in the absence of the project the existing plant will operate with different conditions to those observed in the most recent three years prior to the starting date of the project activity.
H3	If applicable, the continuation of heat generation in existing plants at the project site. The existing plants would operate with different conditions from those observed in the most recent three years prior to the CDM project activity;	No	H3 is not plausible scenario as a new boiler is installed in absence of the project activity in order to meet the sugar mill heat demand.
H4	If applicable, the retrofitting of existing plants at the project site; *The retrofitting may or may not include a change in fuel mix;*	No	In the absence of the project activity, the current heat capacity is increased through the installation of a new boiler of 150 TPH and all the sugar mill heat requirements are covered. Under this scenario all the installed boilers continue to operate without any retrofitting. H4 is not a realistic scenario.
H5	**The installation of new power plants at the project site different from those installed under the project activity;**	**Yes**	**H5 is a plausible baseline scenario as in addition to the current boilers, a new one of 150 TPH would be installed in order to**

			increase the heat-installed capacity and cover sugar mill requirements according to the forecast sugar cane production.
H6	The generation of heat in specific off-site plants;	No	Not credible as there is no off-site heat-generating plants neither existing nor planned to be built near the project site.
H7	The use of heat from district heating.	No	There is no district heating available in Uganda.

Alternative scenarios for the use of biomass residues, as per the methodological tool "Project and leakage emissions form biomass" (Version 04.0):

Description of alternative scenarios		Plausible and credible alternative?	Rationale
H1	**The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields;**	**Yes**	**B1 is a likely baseline scenario since biomass residues are used for cogeneration purposes and the remaining share is left to decay in aerobic conditions in the current sugarcane plantations.**
H2	The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to landfills which are deeper than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields;	No	Not applicable as the biomass residues are used for cogeneration purposes and the remaining share left to decay in the current sugarcane plantations.
H3	The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes;	No	Not applicable as the biomass residues are used for cogeneration purposes and the remaining share left to decay in aerobic conditions in the current sugarcane plantations.
H4	The biomass residues are used for energy or non-energy applications, or the primary source of the biomass residues	No	Not applicable as the biomass residues are not purchased from any market, or the primary source of the biomass

	and/or their fate cannot be clearly identified. For example, this scenario can be used if biomass residues are purchased from biomass processing plants which are not included in the project boundary.		residues and/or their fate in the absence of the project activity cannot be clearly identified.
H5	**The biomass residues are used for power or heat generation at the project site in new and/or existing plants;**	**Yes**	**B5 is a likely baseline scenario since bagasse residues are mainly used to cover the plant energy needs. This is usually the prevailing practice in similar countries and industries. At the time of PDD elaboration no other category of biomass residues is considered in the baseline.**

The baseline scenario for the use of biomass residues should be separately identified for different categories of biomass residues, covering the whole amount of biomass residues supposed to be used in the project activity during the crediting period, and consistent with the alternative scenarios selected for power and heat generation (scenarios P and H above):

Biomass residues category (*k*)	Biomass residues type	Biomass residues source	Biomass residues fate in the absence of the project activity	Biomass residues use in project scenario
1	Cane bagasse	On-site production	Power and heat generation on-site (B5)	Power and heat generation on-site (cogeneration)
		On-site production	Left to decay in aerobic conditions in the current sugarcane plantations (B1)	Power and heat generation on-site (cogeneration)

Outcome of Step 1a: List of plausible alternative scenarios to the project activity

Following the above analysis, the plausible alternative scenarios further considered are:

- For power generation: P1, P5 and P7
- For heat generation: H1 and H5
- For biomass residues: B1 and B5

Sub-step 1b: Consistency with mandatory applicable laws and regulations

The plausible alternative scenarios must be in compliance with all mandatory applicable laws and regulatory requirements. A review of their consistency with these laws and regulations is presented hereafter.

	Regulatory Analysis	Consistency with law and regulations?
P1, H1	As the project activity legal due diligence demonstrates, this alternative scenario complies with all mandatory applicable legal and regulatory requirements.	Yes
P7	Current grid-connected power plants operate under the control and responsibility of the Uganda Electricity Transmission Company Ltd. (UETCL), a Government body in compliance with the law.	Yes
B1, B5	The biomass residues are used for power or heat generation at the project site in plant and left to decay in aerobic conditions in the current sugarcane plantations: As the current sugar mill operation permits demonstrate, this alternative scenario complies with all mandatory applicable legal and regulatory requirements.	Yes

Outcome of Step 1b: List of alternative scenarios to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the region or country.

Following the above analysis, the plausible alternative scenarios compliant with mandatory legislation and regulations in force in Uganda are:

- For power generation P1, P5 and P7
- For heat generation: H1 and H5
- For biomass residues: B1 and B5

Hence the following credible combinations of baseline scenarios still under consideration at this stage:

Baseline Scenario			**Description of the situation**
Power	**Heat**	**Biomass residues**	
P1	H1	B5	The proposed project activity, **not undertaken as a** project activity: • The installation of a high efficiency biomass residues co-generation plant to generate extra power for greater autonomy and export to the grid. • The biomass residues are used for power or heat generation at the project site in the project activity plant.
P5, P7	H5	B1, B5	A low-medium efficiency, common practice cogeneration plant: • The heat and power generation to cover the entire sugar mill according to forecast sugar cane production. • There is no surplus of electricity delivered to the national grid.

			• The biomass residues are used for power or heat generation at the project site and left to decay in aerobic conditions on the current sugarcane plantations.

According to the "Combined tool to identify the baseline scenario and demonstrate additionality":

If there is only one alternative scenario that is not prevented by any barrier, and if this alternative is not the proposed project activity undertaken without being registered as a project activity, then **this alternative scenario is identified as the baseline scenario.**

Therefore, the baseline scenario is identified as the only alternative scenario that is not prevented by any barrier: a low-medium efficiency, business-as-usual cogeneration plant.

3.5 Additionality

The applied methodology requires the project participant to apply the latest approved version of the "Tool for the demonstration and assessment of additionality" (Version 07.0.0) in addition to the procedure mentioned in the methodology.

Step0: Demonstration whether the proposed project activity is the first-of-its-kind

The PP has demonstrated that the proposed project activity is a first-of-its-kind project activity as per "Tool 23: Methodological tool: Additionality of First-of-Its-Kind Project Activities" version 3.

Identifying the applicable geographical area:

As per the tool 23 para 12 (a), applicable geographical area that applies a technology that is different from technologies that are implemented by any other project, which are able to deliver the same output and have started commercial operation in the applicable geographical area before the project design document is published for global stakeholder consultation or before the start date of the proposed project activity, whichever is earlier.

The project activity covers the entire host country as a default. Project participants may provide justification that the applicable geographical area is smaller than the host country for technologies that vary considerably from location to location depending on local conditions. For the project activity, the relevant sectors identified were the renewable energy sector and the sugar sector. A review of the policies concerning these industries indicates that these sectors are governed at a country level and hence varies considerably throughout Uganda. Sugar is one of the essential items in Uganda and Uganda is largest producer of granular brown sugar in the east African community. As the industry in general is controlled by the government and the use and promotion of renewable energy is also managed at a country level, the region for the 'First of its Kind' assessment has been selected as the country where the project activity has been implemented, i.e. Uganda.

Project activity involves the implementation of a high pressure boiler and the baseline involves the implementation of a low pressure boiler with lower efficiency. The project activity is a first instance of the implementation of the particular technology in the identified geographical region. In Uganda no sugar industry have commissioned 87 bar high pressure boiler based on bagasse as a input fuel. Hence project activity is a first of it's kind activity in the geographical region.

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

Sub-step 1a: Define alternatives to the project activity:

The identification of the realistic and credible alternatives to the project activity, consistent with the current laws and regulations, has been detailed in Section 3.4. The plausible alternatives thus identified for power, biomass and heat are provided below:

Power - P4 and P5- The installation of new power plants at the project site different from those installed under the project activity and the Generation of Power in the power grid. Heat:

H5- Generation of heat using biomass residues

Biomass- B1 and B4- Biomass residues is either dumped and left to decay aerobically or used to generate heat and power

Outcome of Step 1a: Identified realistic and credible alternative scenario(s) to the project activity

Sub-step 1b: Consistency with mandatory laws and regulations

All the above identified scenarios are in compliance with the applicable legal and regulatory requirements.

Outcome of Step 1b: Identified realistic and credible alternative scenario(s) to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the country and EB decisions on national and/or sectoral policies and regulations.

Step 2: Investment Analysis

In order to demonstrate the additionality, an Investment Analysis has been conducted between the identified baseline scenario and the project activity scenario without carbon financing. The list of assumptions used for the investment comparison analysis between the baseline reference plant and the project activity plant has been provided in Appendix I.

The reference plant design parameters as been detailed in Appendix I. This step has been implemented following the guidance provided in Step 2 of the latest version of the "Tool for the demonstration and assessment of additionality".

Sub-step 2a: Determine appropriate analysis method

As per paragraph 19 if the "GUIDELINES ON THE ASSESSMENT OF INVESTMENT ANALYSIS", Version (05, EB 62), "If the proposed baseline scenario leaves the project participant no other choice than to make an investment to supply the same (or substitute) products or services, a benchmark analysis is not appropriate and an investment comparison analysis shall be used. If the alternative to the project activity is the supply of electricity from a grid this is not to be considered an investment and a benchmark approach is considered appropriate."

