BRASCARBON METHANE RECOVERY PROJECT BCA-BRA-18

Brascarbon Consultoria, Projetos e Representação S/A

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Project Title	Brascarbon Methane Recovery Project BCA-BRA-18
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1 PROJECT DETAILS

1.1 Summary Description of the Project

The purpose of this project is to mitigate and recover animal effluent related Greenhouse Gas (GHG) by improving the Animal Waste Management System practices in the confined animal feed operations in the different cities located at the Mato Grosso do Sul state, central Brazil, developed by BRASCARBON.

In Brazil the agricultural operations related to the confined animals procedures are very wide and grow progressively and intensive to attend the worldwide food demand. There are three types of Confined Animal Operation for this project: finishing, breeding and nursery.

The project is a non-grouped project activity, which will apply a technology based at an ambient temperature storage covered cells (lagoon) with sufficient capacity to create an adequate Hydraulic Retention Time (HRT). The cell will use a single-piece liner affixed to a reinforced outer concrete frame. The outer cover consists of a synthetic vinyl membrane or High-Density Polyethylene (HDPE)-, which is also fastened to the frame. The liner and cover will be sealed together with bolts and iron plate frame. The system also includes a piping biogas collector, from the digester to the flare system.

The flare is enclosed and controlled by a data logger PLC – Programmable Logic Controller – in which the combustion temperature is stored every one minute in the system. This system will record every each minute the combustion temperature to determinate the flare efficiency according to the specification of the flare. A thermocouple installed in the flare is connected to the PLC to control the combustion temperature. The sparkling system in the flare is automatic. Every one second the system sparks. The biogas flow rate will be also controlled by a PLC in which every each minute the system records the flow rate. The sparkling system, the PLC and the control panel are powered by a 12 volts battery charged by solar cells.

A derivation pipe will be installed before the flare and after the flow meter, for future proposals, to supply biogas to the electricity generators, for in site electricity supply where no claims for emissions reductions by the electricity generation will be requested during the entire project activity but by the emissions reductions of the biogas destroyed in the generators.

The treated effluent is discharged to the open lagoons where it is in contact with the natural air as per the design of the original lagoon system. The treated water can be then recycled and sent back to the farm proposals or used for irrigation. No electricity will be consumed from the grid. The technical parts that will be powered by energy will be supplied by solar cells. The energy will be stored in 12 volts batteries.

The sludge from the digesters will be spread aerobically in the surface of the pasture or plantation as fertilizer in a depth less than 0.30 meters.

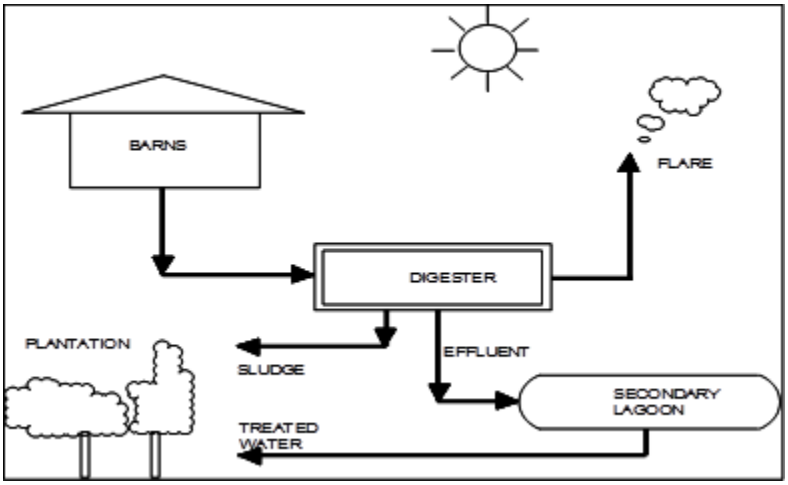

Figure 1 – Flowchart of the treatment system

The scenario existing prior to the implementation of the project activity is the same as the baseline scenario, as follows: the confined animal wastewater, which consists of fresh water mixed with manure and urine that accumulates in pits under or beside the barns, is transported to one open lagoon for evaporation, fed by gravity pipeline systems. The organic material degraded in the primary treatment lagoon is digested, thereby producing significant amounts of methane. These systems emit methane (CH4) resulting from anaerobic decomposition process. The swine livestock operations create profound environmental consequences, such as greenhouse gas emissions, odour and water/land contamination that result of storing animal waste, where this operation is not sustainable due to its sever environmental pollution.