In the proposed project activity, the project participant has identified a reference co-generation plant that would have been set up in the absence of the project activity. Therefore, even in the absence of the proposed carbon project, the project participant would have made an investment to set up the baseline reference plant. Therefore, as per the guidance, benchmark analysis has not been considered appropriate and the project participant has demonstrated additionality through investment comparison analysis.

Sub-step 2b: As the project participant has chosen investment comparison analysis to demonstrate the additionality, Option II under the tool is applicable.

The proposed project activity involves the setting up of a biomass based co-generation plant that would meet the captive thermal and electrical energy requirements at the project site. The project activity also includes a source of revenue through sale of power to the regional grid. Therefore, in the context of decision making and for demonstration of additionality, Internal Rate of Return (IRR) has been used as the financial indicator.

Sub-step 2c: Calculation and comparison of financial indicators Based on the listed set of the assumptions, the IRR for the project activity works out to be 5.7% while the IRR for the reference plant works out to be 19.42%. Thus, in the absence of carbon project, the project participant could have opted to setup the low efficiency reference plant. However, considering the additional revenues that could be generated through the sale of carbon credits, the PP has decided to proceed ahead with the implementation of the project activity.

Sub-step 2d: Sensitivity analysis

The key parameters which are likely to impact the IRR are a) the Project cost, b) Cost of biomass, NCV of biomass, c) Plant Load Factor and d) Efficiency for the reference plant and the project activity power plant. The result of +/- 10% variation in the project cost on the IRR is provided in tabular format below:

Parameter	Variation	Revised Value	Revised IRR
Project Cost of Reference Plant	10%	45000000	19.42%
Project Cost of Project Plant	10%	42548099	12.31%
Biomass Price in Baseline Scenario	10%	32	19.42%
Biomass Price in Project Scenario	10%	30	12.31%
Tariff Escalation in Baseline Scenario	10%	11.00%	19.42%
Tariff Escalation in Project Scenario	10%	11.00%	12.31%
PLF in Baseline Scenario	10%	95%	19.42%
PLF in Project Scenario	10%	95%	12.31%
Calorific Value in Baseline Scenario	10%	3630	19.42%
Calorific Value in Project Scenario	10%	3300	12.31%

Steam to Fuel Ratio for Project Plant	10%	2.475	12.31%
Steam to Fuel Ratio for Reference Plant	10%	2.64	19.42%

As can be seen from the above table, even with a variation ± 10%, in all the key parameters, the IRR for the project plant remains below that of the reference plant. The only identified case wherein the IRR for the reference falls below that of the project plant is when the steam to fuel ratio for the reference plant reduces to 2.64. However, this scenario is unrealistic. Thus it may be concluded that the project activity is financially less attractive as compared to the reference plant. However, the project participant has decided to proceed ahead with the implementation of the project considering carbon funds.

Outcome of Step 2: As per the sensitivity analysis, it is concluded that the proposed project activity is not the most financially/economically attractive option for the project participant.

Step 3: Barrier Analysis

Sub-step 3a: Identify barriers that would prevent the implementation of alternative scenarios

Detailed below are the proposed project activity: The identified barrier that would prevent the implementation of the project activity in the absence of carbon credit is the Lack of prevailing practice. The project activity involves consumption of biomass for the generation of heat and power. The heat thus generated will be used in the sugar manufacturing process. The power generated would also be used to meet the power demand of the sugar plant and the surplus power is planned to be exported to the grid. The high power generation and export to the grid has been possible due to the employment of a highly efficient technology. The boiler proposed to be implemented as a part of the project activity is a 87 bar pressure boiler.

Outcome of Step 2a

The identified barrier is lack of prevailing practice.

Sub Step 3b: Eliminate alternative scenarios which are prevented by the identified barriers

The above listed barriers prevent the implementation of the project activity in the absence of carbon financing. However, these barriers do not prevent the implementation of the identified baseline scenario, i.e., implementation of a reference plant with low efficiency, as it is the most common practice followed by the industry.

Outcome of Step 2b: The list of alternative scenarios that are not prevented by the prevailing practice barrier For Power: P5: The generation of heat in a new cogeneration plant at the project site P7: The generation of power in the power grid For Heat: H5: The generation of hear in a new cogeneration plant at the project site; For Biomass: B1: The Biomass residues are dumped or left to decay mainly under aerobic conditions. This applies for example, to dumping and decay of biomass residues on fields. B4: The biomass residues are used for power or heat generation at the project site in new and/or existing plants Thus, the only remaining alternative for the project is the implementation of a baseline reference plant with a lower efficiency.

As per the applied methodology, if there is only one alternative scenario that is not prevented by

any barrier, and if this alternative is not the proposed project activity undertaken without being registered as a VCS project activity, then this alternative scenario is identified as the baseline scenario. From the above discussion it can be concluded that the baseline for the project would be the implementation of the baseline reference plant with lower efficiency.

Step 4: Common Practice Analysis

This step will justify whether “If similar activities to the proposed project activity are identified, then compare the proposed project activity to the other similar activities and assess whether there are essential distinctions between the proposed project activity and the similar activities”.

The common practice analysis has been conducted as per the guidance provided in Tool 24: Methodological tool: Common Practice, version 3.1

Step 1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

The proposed project activity is a 30 MW bagasse based cogeneration plant. As per the requirement of step 1, the applicable output range works out to ±50% of the rated output of the project plant (30 MW). The applicable output range, is therefore, 15 MW – 45 MW.

Step 2: identify similar projects (both CDM and non-CDM) which fulfil all of the following conditions:

(a) The projects are located in the applicable geographical area;
(b) The projects apply the same measure as the proposed project activity;
(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;
(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;
(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;
(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity

Selection of applicable geographical area:

Project participants may provide justification that the applicable geographical area is smaller than the host country for technologies that vary considerably from location to location depending on local conditions. For the project activity, the relevant sectors identified were the renewable energy sector and the sugar sector. A review of the policies concerning these industries indicates that these sectors are governed at a country level and hence varies considerably throughout Uganda. Sugar is one of the essential items in Uganda and Uganda is largest producer of granular brown sugar in the east African community.

As the industry in general is controlled by the government and the use and promotion of renewable energy is also managed at a country level, the region for the 'project activity has been selected as the country where the project activity has been implemented, i.e. Uganda.

The list of projects that started commercial operation before the start date of the project includes[3]:

Company	Location	Capacity (MW)	Date of commissioning	Plant details
Kakira Sugars Ltd	Jinja, Uganda	52MW (22MW + 30MW)	2008 & 2012	100 TPH (2X50) boiler, 45 bar 160 TPH, 67 bar

[3] https://www.era.go.ug/index.php/stats/generation-statistics/energy-generated-by-utility

Kinyara Sugar works limited	Masindi, Uganda	14.5 MW	2015	
Sugar and Allied Industries Uganda limited	Kaliro, Uganda	11.9 MW	2014	110 TPH boiler, 45 bar
Mayuge Sugar Limited	Mayuge, Uganda	9.2 MW	2018	90 TPH boiler, 45 bar

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number Nall.

Therefore, N_{all} = 4

Step 4: within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

Therefore, Ndiff = 4

Step 5: Calculate factor $F=1-N_{diff}/N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity

F = 1-4/4 = 1-1 = 0

The proposed project activity is a "common practice" within a sector in the applicable geographical area if the factor F is greater than 0.2 and Nall-Ndiff is greater than 3.

As F = 0 (<0.2), the proposed project activity is not a common practice in the sector in the applicable area.

A review of the operational sugar plants reveal that the common practice in the region is to set up cogeneration plants with low pressure boilers. The most common configuration is setting up of lower pressure boilers. No activities similar to the project activity, ie. High pressure Boilers with 87 bar pressure has been observed. Therefore there is no scope of comparison with similar activities. Hence the proposed project activity is additional.

3.6 Methodology Deviations

There was no deviation in methodology followed. Thus, this section is not applicable.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions are calculated as follows:

$$BE_y = EL_{BL,GR,y} \times EF_{EG,GR,y} + \sum_f FF_{BL,HG,y,f} \times EF_{FF,y,f} + EL_{BL,FF/GR,y} \times min(EF_{EG,GR,y}, EF_{EG,FF,y}) + BE_{BR,y}$$ Equation (1)

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2)
$EL_{BL,GR,y}$	=	Baseline electricity sourced from the grid in year *y* (MWh)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (t CO_2/MWh)
$FF_{BL,HG,y,f}$	=	Baseline fossil fuel demand for process heat in year *y* (GJ)
$EF_{FF,y,f}$	=	CO_2 emission factor for fossil fuel type *f* in year *y* (t CO_2/GJ)
$EL_{BL,FF/GR,y}$	=	Baseline uncertain electricity generation in the grid or on-site or off-site power-only units in year *y* (MWh)
$EF_{EG,FF,y}$	=	CO_2 emission factor for electricity generation at the project site or off-site plants in the baseline in year *y* (t CO_2/MWh)
$BE_{BR,y}$	=	Baseline emissions due to disposal of biomass residues in year *y* (t CO2e)
f	=	Fossil fuel type

Step 1: Determine the total baseline process heat generation *($HC_{BL,y}$)*, electricity generation and capacity constraints, and efficiencies

Step 1.1: Determine the total baseline process heat generation

The amount of process heat that would be generated in the baseline in year *y* ($HC_{BL,y}$) is determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generators.

This methodology assumes for the sake of simplicity that the proposed project activity consumes steam from the same quality as in baseline process transported through one steam header.

Step 1.2: Determine the baseline capacity of electricity generation *($CAP_{EG,total,y}$)*

$$CAP_{EG,total,y} = LOC_y \times \left[\sum_i \left(CAP_{EG,CG,i} \times LFC_{EG,CG,i}\right) + \sum_j \left(CAP_{EG,PO,j} \times LFC_{EG,PO,j}\right) \right]$$ Equation (2)

Where:

$CAP_{EG,total,y}$	=	Baseline electricity generation capacity in on-site and off-site plants in year y (MWh)
$CAP_{EG,CG,i}$	=	Baseline electricity generation capacity of cogeneration-type heat engine *i* (MW)
$CAP_{EG,PO,j}$	=	Baseline electricity generation capacity of power-only-type heat engine *j* (MW)
$LFC_{EG,CG,i}$	=	Baseline load factor of cogeneration-type heat engine *i* (ratio)
$LFC_{EG,PO,j}$	=	Baseline load factor of power-only-type heat engine *j* (ratio)
LOC_y	=	Operation of the industrial facility using the process heat in year *y* (hour)
i	=	Cogeneration-type heat engine in the baseline scenario
j	=	Power-only-type heat engine in the baseline scenario

Step 1.3: Determine the efficiencies of heat generators, and efficiencies and heat-to-power ratio of heat engines

Heat Generators

According to the methodology, different options can be used to determine the heat generators efficiency. The following considerations have been taken:

- Option 1 (Default values): for the new boiler that would be constructed and operated at the project site in the baseline scenario

➔ A value of 90% has been used for the boiler of 140 TPH to be installed. This value is also comparable to the project activity boiler efficiency value.

- Option 2 (Manufacturer's data): for the current installed boilers, which have been in operation prior to the implementation of the project activity. This option is applicable since heat engines and heat generators were operated at the project site prior to the implementation of the project activity (no new equipment would be constructed and operated at the project site in the baseline scenario). The efficiency of the heat generator or heat engine is determined based on manufacturer's data of the efficiency under optimal operating conditions and take into account the actual conditions of the fuel used (including moisture content of biomass residues).

➔ Boiler, have an efficiency of 80% respectively. As practical and conservative approach, the highest value of 80% has been used for both boilers in the heat baseline emissions calculation.

Heat Engines

Based on design conditions of the plant a value of 7.71 tonnes of steam per MWh has been used in order to determine the heat engine efficiency.

➔ Based on enthalpy values of 3.43 GJ/tonne of steam (h_{high}) and 7.71 tonnes of steam/MWh, the engine efficiency results in 0.038 MWh/GJ.

Heat to power ratio

As per Case 2 of the methodology, for heat engines without a minimum three-year operational history prior to the project activity the heat-to-power ratio should be determined as per the design conditions of the plant, for the configuration identified as baseline scenario in the selection of the baseline scenario and demonstration of additionality.

- ➔ Based on design conditions of the plant, the value has been estimated through the expected quantity of process heat extracted from the heat engine (h_{low}=2.727 kJ/kg) and the heat energy efficiency expressed in tonnes of steam per MWh (7.71 t/MWh). This results in a ratio of 5.935

Step 2: Determine the baseline electricity generation in the grid and emission factors

Step 2.1: Determine the baseline electricity generation *($EL_{BL,y}$)*

The amount of electricity that would be generated in the baseline in year *y* equals the amount of electricity generated in the project scenario as follows:

$$EL_{BL,y} = EL_{PJ,gross,y} + EL_{PJ,imp,y} - EL_{PJ,aux,y} \quad \text{Equation (3)}$$

Where:

$EL_{BL,y}$	=	Baseline electricity generation in year *y* (MWh)
$EL_{PJ,gross,y}$	=	Gross quantity of electricity generated in all power plants included in the project boundary in year *y* (MWh)
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year *y* (MWh)
$EL_{PJ,aux,y}$	=	Total auxiliary electricity consumption required for the operation of the power plants in year *y* (MWh)

$EL_{PJ,aux,y}$ includes all electricity required for the operation of equipment related to the preparation, storage and transport of biomass residues (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.) and electricity required for the operation of all power or heat generating plants which are located at the project site and included in the project boundary (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.).

Step 2.2: Determine the baseline electricity sourced from the grid *($EG_{BL,GR,y}$)*

The amount of electricity that would be sourced from the grid in the baseline is calculate assuming that the amount of electricity generated on-site and off-site in the baseline shall be limited by the installed capacity of power generation available in the baseline scenario (on-site and off-site):

$$EL_{BL,GR,y} = max\left(0, EL_{BL,y} - CAP_{EG,total,y}\right)$$ Equation (4)

Where:

$EL_{BL,GR,y}$	=	Baseline electricity sourced from the grid in year *y* (MWh)
$EL_{BL,y}$	=	Baseline electricity generation in year *y* (MWh)
$CAP_{EG,total,y}$	=	Baseline electricity generation capacity in on-site and off-site plants in year *y* (MWh)

Step 2.3: Determine the emission factor of grid electricity generation *($EF_{EG,GR,y}$)*

The grid emission factor ($EF_{EG,GR,y}$) shall be determined using the latest approved version of "TOOL07: Tool to calculate the emission factor for an electricity system".

Step 2.4: Determine the emission factor of on-site electricity generation with fossil fuels ($EF_{EG,FF,y}$)

Since no fossil fuel based power generation was identified as part of the baseline scenario, $EF_{EG,FF,y} = EF_{EG,GR,y}$.

Step 3: Determine the baseline biomass-based heat and power generation

Step 3.1: Determine the baseline biomass-based heat generation ($HG_{BL,BR,y}$)

$$HG_{BL,BR,y} = \sum_{h}\sum_{n}\left(BR_{B5,n,h,y} \times NCV_{BR,n,y} \times \eta_{BL,HG,BR,h}\right)$$ Equation (5)

Where:

$HG_{BL,BR,y}$	=	Baseline biomass-based heat generation in year *y* (GJ)
$BR_{B5,n,h,y}$	=	Quantity of biomass residues of category *n* used in heat generator *h* in year *y* with baseline scenario B5 (tonne on dry-basis)
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category *n* in year *y* (GJ/tonne on dry-basis)
$\eta_{BL,HG,BR,h}$	=	Baseline biomass-based heat generation efficiency of heat generator *h* (ratio)

Step 3.2: Determine the baseline biomass-based cogeneration of process heat and electricity and heat extraction

Based on the quantity of heat used in the heat engine the biomass-based cogeneration electricity and heat have been estimated as follows:

$$EL_{BL,BR,CG,y} = \frac{1}{3.6} \times \sum_{i} \left(\frac{1}{(HPR_{BL,i} + 1)} \times \eta_{BL,EG,CG,i} \times HG_{BL,BR,CG,y,i} \right)$$ Equation (6)

$$HC_{BL,BR,CG,y} = \sum_{i} \left(\frac{HPR_{BL,i}}{(HPR_{BL,i} + 1)} \times \eta_{BL,EG,CG,i} \times HG_{BL,BR,CG,y,i} \right)$$ Equation (7)

Where:

$EL_{BL,BR,CG,y}$	=	Baseline biomass-based cogenerated electricity in year *y* (MWh)
$\eta_{BL,EG,CG,i}$	=	Baseline electricity generation efficiency of heat engine *i* (MWh/GJ)
$HG_{BL,BR,CG,y,i}$	=	Baseline biomass-based heat used in heat engine *i* in year *y* (GJ)
$HC_{BL,BR,CG,y}$	=	Baseline biomass-based process heat cogenerated in year *y* (GJ)
$HPR_{BL,i}$	=	Baseline heat-to-power ratio of the heat engine *i* (ratio)

Case 3.2.3: $HG_{BL,BR,y} > \sum_i HG_{BL,BR,CG,y,i}$ and $HC_{BL,y} \geq HC_{BL,BR,CG,y}$ is verified

i.e. there would be biomass-based heat in the baseline that could still be used and process heat demand to be met. It is assumed then that this balance of biomass-based heat would be extracted from the heat header and used to meet the process heat demand without cogeneration of power.

As per case 3.2.3.2. the balance of biomass-based heat (right-hand side of the equation 14) is less than the remaining demand for process heat (left-hand side of the equation). Then all biomass-based heat is used and there still remains process heat demand to be met. However this lack of biomass- based heat is supplied through the two remain boilers, which feed directly the sugar mill process without cogeneration.

Moreover, no fossil fuels use occurs in the current business-as-usual baseline

$$HC_{BL,y} - HC_{BL,BR,CG,y} > \frac{h_{LOW,y}}{h_{HIGH,y}} \times \left(HG_{BL,BR,y} - \sum_{i} HG_{BL,BR,CG,y,i} \right),$$

Therefore, the slight resulting difference $HC_{balance,FF,y}$ is considered as due to inappropriate default values and conservatively neglected, as well as $EL_{balance,FF,y}$, and step 4 are skipped.

Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation

As mentioned before, the use of fossil fuels has not been considered therefore the step 4 does not apply.

Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues

Project participants decided not to include these emission sources. Therefore, $BE_{BR,y} = 0$.

Baseline emissions

$$BE_y = EL_{BL,GR,y} \times EF_{EG,GR,y} + \sum_f FF_{BL,HG,y,f} \times EF_{FF,y,f} + EL_{BL,FF/GR,y} \times min\left(EF_{EG,GR,y}, EF_{EG,FF,y}\right) + BE_{BR,y}$$

4.2 Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{GR1,y} + PE_{GR2,y} + PE_{TR,y} + PE_{BR,y} + PE_{WW,y} + PE_{BG2,y} + PE_{BC,y}$$ Equation (8)

Determination of PE_{FFy}

The following emission sources should be included in determining $PE_{FF,y}$:

- Emissions from on-site fossil fuel consumption for the generation of electric power and heat. This includes all fossil fuels used at the project site in heat generators (e.g. boilers) for the generation of electric power and heat; and
- Emissions from on-site fossil fuel consumption of auxiliary equipment and systems related to the generation of electric power and heat. This includes fossil fuels required for the operation of auxiliary equipment related to the power and heat plants (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.) which are not accounted in the first bullet, and fossil fuels required for the operation of equipment related to the preparation, storage and transportation of fuels (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.).

➔ At the time of PDD elaboration no on-site fossil fuel consumption is foreseen during normal operation of the plant, however, a minor amount of fossil fuel could be used to launch the boilers at the beginning of the crop season. In addition, fossil fuel could be used in the unlikely situation of lack of bagasse. At this stage, for the purpose of PDD ex-ante estimations, **$PE_{FF,y} = 0$** however, fossil fuel will be monitored in case to be used.

Determination of $PE_{GR1,y}$

If electricity is imported from the grid to the project site during year *y*, corresponding emissions should be accounted for as project emissions, as follows:

$$PE_{GR1,y} = EF_{EG,GR,y} \times EL_{PJ,imp,y}$$ Equation (9)

Where:

$PE_{GR1,y}$	=	Emissions during the year *y* due to grid electricity imports to the project site (t CO_2)
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year *y* (MWh)

$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (t CO_2/MWh)

No electricity imports are envisaged from the grid, except in the unlikely situation of default of the turbo-generator. If this situation occurs electricity from the grid will be monitored and therefore the related project emissions will be accounted. For the purpose of the ex-ante estimations in the PDD **$PE_{GR1,y}$ = 0.**

Determination of *$PE_{GR2,y}$*

If $EL_{balance,PO,y} < EL_{BL,BR,PO,y}$ (Step 3.3.2) or $EL_{balance,FF,y} < EL_{BL,FF,y}$ (Step 4.2.2), the amount of electricity generated on-site in the baseline is higher than the amount of electricity generated in the project scenario. In such cases, it is assumed that an equivalent amount of electricity is generated during year *y* in order to offset this reduction in electricity generation at the project site. Corresponding emissions should be accounted as project emissions as follows:

$$PE_{GR2,y} = EF_{EG,GR,y} \times EL_{PJ,offset,y} \quad \text{Equation (10)}$$

Where:

$PE_{GR2,y}$	=	Emissions due to a reduction in electricity generation at the project site in year *y* (tCO_2)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (tCO_2/MWh)
$EL_{PJ,offset,y}$	=	Electricity that would be generated in the baseline that exceeds the generation of electricity during year *y* (MWh)

The amount of electricity generated on-site in the baseline does not exceed the amount of electricity generated in the project scenario, therefore **$PE_{GR2,y}$ = 0.**

Determination of *$PE_{TR,y}$*

In cases where the biomass residues are not generated directly at the project site, project participants shall determine CO_2 emissions resulting from transportation of the biomass residues to the project plant.

➔ Since no additional biomass residues used in the project activity are transported from the fields compared to the baseline practise, no related project emissions are accounted for and **$PE_{TR,y}$ = 0 .**

Determination of $PE_{BR,y}$

If project proponents chose to include emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$) in the calculation of baseline emissions, then emissions from the combustion of biomass residues have also to be included in the project scenario. Otherwise, this emission source may be excluded.

➔ Emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$) were not included in the calculation of baseline emissions, therefore **$PE_{BR,y}$ = 0.**

Determination of $PE_{WW,y}$

This emission source should be estimated in cases where wastewater originating from the treatment of the biomass is (partly) treated under anaerobic conditions and where methane from the waste water is not captured and flared or combusted.

➔ There is no anaerobic wastewater treatment due to project activity therefore **$PE_{WW,y}$ = 0.**

Determination of $PE_{BG2,y}$

This emission source is considered in case of biogas production.
➔ As there is no production of biogas due to project activity therefore **$PE_{BG2,y}$ = 0.**

Determination of $PE_{BC,y}$

According to the methodology, if the project includes biomass from dedicated plantations, the associated project emissions shall be calculated according to the methodological tool "Project and leakage emissions from biomass".

For now, according to the baseline scenario defined in above section there is not cultivation of land to produce biomass therefore can be considered as **$PE_{BC,y}$= 0.**

4.3 Leakage

Leakage emissions due to diversion of biomass residues from other applications shall be calculated according to the methodological tool "Project and leakage emissions from biomass".

➔ Leakage emissions due to shift of pre-project activities shall be calculated according to the methodological tool "Project and leakage emissions from biomass". No biomass scenarios for biomass residues used in the Project activity are subject to leakage, therefore **LE_y = 0.**

4.4 Estimated Net GHG Emission Reductions and Removals

Emission reduction:

$ER_y = BE_y – PE_y – LE_y$

Where:

ER_y = Emission reductions in year y (t CO2e)
BE_y = Baseline emissions in year y (t CO2e)
PE_y = Project emissions in year y (t CO2)

LE_y = Leakage emissions in year y (tCO2)

The detailed calculation has been provided in the Excel Sheet.

Year	Estimated baseline emissions or	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or

	removals (tCO_2e)			removals (tCO_2e)
19/07/2021 - 31/12/2021	49,567	0	0	49,567
01/01/2022 - 31/12/2022	108,988	0	0	108,988
01/01/2023 - 31/12/2023	108,988	0	0	108,988
01/01/2024 - 31/12/2024	108,988	0	0	108,988
01/01/2025 - 31/12/2025	108,988	0	0	108,988
01/01/2026 - 31/12/2026	108,988	0	0	108,988
01/01/2027 - 31/12/2027	108,988	0	0	108,988
01/01/2028 – 18/07/2028	59,719	0	0	59,719
Total	**763,215**	**0**	**0**	**763,215**

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	Biomass residues categories and quantities used for the selection of the baseline scenario selection and assessment of additionality.
Data unit	– Category (i.e. bagasse, rice husks, empty fruit bunches, etc.); – Source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, from dedicated plantations etc.); – Fate in the absence of the project activity (scenarios B); – Use in the project scenario (scenarios P); – Quantity (tonnes on dry-basis)
Description	Refer to Biomass Residues Description in section 3.4
Source of data	On-site assessment of biomass residues categories and quantities
Value applied	363,957 tonne/year
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Baseline emission calculation
Comments	This parameter is related to the procedure for the selection of the baseline scenario selection and assessment of additionality.

Data / Parameter	$BR_{HIST,n,x}$
Data unit	tonnes on dry-basis
Description	Quantity of biomass residues of category n used for power or heat generation at the project site in year *x* prior the date of submission of the PDD for validation of the project activity (tonnes on dry-basis) prior the time of submission of the PDD for validation of the project activity
Source of data	On-site measurements
Value applied	122,631

Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions.
Comments	These figures are used to determine the max value to estimate $BR_{B5,n,y}$

Data / Parameter	P_x
Data unit	Tonnes of sugarcane
Description	Quantity of the sugar cane produced in year x from plants operated at the project site
Source of data	On-site measurements
Value applied	1,400,000
Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Baseline emission calculation
Comments	

Data / Parameter	$NCV_{BR,n,x}$
Data unit	GJ/tonnes on dry-basis
Description	Net calorific value of biomass residues of category n in year *x*
Source of data	On-site measurements
Value applied	7.4-7.8
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Baseline emission calculation
Comments	

Data / Parameter	$CAP_{EG,CG,i}$
Data unit	MW
Description	Baseline electricity generation capacity of heat engine i (MW).
Source of data	Technical feasibility report
Value applied	9.5
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Baseline emission calculation
Comments	

Data / Parameter	$LFC_{HG,h}$
Data unit	Ratio
Description	Baseline load factor of heat generator *h* (ratio)
Source of data	Technical feasibility report
Value applied	0.85
Justification of choice of data or description of measurement methods and procedures applied	The chosen value has been calculated based on the actual electricity generation which takes into account lost time (due to maintenance and seasonal operational patterns) and design power generation which is based on the total heat generator capacity.
Purpose of Data	Baseline emission calculation
Comments	