The Project Activity consists in the construction of a new covered in-ground anaerobic reactor (digester) that will utilize the organic material currently treated in the wastewater opened lagoon, of the confined animal operations to produce biogas. All manure will be sent daily directly to digester not exceeding 24 hours in the barns.

The expected result of this project is a significant reduction of GHG emissions compared to those emissions that would have occurred in the absence of the project and also promotion of sustainable swine production farms, bringing environmental and social benefits, moving from a high-GHG animal waste management system practice to anaerobic digester with capture and combustion of resulting biogas. The project proponent estimates 57,885 tCO2e / year and 405.195 tCO2e over the first 7 years crediting period will be reduced from the baseline scenario as a result of the installation of the project activity.

Total emission reductions achieved in this monitoring period:

During the current Monitoring Period from 02/01/2022 to 31/12/2022 (First and last date included) the project activity has contributed 54,214 tCO2e GHG reductions.

1.2 Sectoral Scope and Project Type

The project is a small-scale individual project using the Sectoral Scope 13 – Waste handling and disposal. It's important to highlight that the project also is in compliance with the small-scale criteria in the VCS Standard version 4.3 since it refers that the threshold is 300kt CO_2e/year.

The Project applies the Methodology AMS-III.D – "Methane recovery in animal manure management systems" (Version 21.0).

For more information on this methodology, please refer to the link:

http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

The following tools were also used:

Methodological Tool: "Project and leakage emissions from anaerobic digesters" (version 02)

Methodological Tool: "Project emissions from flaring" (version 04)

1.3 Project Eligibility

The scope of the VCS Program includes:

1) The six Kyoto Protocol greenhouse gases.
2) Ozone-depleting substances.
3) Project activities supported by a methodology approved under the VCS Program through the methodology approval process.
4) Project activities supported by a methodology approved under an approved GHG program, unless explicitly excluded (see the Verra website for exclusions).
5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements.

The emissions reduction of the project comes from three sources:

1) Methane (CH4) emissions from the previously open lagoons that will be captured and destroyed in the project scenario; 2) CO2 emissions from the project emissions from flaring. Thus, the project applicable to this scope.

2) Ozone-depleting substances: Not applicable.

3) Project activities supported by a methodology approved under the VCS Program through the methodology approval process: Not applicable.

4) Project activities supported by a methodology approved under a VCS approved GHG program unless explicitly excluded under the terms of Verra approval: The methodology AMS III-D (version 21.0) adopted by the project is a methodology approved under CDM Program, which is a VCS approved GHG program.

5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements: Not applicable.

The project is a manure management project, with the manure collected from the existing farms, which have been put into operation for many years. The project will recover and use the biogas generated from the anaerobic digester, which consists mainly of methane, for flaring, which is apparently not a project that generates GHG emissions primarily for the purpose of their subsequent reduction, removal or destruction. Meanwhile, the project does not belong to the projects excluded in Table 1 of VCS Standard v4.3. Thus, the project is eligible under the scope of VCS program.

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

The project is not a grouped project, it's a sole project which will comprises a total of 7 farms (fixed number for all the crediting period of the project), has further detailed in point 1.11, which will produce an estimated total of 57,885 tCO2e/year. Hence, the project is a multiple project activity instance.

Eligibility Criteria

Not Applicable. Not a grouped project.

1.5 Project Proponent

Organization name	Brascarbon Consultoria, Projetos e Representação S/A
Contact person	David Garcia
Title	Carbon Manager
Address	Rua Amália de Noronha, 151, CJ 501, 05410-010 São Paulo, SP, Brazil
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1.6 Other Entities Involved in the Project

There are no other Entities involved in the project.

1.7 Ownership

According with the section 3.6 of the VCS Standard, the project description shall be accompanied by one or more of the following types of evidence establishing project ownership accorded to the project proponent(s), or program ownership accorded to the jurisdictional proponent(s), as the case may be (see the VCS Program document Program Definitions for definitions of project ownership and program ownership). To aid the readability of this section, the term project ownership is used below, but should be substituted by the term program ownership, as appropriate:

1) Project ownership arising or granted under statute, regulation or decree by a competent authority.

2) Project ownership arising under law.

3) Project ownership arising by virtue of a statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions and/or removals (where the project proponent has not been divested of such project ownership).

4) Project ownership arising by virtue of a statutory, property or contractual right in the land, vegetation or conservational or management process that generates GHG emission reductions and/or removals (where the project proponent has not been divested of such project ownership).

5) An enforceable and irrevocable agreement with the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions and/or removals which vests project ownership in the project proponent.

6) An enforceable and irrevocable agreement with the holder of the statutory, property or contractual right in the land, vegetation or conservational or management process that generates GHG emission reductions or removals which vests project ownership in the project proponent.

7) Project ownership arising from the implementation or enforcement of laws, statutes or regulatory frameworks that require activities be undertaken or incentivize activities that generate GHG emission reductions or

The PP is in compliance with the ownership criteria since it is in line with option 3 of the above mentioned points. As evidence, Brascarbon has contracts with all the swine producers included in the project is the sole owner of the project since all the contracts both with the sites included in the project activity as well as all the actions which will occur under the VCS programme are all Brascarbon responsibility for the length of the project activity.

1.8 Project Start Date

The date on which the project began generating GHG emission reductions or removals; equal to "Project Start Date" 02/01/2022, date in which the first farm begun the monitoring phase.

All sites included in the PD and the relevant dates of the project implementation for each site are described in the following table1. The project activity is composed by 7 sites (farms)and consists in gathering and destroying the biogas by the use of an enclosed flare, as previously stated. Hence, considering all the phases presented in table 1 bellow, and according with section 3.7 of the VCS Standard project start date definition, the project begun the generation of emissions reductions in the phase of monitoring phase, where all the biodigesters where fully installed, the flaring system put into place and the biogas started to be flared, therefore destroying methane and by consequence avoiding GHG emissions which are fully accounted since the electric system was installed and tested (PLC and monitoring equipment) and hence, where the monitoring process started (and also the crediting period, see section 1.9).

According with section 3.7 of the VCS Standard, the project start date of a non-AFOLU project is the date on which the project began generating GHG emission reductions or removals. Projects shall complete validation within specific timeframes from the project start date.

Table 1 – Relevant dates of project implementation.

Farm/Site Name	Brascarbon ID	Start Construction	Finish Construction	Start-up and Tests	Monitoring Start Date
Sitio Boa esperança parte lotes 67 e 69	BCA-316MS1-18	02/03/2021	21/09/2021	27/12/2021	03/01/2022
Lote 11, Quadra 27	BCA-317MS1-18	02/03/2021	25/09/2021	28/12/2021	03/01/2022
Lotes 47, 49 e 51 Quadra 28	BCA-318MS1-18	02/03/2021	20/07/2021	27/12/2021	04/01/2022
Parte dos Lotes 1 e 3 Quadra 27	BCA-319MS1-18	16/03/2021	25/08/2021	28/12/2021	03/01/2022
Lote 25, 27 e 29 Quadra 27	BCA-320MS1-18	17/03/2021	02/09/2021	28/12/2021	03/01/2022
Lote N 9 e Lote N 11 Quadra N 24	BCA-321MS1-18	27/03/2021	15/10/2021	28/12/2021	04/01/2022
Lote 54, 56, 58 Quadra 10	BCA-322MS1-18	05/04/2021	23/11/2021	28/12/2021	04/01/2022

1.9 Project Crediting Period

The starting date of the crediting period is: 02/01/2022 until 01/01/2029 (seven years period), twice renewable for a total of 21 years.

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

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2022	57,726
2033	57,885
2024	57,885
2025	57,885
2026	57,885
2027	57,885
2028	57,885
2029	159
Total estimated ERs	**405,195**
Total number of crediting years	**7**
Average annual ERs	**57,885**

1.11 Description of the Project Activity

As part of an integrated waste management system, anaerobic digestion reduces the emission of the greenhouse gas into the atmosphere. Anaerobic digestion is a renewable energy source because the process produces a methane and carbon dioxide, rich biogas, suitable for energy production helping replace fossil fuels. The nutrient-rich solids left after digestion can be used as fertilizer also.

The digestion process begins with bacterial hydrolysis of the input materials in order to break down insoluble organic polymers such as carbohydrates and make them available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. Acetogenic bacteria then convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Methanogenic bacteria finally are able to convert these products to methane and carbon dioxide.

The equipment is based at an ambient temperature storage covered cells (lagoon) with sufficient capacity to create an adequate Hydraulic Retention Time (HRT). The cell will use a single-piece

liner affixed to a reinforced outer concrete frame. The outer cover consists of a synthetic vinyl membrane or High-Density Polyethylene (HDPE)-, which is also fastened to the frame. The liner and cover will be sealed together with bolts and iron plate frame. The system also includes a piping biogas collector, from the digester to the flare system.