Data / Parameter	$LFC_{EG,CG,i}$
Data unit	Ratio
Description	$LFC_{EG,CG,i}$ = Baseline load factor of cogeneration-type heat engine *i* (ratio)

Source of data	Plant design parameters
Value applied	0.87
Justification of choice of data or description of measurement methods and procedures applied	This parameter should reflect the maximum load factor (i.e. the ratio between the 'actual heat generation' of the heat generator and its 'design maximum heat generation' along one year of operation) of the baseline heat generator *h*. Actual heat generation takes into account lost time (due to maintenance and seasonal operational patterns), design heat generation is based on the total heat generator capacity. Source values are based on the sugar mill production and related energy requirements.
Purpose of Data	Baseline emission calculation
Comments	

Data / Parameter	$HPR_{BL,i}$
Data unit	Ratio
Description	Baseline heat-to-power ratio of the heat engine *i* (ratio)
Source of data	On-site measurements or reference plant design parameters
Value applied	5.935
Justification of choice of data or description of measurement methods and procedures applied	Case 2 of the methodology.
Purpose of Data	Baseline emission calculation
Comments	

Data / Parameter	$\eta_{BL,HG,BR,h}$
Data unit	Ratio
Description	Baseline biomass-based heat generation efficiency of heat generator *h*
Source of data	Manufacturer's data
Value applied	71.4%

Justification of choice of data or description of measurement methods and procedures applied	A high efficiency of 71.4% corresponding to high-pressure boilers has been used for the new baseline boiler. This value corresponds also to the boilers used in the project activity.
Purpose of Data	Baseline emission calculation
Comments	

Data / Parameter	$EF_{grid,CM,y}$
Data unit	*tCO2e/MWh*
Description	Combined Margin Emission Factor of the national grid
Source of data	CDM standardized baseline https://cdm.unfccc.int/methodologies/standard_base/2015/sb45.html
Value applied	0.550
Justification of choice of data or description of measurement methods and procedures applied	CDM standardized baseline expired on 20th Oct 2017, in absence of latest available information PP has adopted the same.
Purpose of Data	Baseline emission calculation
Comments	

5.2 Data and Parameters Monitored

Data / Parameter	Biomass residues categories and quantities used in the project activity
Data unit	- Type (i.e. bagasse, rice husks, empty fruit bunches, etc.); - Source (e.g. produced on-site, obtained from an identified biomass residues producer, obtained from a biomass residues market, etc.); - Fate in the absence of the project activity (scenarios B); - Use in the project scenario (scenarios P and H); - Quantity (tonnes on dry-basis)
Description	Include the quantity of each category of biomass residues (tonnes on dry-basis). These quantities should be updated every

	year of the crediting period as part of the monitoring plan so as to reflect the actual use of biomass residues in the project scenario. These updated values should be used for emissions reductions calculations.
Source of data	On site instruments.
Value of data applied for the purpose of calculating expected emission reductions	537,832
Description of measurement methods and procedures to be applied	Use calibrated weight meters. Adjust for the moisture content in order to determine the quantity of dry biomass. Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures to be applied	Crosscheck the measurements with an annual energy balance that is based on quantities and stock changes.
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$HC_{BL,y}$
Data unit	GJ
Description	Baseline process heat generation in year y (GJ)
Source of data	On site instruments.
Value of data applied for the purpose of calculating expected emission reductions	3,*186,117*
Description of measurement methods and procedures to be applied	This parameter should be determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return of the heat generators. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure.
QA/QC procedures to be applied	Calculated based on continuously monitored data and aggregated as appropriate, to calculate emissions reductions.
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$EL_{PJ,gross,y}$
Data unit	MWh
Description	Gross quantity of electricity generated in all power plants which are located at the project site and included in the project boundary in year *y* (MWh)
Source of data	On site measurement
Value of data applied for the purpose of calculating expected emission reductions	208,822
Description of measurement methods and procedures to be applied	Use calibrated electricity meters. Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures to be applied	The consistency of metered electricity generation should be cross-checked with receipts from electricity sales (if available).
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$EL_{PJ,imp,y}$
Data unit	MWh
Description	Project electricity imports from the grid in year y (MWh)
Source of data	On site measurement
Value of data applied for the purpose of calculating expected emission reductions	0
Description of measurement methods and procedures to be applied	Use calibrated electricity meters. Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures to be applied	The consistency of metered electricity generation should be cross-checked with receipts from electricity purchases
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$EL_{PJ,aux,y}$

Data unit	MWh
Description	Total auxiliary electricity consumption required for the operation of the power plants at the project site in year y (MWh).
Source of data	On site measurement
Value of data applied for the purpose of calculating expected emission reductions	20882
Description of measurement methods and procedures to be applied	Use calibrated electricity meters. Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures to be applied	The consistency of metered electricity generation should be cross-checked with receipts from electricity sales
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$BR_{PJ,n,y}$
Data unit	tonnes on dry-basis
Description	Quantity of biomass residues of category n used in the project activity in year *y* (tonnes on dry-basis)
Source of data	Onsite measurement
Value of data applied for the purpose of calculating expected emission reductions	-
Description of measurement methods and procedures to be applied	Use weight meters. Adjust for the moisture content in order to determine the quantity of dry biomass. Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures to be applied	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$BR_{B5,n,y}$
Data unit	tonnes on dry-basis

Description	Quantity of biomass residues of category n used in the project activity in year y for which the baseline scenario is B5 (tonne on dry-basis)
Source of data	Onsite measurement
Value of data applied for the purpose of calculating expected emission reductions	-
Description of measurement methods and procedures to be applied	Use of weight meters calibrated in accordance to manufacturing specifications Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures to be applied	Crosscheck the measurements with an annual energy balance that is based on purchased quantities and stock changes
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$NCV_{BR,n,y}$
Data unit	GJ/tonnes of dry matter
Description	Net calorific value of biomass residue of category n in year y (GJ/tonne on dry-basis)
Source of data	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions	*7.4-7.8*
Description of measurement methods and procedures to be applied	Measurements shall be carried out at reputed laboratories and according to relevant international standards. Measure the NCV on dry-basis, at least every six months, taking at least three samples for each measurement.
QA/QC procedures to be applied	Check the consistency of the measurements by comparing the measurement results with measurements from previous years, relevant data sources (e.g. values in the literature, values used in the national GHG inventory) and default values by the IPCC. If the measurement results differ significantly from previous measurements or other relevant data sources, conduct additional measurements. Ensure that the NCV is determined on the basis of dry biomass.
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	Moisture content of the biomass residues
Data unit	% Water content in mass basis in wet biomass residues
Description	Moisture content of each biomass residues type *k*
Source of data	On site measurement
Value of data applied for the purpose of calculating expected emission reductions	50%
Description of measurement methods and procedures to be applied	The moisture content should be monitored for each batch of biomass of homogeneous quality. The weighted average should be calculated for each monitoring period and used in the calculations.
QA/QC procedures to be applied	-
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	Py
Data unit	Tonnes sugar/y
Description	Quantity of the main product of the production process (e.g. sugar cane, rice) produced in year y from plants operated at the project site
Source of data	Onsite measurements
Value of data applied for the purpose of calculating expected emission reductions	1,400,000
Description of measurement methods and procedures to be applied	Data monitored annually
QA/QC procedures to be applied	-
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$FF_{f,h,y}$
Data unit	Mass or volume unit/yr
Description	Quantity of fossil fuel type f fired in heat generator h in year x (mass or volume unit/yr)
Source of data	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions	-
Description of measurement methods and procedures to be applied	Use weight or volume meters. The quantity shall be cross-checked with the quantity of heat generated and any fuel purchase receipts (if available). In case of volume meters use the fuel density to convert the measurement to mass basis. Data monitored annually
QA/QC procedures to be applied	-
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	LOC_y
Data unit	hours
Description	Length of the operational campaign in year y (hour)
Source of data	On site measurements
Value of data applied for the purpose of calculating expected emission reductions	7590 h (corresponding to 330 days).
Description of measurement methods and procedures to be applied	Record and sum the hours of operation of the project activity facilities during year *y*.
QA/QC procedures to be applied	-
Comments	Data will be kept for crediting period + 2 years.

Data / Parameter	$EF_{grid,CM,y}$
Data unit	tCO2e/MWh

Description	Combined Margin Emission Factor of the national grid
Source of data	CDM standardized baseline https://cdm.unfccc.int/methodologies/standard_base/2015/sb45.html
Value of data applied for the purpose of calculating expected emission reductions	0.550
Description of measurement methods and procedures to be applied	CDM standardized baseline expired on 20th Oct 2017, in absence of latest available information PP has adopted the same.
QA/QC procedures to be applied	-
Comments	-

Data / Parameter	$h_{LOW,y}$ $h_{HIGH,y}$
Data unit	GJ/tonnes
Description	$h_{LOW,y}$: Specific enthalpy of the heat carrier at the process heat demand side $h_{HIGH,y}$: Specific enthalpy of the heat carrier at the heat generator side
Source of data	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions	$h_{LOW,y}$ = 2.727 $h_{HIGH,y}$ = 3.445
Description of measurement methods and procedures to be applied	The specific enthalpies should be determined based on the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure. Data monitored continuously and aggregated as appropriate, to calculate emissions reductions.
QA/QC procedures to be applied	-
Comments	Data will be kept for crediting period + 2 years.