The flare is enclosed and controlled by a data logger PLC – Programmable Logic Controller – in which the combustion temperature is stored every one minute in the system. This system will record every each minute the combustion temperature to determinate the flare efficiency according to the specification of the flare. A thermocouple installed in the flare is connected to the PLC to control the combustion temperature. The sparkling system in the flare is automatic. Every one second the system sparks. The biogas flow rate will be also controlled by a PLC in which every each minute the system records the flow rate. The sparkling system, the PLC and the control panel are powered by a 12 volts battery charged by solar cells.

A derivation pipe will be installed before the flare and after the flow meter, for future proposals, to supply biogas to the electricity generators, for in site electricity supply where no claims for emissions reductions by the electricity generation will be requested during the entire project activity but by the emissions reductions of the biogas destroyed in the generators.

The treated effluent is discharged to the open lagoons where it is aerated as per the design of the original lagoon system. The treated water can be then recycled and sent back to the farm proposals or used for irrigation. No electricity will be consumed from the grid. The technical parts that will be powered by energy will be supplied by solar cells. The energy will be stored in 12 volts batteries

The sludge from the digesters will be spread aerobically in the surface of the pasture or plantation as fertilizer in a depth less than 0.30 meters.

Prior to the implementation of the project activity, the confined animal wastewater, which consists of fresh water mixed with manure and urine that accumulates in pits under or beside the barns, is transported to one open lagoon for evaporation, fed by gravity pipeline systems. The organic material degraded in the primary treatment lagoon is digested, thereby producing significant amounts of methane. These systems emit methane (CH4) resulting from anaerobic decomposition process. The scenario existing prior to the implementation of the project activity is the same as the baseline scenario.

Each farm will have one biodigestor which will send the biogas through a pipe where it will be located the flow meter. The biogas will then be burned in an enclosed flare and all data stored in a Control Logic Program (CLP).

The project uses current available technology in the country for methane capture and destruction and the project design engineering reflect current good practices. The biodigestor technology results in a significantly better performance than the open lagoons used in the baseline scenario.

The implementation of biodigester instead of open lagoon needs special skills with respect to design of the facility and operation and maintenance of flare and operation control (pressure, temperature, flow etc) that will be provided by specialized technicians.

1.12 Project Location

The project activity has several project sites (7) but it is important to highlight that it is not a grouped project. It is located in the Central Region/State of Mato Grosso do Sul, cities of Jateí, Caarapó and Gloria de Dourados. The geographical location of the project sites is shown in Figure 2 with specifics detailed in Table 2.

Table 2 – Detailed physical location and identification of project site

Sitio Boa Esperança parte lotes 67 e 69	BCA-316MS1-18	Sexta Linha Poente KM 2	Gloria de Dourados / MS	Samy Arfux de Figueiredo	67 99332 1415	22 21 48.76 54 13 21.43
Lote 11, Quadra 27	BCA-317MS1-18	Bairro Zona Rural, 2 ZNCD	Jatei / MS	Aroldo Henrique da Silva Boigues	67 9 9834 1523	22 31 47.36 54 09 40,54
Lotes 47, 49 e 51 Quadra 28	BCA-318MS1-18	Bairro Zona Rural, 2 NCD	Gloria de Dourados / MS	Claudenir Rodrigues de Matos	67 98436 7121	22 31 01.00 54 12 35.58
Parte dos Lotes 1 e 3 Quadra 27	BCA-319MS1-18	Zona Rural, Linha Barreirinho	Jatei / Ms	Cicera Bento Inacio	67 9943 1716	22 31 30,87 54 10 15,29
Lote 25, 27 e 29 Quadra 27	BCA-320MS1-18	Linha Barreirinho Nascente KM 15	Jatei / MS	Alvaro Henrique da silva Boigues	67 98932 1521	22 32 38,07 54 08 36,92
Lote N 9 e Lote N 11 Quadra N 24	BCA-321MS1-18	Linha Potreirito, Zona Rural	Jatei / MS	João Joaquim Felipe	67 98567 1720	22 29 02,51 54 21 12,37
Lote 54, 56, 58 Quadra 10	BCA-322MS1-18	Linha do Oculto. KM 09	Jatei / MS	Jose Pereira da silva	67 9943 5423	22 33 01,12 54 19 23,84
Sitio Boa Esperança parte lotes 67 e 69	BCA-316MS1-18	Sexta Linha Poente KM 2	Gloria de Dourados / MS	Samy Arfux de Figueiredo	67 99332 1415	22 21 48.76 54 13 21.43

Samy has one site in Jatei city:

- Sitio Boa Esperança Parte Lotes 67 e 69 is a finishing swine operation. The site uses two primary open lagoons for animal waste storage. Waste from the barns is removed via the pull plug method and then routed to the open lagoon. The methods of effluent disposition used are surface spread and irrigation.

Aroldo has one site in Jatei city:

- Lote 11 Quadra 27 is a finishing swine operation. The site uses two primary open lagoons for animal waste storage. Waste from the barns is removed via the pull plug method and then routed to the open lagoon. The methods of effluent disposition used are surface spread and irrigation.

Claudenir has one site in Jatei city:

- Lotes 47, 49 e 51 Quadra 27 is a finishing swine operation. The site uses two primary open lagoons for animal waste storage. Waste from the barns is removed via the pull plug method and then routed to the open lagoon. The methods of effluent disposition used are surface spread and irrigation. Water from this lagoon will be used for irrigation.

Cicera has one site in Gória de Dourados city:

- Parte dos Lotes 1 e 3 Quadra 27 is a finishing swine operation. The site uses two primary open lagoons for animal waste storage. Waste from the barns is removed via the pull plug method and then routed to the open lagoon. The methods of effluent disposition used are surface spread and irrigation. Water from this lagoon will be used for irrigation.

Alvaro has one site in Jatei city:

- Lotes 25, 27 e 29 Quadra 27 is a farrow-to-finish swine operation. The site uses two primary open lagoons for animal waste storage. Waste from the barns is removed via the pull plug method and then routed to the open lagoon. The methods of effluent disposition used are surface spread and irrigation.

João has one site in Glória de Dourados city:

- Lote N 9 e Lote N 11 Quadra N 24 is a finishing swine operation. The site uses two primary open lagoons for animal waste storage. Waste from the barns is removed via the pull plug method and then routed to the open lagoon. The methods of effluent disposition used are surface spread and irrigation.

José has one site in Caarapó city:

- Lotes 54, 56, 58 Quadra 10 is a finishing swine operation. The site uses two primary open lagoons for animal waste storage. Waste from the barns is removed via the pull plug method and then routed to the open lagoon. The methods of effluent disposition used are surface spread and irrigation.

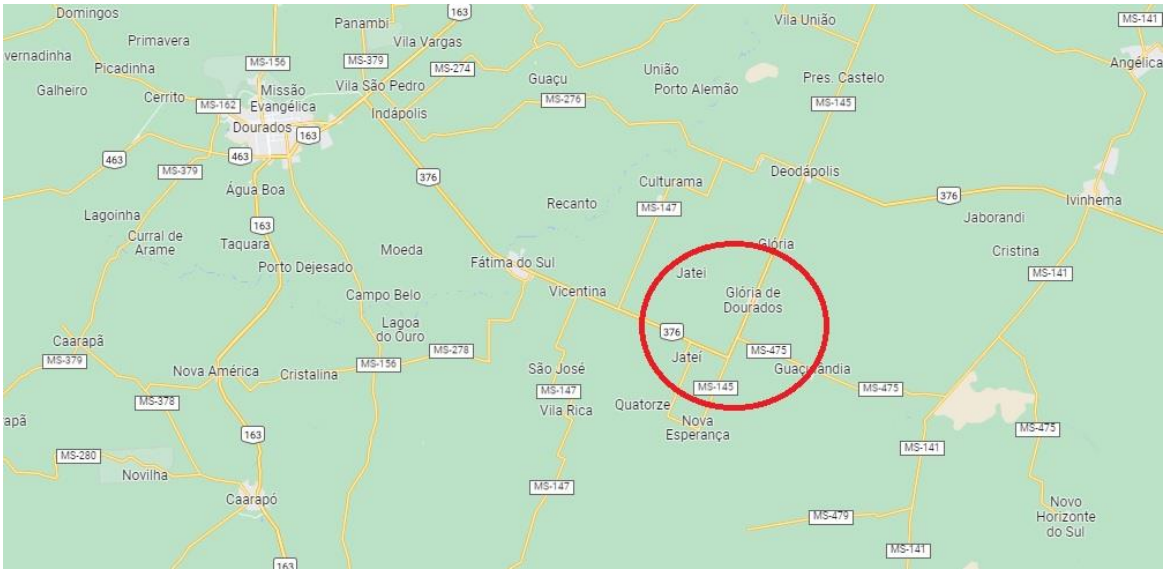


Figure 2 – State of Mato Grosso do Sul, Brazil – city location of the project sites