5.3 Monitoring Plan

For above stated parameters for which monitoring and measurements apply, Supervisors take measurements and records are made.

Management of SCOUL ensures that appropriate equipment's required for the measurement are provided.

These measuring instruments viz., Weigh Bridge and energy meters are calibrated from third party instrumentation labs once in three years, and records of it are maintained.

All the monitoring equipments required for the calculation of emission reductions have been installed after procedural check; therefore there is less possibility of defects. However, all these equipments are daily inspected by the concerned operator while taking the reading. In case of any irregular reading or unexpected reading the shift in charge is informed for further check and calibration of the equipments. More over all the equipment are calibrated once in a three year to ensure proper data value.

Internal audit will be carried out by the upper management once in three months. In case of having corrective action or preventive action it will be checked in next internal audit.

Responsibility and competence of persons taking measurement, when the measurement should take place and controls of records are established.

Data, which are collected, are safely stored. Records such as log books, purchase receipts, calibration records of measuring devices, and public data such as IPCC are maintained for the retention period specified.

Data of inputs and outputs are summarized on monthly basis and calculation of emission reduction is updated.

Emergency preparedness: The project activity will not result in any unidentified activity that can result in substantial emissions from the project activity. No need for emergency preparedness in data monitoring is visualized.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

This section will be updated later

Data / Parameter	Biomass residues categories and quantities used in the project activity

Data unit	tonnes on dry-basis
Description	Include the quantity of each category of biomass residues (tonnes on dry-basis). These quantities should be updated every year of the crediting period as part of the monitoring plan so as to reflect the actual use of biomass residues in the project scenario. These updated values should be used for emissions reductions calculations.
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$HC_{BL,y}$
Data unit	GJ
Description	Baseline process heat generation in year y (GJ)
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$EL_{PJ,gross,y}$
Data unit	MWh
Description	Gross quantity of electricity generated in all power plants which are located at the project site and included in the project boundary in year *y* (MWh)
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$EL_{PJ,imp,y}$

Data unit	MWh
Description	Project electricity imports from the grid in year y (MWh)
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$EL_{PJ,aux,y}$
Data unit	MWh
Description	Total auxiliary electricity consumption required for the operation of the power plants at the project site in year y (MWh).
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$BR_{PJ,n,y}$
Data unit	tonnes on dry-basis
Description	Quantity of biomass residues of category n used in the project activity in year *y* (tonnes on dry-basis)
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$BR_{B5,n,y}$
Data unit	tonnes on dry-basis
Description	Quantity of biomass residues of category n used in the project activity in year y for which the baseline scenario is B5 (tonne on dry-basis)

Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$NCV_{BR,n,y}$
Data unit	GJ/tonnes of dry matter
Description	Net calorific value of biomass residue of category n in year y (GJ/tonne on dry-basis)
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	Moisture content of the biomass residues
Data unit	% Water content in mass basis in wet biomass residues
Description	Moisture content of each biomass residues type *k*
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	Py
Data unit	Tonnes sugar/y
Description	Quantity of the main product of the production process (e.g. sugar cane, rice) produced in year y from plants operated at the project site
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$FF_{f,h,y}$
Data unit	Mass or volume unit/yr
Description	Quantity of fossil fuel type f fired in heat generator h in year x (mass or volume unit/yr)
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	LOC_y
Data unit	hours
Description	Length of the operational campaign in year y (hour)
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$EF_{grid,CM,y}$
Data unit	tCO2e/MWh
Description	Combined Margin Emission Factor of the national grid
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

Data / Parameter	$h_{LOW,y}$ $h_{HIGH,y}$
Data unit	GJ/tonnes
Description	$h_{LOW,y}$: Specific enthalpy of the heat carrier at the process heat demand side

	$h_{HIGH,y}$: Specific enthalpy of the heat carrier at the heat generator side
Value applied:	*Provide the monitored value for the data/parameter*
Comments	*Provide any additional comments*

6.2 Baseline Emissions

Baseline emissions are calculated as follows:

$$BE_y = EL_{BL,GR,y} \times EF_{EG,GR,y} + \sum_f FF_{BL,HG,y,f} \times EF_{FF,y,f} + EL_{BL,FF/GR,y} \times min\left(EF_{EG,GR,y}, EF_{EG,FF,y}\right) + BE_{BR,y}$$

Equation (11)

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2)
$EL_{BL,GR,y}$	=	Baseline electricity sourced from the grid in year *y* (MWh)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (t CO_2/MWh)
$FF_{BL,HG,y,f}$	=	Baseline fossil fuel demand for process heat in year *y* (GJ)
$EF_{FF,y,f}$	=	CO_2 emission factor for fossil fuel type *f* in year *y* (t CO_2/GJ)
$EL_{BL,FF/GR,y}$	=	Baseline uncertain electricity generation in the grid or on-site or off-site power-only units in year *y* (MWh)
$EF_{EG,FF,y}$	=	CO_2 emission factor for electricity generation at the project site or off-site plants in the baseline in year *y* (t CO_2/MWh)
$BE_{BR,y}$	=	Baseline emissions due to disposal of biomass residues in year *y* (t CO2e)
f	=	Fossil fuel type

Step 2: Determine the total baseline process heat generation *($HC_{BL,y}$)*, electricity generation and capacity constraints, and efficiencies

Step 1.2: Determine the total baseline process heat generation

The amount of process heat that would be generated in the baseline in year *y* ($HC_{BL,y}$) is determined as the difference of the enthalpy of the process heat (steam or hot water) supplied to process heat loads in the project activity minus the enthalpy of the feed-water, the boiler blow-down and any condensate return to the heat generators.

This methodology assumes for the sake of simplicity that the proposed project activity consumes steam from the same quality as in baseline process transported through one steam header.

Step 1.2: Determine the baseline capacity of electricity generation *($CAP_{EG,total,y}$)*

$$CAP_{EG,total,y} = LOC_y \times \left[\sum_i \left(CAP_{EG,CG,i} \times LFC_{EG,CG,i}\right) + \sum_j \left(CAP_{EG,PO,j} \times LFC_{EG,PO,j}\right)\right] \quad \text{Equation (12)}$$

Where:

$CAP_{EG,total,y}$	=	Baseline electricity generation capacity in on-site and off-site plants in year y (MWh)
$CAP_{EG,CG,i}$	=	Baseline electricity generation capacity of cogeneration-type heat engine *i* (MW)
$CAP_{EG,PO,j}$	=	Baseline electricity generation capacity of power-only-type heat engine *j* (MW)
$LFC_{EG,CG,i}$	=	Baseline load factor of cogeneration-type heat engine *i* (ratio)
$LFC_{EG,PO,j}$	=	Baseline load factor of power-only-type heat engine *j* (ratio)
LOC_y	=	Operation of the industrial facility using the process heat in year *y* (hour)
i	=	Cogeneration-type heat engine in the baseline scenario
j	=	Power-only-type heat engine in the baseline scenario

Step 1.3: Determine the efficiencies of heat generators, and efficiencies and heat-to-power ratio of heat engines

Heat Generators

According to the methodology, different options can be used to determine the heat generators efficiency. The following considerations have been taken:

- Option 1 (Default values): for the new boiler that would be constructed and operated at the project site in the baseline scenario

➔ A value of 90% has been used for the boiler of 140 TPH to be installed. This value is also comparable to the project activity boiler efficiency value.

- Option 2 (Manufacturer's data): for the current installed boilers, which have been in operation prior to the implementation of the project activity. This option is applicable since heat engines and heat generators were operated at the project site prior to the implementation of the project activity (no new equipment would be constructed and operated at the project site in the baseline scenario). The efficiency of the heat generator or heat engine is determined based on manufacturer's data of the efficiency under optimal operating conditions and take into account the actual conditions of the fuel used (including moisture content of biomass residues).

➔ Boiler, have an efficiency of 80% respectively. As practical and conservative approach, the highest value of 80% has been used for both boilers in the heat baseline emissions calculation.

Heat Engines

Based on design conditions of the plant a value of 7.71 tonnes of steam per MWh has been used in order to determine the heat engine efficiency.

➔ Based on enthalpy values of 3.43 GJ/tonne of steam (h_{high}) and 7.71 tonnes of steam/MWh, the engine efficiency results in 0.038 MWh/GJ.

Heat to power ratio

As per Case 2 of the methodology, for heat engines without a minimum three-year operational history prior to the project activity the heat-to-power ratio should be determined as per the design conditions of the plant, for the configuration identified as baseline scenario in the selection of the baseline scenario and demonstration of additionality.

- ➔ Based on design conditions of the plant, the value has been estimated through the expected quantity of process heat extracted from the heat engine (h_{low}=2.727 kJ/kg) and the heat energy efficiency expressed in tonnes of steam per MWh (7.71 t/MWh). This results in a ratio of 5.935

Step 2: Determine the baseline electricity generation in the grid and emission factors

Step 2.1: Determine the baseline electricity generation *($EL_{BL,y}$)*

The amount of electricity that would be generated in the baseline in year *y* equals the amount of electricity generated in the project scenario as follows:

$$EL_{BL,y} = EL_{PJ,gross,y} + EL_{PJ,imp,y} - EL_{PJ,aux,y} \qquad \text{Equation (13)}$$

Where:

$EL_{BL,y}$	=	Baseline electricity generation in year *y* (MWh)
$EL_{PJ,gross,y}$	=	Gross quantity of electricity generated in all power plants included in the project boundary in year *y* (MWh)
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year *y* (MWh)
$EL_{PJ,aux,y}$	=	Total auxiliary electricity consumption required for the operation of the power plants in year *y* (MWh)

$EL_{PJ,aux,y}$ includes all electricity required for the operation of equipment related to the preparation, storage and transport of biomass residues (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.) and electricity required for the operation of all power or heat generating plants which are located at the project site and included in the project boundary (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.).

Step 2.2: Determine the baseline electricity sourced from the grid *($EG_{BL,GR,y}$)*

The amount of electricity that would be sourced from the grid in the baseline is calculate assuming that the amount of electricity generated on-site and off-site in the baseline shall be limited by the installed capacity of power generation available in the baseline scenario (on-site and off-site):

$$EL_{BL,GR,y} = max\left(0, EL_{BL,y} - CAP_{EG,total,y}\right)$$ Equation (14)

Where:

$EL_{BL,GR,y}$	=	Baseline electricity sourced from the grid in year *y* (MWh)
$EL_{BL,y}$	=	Baseline electricity generation in year *y* (MWh)
$CAP_{EG,total,y}$	=	Baseline electricity generation capacity in on-site and off-site plants in year *y* (MWh)

Step 2.3: Determine the emission factor of grid electricity generation *($EF_{EG,GR,y}$)*

The grid emission factor ($EF_{EG,GR,y}$) shall be determined using the latest approved version of "TOOL07: Tool to calculate the emission factor for an electricity system".

Step 2.4: Determine the emission factor of on-site electricity generation with fossil fuels ($EF_{EG,FF,y}$)

Since no fossil fuel based power generation was identified as part of the baseline scenario, $EF_{EG,FF,y} = EF_{EG,GR,y}$.

Step 3: Determine the baseline biomass-based heat and power generation

Step 3.3: Determine the baseline biomass-based heat generation ($HG_{BL,BR,y}$)

$$HG_{BL,BR,y} = \sum_{h}\sum_{n}\left(BR_{B5,n,h,y} \times NCV_{BR,n,y} \times \eta_{BL,HG,BR,h}\right)$$ Equation (15)

Where:

$HG_{BL,BR,y}$	=	Baseline biomass-based heat generation in year *y* (GJ)
$BR_{B5,n,h,y}$	=	Quantity of biomass residues of category *n* used in heat generator *h* in year *y* with baseline scenario B5 (tonne on dry-basis)
$NCV_{BR,n,y}$	=	Net calorific value of biomass residue of category *n* in year *y* (GJ/tonne on dry-basis)
$\eta_{BL,HG,BR,h}$	=	Baseline biomass-based heat generation efficiency of heat generator *h* (ratio)

Step 3.4: Determine the baseline biomass-based cogeneration of process heat and electricity and heat extraction

Based on the quantity of heat used in the heat engine the biomass-based cogeneration electricity and heat have been estimated as follows:

$$EL_{BL,BR,CG,y} = \frac{1}{3.6} \times \sum_{i}\left(\frac{1}{(HPR_{BL,i}+1)} \times \eta_{BL,EG,CG,i} \times HG_{BL,BR,CG,y,i}\right)$$ Equation (16)

$$HC_{BL,BR,CG,y} = \sum_{i}\left(\frac{HPR_{BL,i}}{(HPR_{BL,i}+1)} \times \eta_{BL,EG,CG,i} \times HG_{BL,BR,CG,y,i}\right)$$ Equation (17)

Where:

$EL_{BL,BR,CG,y}$	=	Baseline biomass-based cogenerated electricity in year *y* (MWh)
$\eta_{BL,EG,CG,i}$	=	Baseline electricity generation efficiency of heat engine *i* (MWh/GJ)
$HG_{BL,BR,CG,y,i}$	=	Baseline biomass-based heat used in heat engine *i* in year *y* (GJ)
$HC_{BL,BR,CG,y}$	=	Baseline biomass-based process heat cogenerated in year *y* (GJ)
$HPR_{BL,i}$	=	Baseline heat-to-power ratio of the heat engine *i* (ratio)

Case 3.2.3: $HG_{BL,BR,y} > \sum_i HG_{BL,BR,CG,y,i}$ and $HC_{BL,y} \geq HC_{BL,BR,CG,y}$ is verified

i.e. there would be biomass-based heat in the baseline that could still be used and process heat demand to be met. It is assumed then that this balance of biomass-based heat would be extracted from the heat header and used to meet the process heat demand without cogeneration of power.

As per case 3.2.3.2. the balance of biomass-based heat (right-hand side of the equation 14) is less than the remaining demand for process heat (left-hand side of the equation). Then all biomass-based heat is used and there still remains process heat demand to be met. However this lack of biomass- based heat is supplied through the two remain boilers, which feed directly the sugar mill process without cogeneration.

Moreover, no fossil fuels use occurs in the current business-as-usual baseline

$$HC_{BL,y} - HC_{BL,BR,CG,y} > \frac{h_{LOW,y}}{h_{HIGH,y}} \times \left(HG_{BL,BR,y} - \sum_{i} HG_{BL,BR,CG,y,i}\right),$$

Therefore, the slight resulting difference $HC_{balance,FF,y}$ is considered as due to inappropriate default values and conservatively neglected, as well as $EL_{balance,FF,y}$, and step 4 are skipped.

Step 4: Determine the baseline demand for fossil fuels to meet the balance of process heat and the corresponding electricity generation

As mentioned before, the use of fossil fuels has not been considered therefore the step 4 does not apply.

Step 5: Determine the baseline emissions due to uncontrolled burning or decay of biomass residues

Project participants decided not to include these emission sources. Therefore, **$BE_{BR,y}$ = 0**.

Baseline emissions

$$BE_y = EL_{BL,GR,y} \times EF_{EG,GR,y} + \sum_f FF_{BL,HG,y,f} \times EF_{FF,y,f} + EL_{BL,FF/GR,y} \times min(EF_{EG,GR,y}, EF_{EG,FF,y}) + BE_{BR,y}$$

6.3 Project Emissions

roject emissions are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{GR1,y} + PE_{GR2,y} + PE_{TR,y} + PE_{BR,y} + PE_{WW,y} + PE_{BG2,y} + PE_{BC,y}$$ Equation (18)

Determination of PE_{FFy}

The following emission sources should be included in determining $PE_{FF,y}$:

- Emissions from on-site fossil fuel consumption for the generation of electric power and heat. This includes all fossil fuels used at the project site in heat generators (e.g. boilers) for the generation of electric power and heat; and
- Emissions from on-site fossil fuel consumption of auxiliary equipment and systems related to the generation of electric power and heat. This includes fossil fuels required for the operation of auxiliary equipment related to the power and heat plants (e.g. for pumps, fans, cooling towers, instrumentation and control, etc.) which are not accounted in the first bullet, and fossil fuels required for the operation of equipment related to the preparation, storage and transportation of fuels (e.g. for mechanical treatment of the biomass, conveyor belts, driers, etc.).

➔ At the time of PDD elaboration no on-site fossil fuel consumption is foreseen during normal operation of the plant, however, a minor amount of fossil fuel could be used to launch the boilers at the beginning of the crop season. In addition, fossil fuel could be used in the unlikely situation of lack of bagasse. At this stage, for the purpose of PDD ex-ante estimations, **$PE_{FF,y}$ = 0** however, fossil fuel will be monitored in case to be used.

Determination of $PE_{GR1,y}$

If electricity is imported from the grid to the project site during year *y*, corresponding emissions should be accounted for as project emissions, as follows:

$$PE_{GR1,y} = EF_{EG,GR,y} \times EL_{PJ,imp,y}$$ Equation (19)

Where:

$PE_{GR1,y}$	=	Emissions during the year *y* due to grid electricity imports to the project site (t CO_2)
$EL_{PJ,imp,y}$	=	Project electricity imports from the grid in year *y* (MWh)

$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (t CO_2/MWh)

No electricity imports are envisaged from the grid, except in the unlikely situation of default of the turbo-generator. If this situation occurs electricity from the grid will be monitored and therefore the related project emissions will be accounted. For the purpose of the ex-ante estimations in the PDD **$PE_{GR1,y}$ = 0.**

Determination of *$PE_{GR2,y}$*

If $EL_{balance,PO,y} < EL_{BL,BR,PO,y}$ (Step 3.3.2) or $EL_{balance,FF,y} < EL_{BL,FF,y}$ (Step 4.2.2), the amount of electricity generated on-site in the baseline is higher than the amount of electricity generated in the project scenario. In such cases, it is assumed that an equivalent amount of electricity is generated during year *y* in order to offset this reduction in electricity generation at the project site. Corresponding emissions should be accounted as project emissions as follows:

$$PE_{GR2,y} = EF_{EG,GR,y} \times EL_{PJ,offset,y} \qquad \text{Equation (20)}$$

Where:

$PE_{GR2,y}$	=	Emissions due to a reduction in electricity generation at the project site in year *y* (tCO_2)
$EF_{EG,GR,y}$	=	Grid emission factor in year *y* (tCO_2/MWh)
$EL_{PJ,offset,y}$	=	Electricity that would be generated in the baseline that exceeds the generation of electricity during year *y* (MWh)

The amount of electricity generated on-site in the baseline does not exceed the amount of electricity generated in the project scenario, therefore **$PE_{GR2,y}$ = 0.**

Determination of *$PE_{TR,y}$*

In cases where the biomass residues are not generated directly at the project site, project participants shall determine CO_2 emissions resulting from transportation of the biomass residues to the project plant.

➔ Since no additional biomass residues used in the project activity are transported from the fields compared to the baseline practise, no related project emissions are accounted for and **$PE_{TR,y}$ = 0 .**

Determination of $PE_{BR,y}$

If project proponents chose to include emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$) in the calculation of baseline emissions, then emissions from the combustion of biomass residues have also to be included in the project scenario. Otherwise, this emission source may be excluded.

➔ Emissions due to uncontrolled burning or decay of biomass residues ($BE_{BR,y}$) were not included in the calculation of baseline emissions, therefore **$PE_{BR,y}$ = 0.**

Determination of $PE_{WW,y}$

This emission source should be estimated in cases where wastewater originating from the treatment of the biomass is (partly) treated under anaerobic conditions and where methane from the waste water is not captured and flared or combusted.

➔ There is no anaerobic wastewater treatment due to project activity therefore **$PE_{WW,y}$ = 0.**

Determination of $PE_{BG2,y}$

This emission source is considered in case of biogas production.
➔ As there is no production of biogas due to project activity therefore **$PE_{BG2,y}$ = 0.**

Determination of $PE_{BC,y}$

According to the methodology, if the project includes biomass from dedicated plantations, the associated project emissions shall be calculated according to the methodological tool "Project and leakage emissions from biomass".

For now, according to the baseline scenario defined in above section there is not cultivation of land to produce biomass therefore can be considered as **$PE_{BC,y}$= 0.**

6.4 Leakage

Leakage emissions due to diversion of biomass residues from other applications shall be calculated according to the methodological tool "Project and leakage emissions from biomass".

➔ Leakage emissions due to shift of pre-project activities shall be calculated according to the methodological tool "Project and leakage emissions from biomass". No biomass scenarios for biomass residues used in the Project activity are subject to leakage, therefore **LE_y = 0.**

6.5 Net GHG Emission Reductions and Removals

This section will be updated later

Quantify the net GHG emission reductions and removals achieved for this monitoring period, summarizing the key results using the table below. Specify breakdown of GHG emission reductions and removals by vintages where the intent is to issue each vintage separately in the VCS registry system.

For non-AFOLU projects, use the following table:

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
Year A				
Year…				

Total				

For AFOLU projects, include quantification of the net change in carbon stocks. Also, state the non-permanence risk rating (as determined in the AFOLU non-permanence risk report) and calculate the total number of buffer credits that need to be deposited into the AFOLU pooled buffer account. Attach the non-permanence risk report as either an appendix or a separate document.

For AFOLU projects, use the following table:

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)	Buffer pool allocation	VCUs eligible for Issuance
Year A						
Year…						
Total						

APPENDIX I: IRR CALCULATION ASSUMPTION VALUES

Project Plant

		Project Plant		Source
Sugar Plant Parameters	Sugar Plant Capacity	4600	TCD	
	Bagasse to Cane Ratio	38%	%	
	Days of Operation	322	Days	
	Gross Captive Consumption inclusive of axilary consumption	9.50	MW	
Power Plant Parameters	Power Plant Capacity	30	MW	
	Plant Load Factor	95%	%	
	No of Days of operation	330	Days	
	Auxiliary Consumption	10.00%	%	Assumed- Standard value
Steam Parameters	Pressure	87	bar	
	Temperature	525	Deg C	
	Enthalpy	3464.00	kJ/kg	Steam table
Project Cost	Cost per MW	-	-	-
	Total Project Cost	42548099	USD	
	Debt	0.95	%	
	Equity	0.05	%	
	Interest on Long Term Debt	0.06	%	
Operational Cost	O&M Cost	1611936	USD	FSR Page 26
	Escalation	5%		

	Manpower Cost- First year of Operation	870 000	USD	FSR Page 118
	Escalation	5%	%	
Fuel Related Parameters	Cost for Inhouse Bagasse	0	USD	
	Cost of Procured Biomass	30	USD/Ton	
	Escalation	5%	%	
	Calorific Value of Bagasse	2400	kcal/kg	
		10.05	GJ/Ton	Calculated
	Calorific Value of Biomass	3300	kcal/kg	Assumed- Standard value
		13.81	GJ/Ton	Calculated
Tariff	First Ten Years of Operation	0.095	USD/kWh	PPA
	Escalation for 11th to 20th Year	11.0%	%	Assumed conservatively
Tax	Minimum Alternate Tax	10.00%	%	Assumption
	Corporate Tax Rate	30.00%	%	As per IT Act (https://taxsummaries.pwc.com/uganda/corporate/taxes-on-corporate-income)
	Tax Holiday Period	0	Years	As per IT Act (https://taxsummaries.pwc.com/uganda/corporate/taxes-on-corporate-income)
Depreciation as per Companies Act	Automation and computers	40%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
	Civil Works	5.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
	Mechanical & Electrical Equipments	20.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
Depreciation as per IT Act	Land	0%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
	Civil Works	10.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)

	Mechanical & Electrical Equipments	5.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
Salvage Value	Plant, Machinery and Civil Works	10%	%	https://www.ugandainvest.go.ug/wp-content/uploads/2016/03/Inventory-of-Tax-Incentives-in-Uganda.pdf
Savings	HT Tariff (Energy Charges) (USD/kWh)	0.095	USD/kWh	PPA
	Demand Charges (USD/kWh)	3.17	USD/kWh	PPA

Reference Plant

		Reference Plant		Source
Sugar Plant Parameters	Sugar Plant Capacity	6000	TCD	Same as that in project case
	Bagasse to Cane Ratio	30%	%	Same as that in project case
	Days of Operation	322	Days	Same as that in project case
	Gross Captive Consumption inclusive of axilary consumption	9.50	MW	Same as that in project case
Power Plant Parameters	Power Plant Capacity	30.00	MW	Calculated
	Plant Load Factor	95%	%	Same as that in project case
	No of Days of operation	330	Days	Same as that in project case
	Auxiliary Consumption	10.00%	%	Same as that in project case
Steam Parameters	Pressure	45	bar	As per common practice
	Temperature	420	Deg C	
	Enthalpy	3253.4	kJ/kg	Steam table
Project Cost	Cost per MW			https://www.rvo.nl/sites/default/files/2019/02/Final-Energy-report-Uganda.pdf
	Total Project Cost	45000000.00		Calcuated as per that in project case
	Debt	0.70	%	Same as that in project case
	Equity	0.30	%	Same as that in project case

	Interest on Long Term Debt	0.06	%	Same as that in project case
Operational Cost	O&M Cost	1611936	USD	Same as that in project case
	Escalation	5%		Same as that in project case
	Manpower Cost- First year of Operation	920135	USD	Calcuated as per that in project case
	Escalation	5%	%	Same as that in project case
Fuel Related Parameters	Cost for Inhouse Bagasse	0	USD	Same as that in project case
	Cost of Procured Biomass	32	USD/Ton	Same as that in project case
	Escalation	5%	%	Same as that in project case
	Calorific Value of Bagasse	2400	kcal/kg	Same as that in project case
		10.05	GJ/Ton	Same as that in project case
	Calorific Value of Biomass	3630	kcal/kg	Same as that in project case
		15.20	GJ/Ton	Same as that in project case
Tariff	First Ten Years of Operation	0	USD/kWh	Same as that in project case
	Escalation for 11th to 20th Year	11%	%	Same as that in project case
Tax	Minimum Alternate Tax	10.00%	%	Assumption
	Corporate Tax Rate	30.00%	%	As per IT Act (https://taxsummaries.pwc.com/uganda/corporate/taxes-on-corporate-income)
	Tax Holiday Period	0	Years	As per IT Act (https://taxsummaries.pwc.com/uganda/corporate/taxes-on-corporate-income)
Depreciation as per Companies Act	Automation and computers	40%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
	Civil Works	5.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
	Mechanical & Electrical Equipments	20.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)

Depreciation as per IT Act	Land	0%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
	Civil Works	10.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
	Mechanical & Electrical Equipments	5.00%	%	As per Companies Act (https://taxsummaries.pwc.com/uganda/corporate/deductions)
Salvage Value	Plant, Machinery and Civil Works	10%	%	https://www.ugandainvest.go.ug/wp-content/uploads/2016/03/Inventory-of-Tax-Incentives-in-Uganda.pdf
Savings	HT Tariff (Energy Charges) (USD/kWh)	0.08	USD/kWh	https://www.umeme.co.ug/umeme_api/wp-content/uploads/2022/01/Tariffs-1.pdf
	Demand Charges (USD/kWh)	3.17	USD	https://www.umeme.co.ug/umeme_api/wp-content/uploads/2022/01/Tariffs-1.pdf