1.13 Conditions Prior to Project Initiation

Prior to the implementation of the project activity, the confined animal wastewater, which consists of fresh water mixed with manure and urine that accumulates in pits under or beside the barns, is transported to one open lagoon for evaporation, fed by gravity pipeline systems. The organic material degraded in the primary treatment lagoon is digested, thereby producing significant amounts of methane. These systems emit methane (CH4) resulting from anaerobic decomposition process. The scenario existing prior to the implementation of the project activity is the same as the baseline scenario.

Each farm will have one biodigestor which will send the biogas through a pipe where it will be located the flow meter. The biogas will then be burned in an enclosed flare and all data stored in a Control Logic Program (CLP).

The project uses current available technology in the country for methane capture and destruction and the project design engineering reflect current good practices. The biodigestor technology results in a significantly better performance than the open lagoons used in the baseline scenario. The implementation of biodigester instead of open lagoon needs special skills with respect to design of the facility and operation and maintenance of flare and operation control (pressure, temperature, flow etc) that will be provided by specialized technicians.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project sites are installed in already operating facilities of swine production. All the swine producers in the state of Mato Grosso do Sul are required, by the Environmental Agency of the sate (IMASUL) to have operating licenses in order for them to continue to exercise their activity.

The project activity is installed in a prior operating facility – swine farm. The implementation of the project does not require any dedicated or specific license or environmental assessment study due to its project design.

The baseline scenario is also the sole legal requirement for all the farms and by having that it is assured that the site is in compliance with all the laws and other legal requirements.

It is important to highlight that the project activity is an upgrade on the effluent treatment system required by the law (open lagoons) and that each farm has the requirement to have a valid license in order to to be eligible for a Brascarbon project.

Additionally, Brascarbon also performed a due diligence to all the assuring that the sites involved in the project are in compliance with all the any relevant local, regional and national laws, statutes and regulatory frameworks.

1.15 Participation under Other GHG Programs

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

This project has not been registered and is not seeking registration under any other GHG Programs.

1.15.2 Projects Rejected by Other GHG Programs

Not applicable. This project is not requesting registration in any other GHG Programs nor has the project been rejected by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

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

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

According to Brazil's Inter-Ministerial Commission on Global Climatic Change, manure management is an important issue that needs to be solved. The swine waste storage and treatment systems in Brazil consists of open tanks, open digesting and ponds (anaerobic lagoons) once they are the most economic and viable system approved to manage the manure

in confined animals feed operations. Economic barriers are very common because can invest only in the confined feed operations and with no need to invest in waste management systems. Financial resources are always used to maintain the confined feed operation working. Also, waste treatment involves low technology, as open lagoons need less employees and technicians for operation and maintenance. For these reasons the project is additional, and more details can be found in the section 3.5.

Just few producers invest in bio-digesters to have a modern waste management system. The material cumulated in the open lagoons is normally distributed by pumps or gravity and applied to crops and pastures. EMBRAPA stimulated by the Expansion and Waste Treatment Program of the State of Santa Catarina by giving instructions and providing publications to help the producers and agro-industries to implement projects or systems to control the animal waste management protecting the eco-system.

Failure to do so will spread existing disease continually (i.e. increased (insect) pest populations, problems with allergies and livestock disease). With the purpose of avoiding this problem, Brazil has in recent years, required all confined animals feed operations to change from single to multi-lagoon systems, introducing a Good Practices in confined animal feed operations and even more recently has required them to line the bottom of their primary sedimentation lagoon to prevent effluent infiltration.

In 2005, the swine population in Mato Grosso do Sul state was 855,000. Considering that a typical hog produces 4.9 kilograms of effluent daily (Table 3), annually some 4.2 million metric tons of hog waste are produced in this state alone. Introducing a progressive animal waste management practices throughout this region of Brazil could result in an annual reduction of approximately 655 thousand tons of carbon dioxide equivalent (CO_2e/year).

Table 3 – Daily production of effluent by type of swine production

Stage	Manure kg/day	Manure and Urine kg/day	Volume litres/day
25-100 kg	2.3	4.9	7.0
Gestating sows	3.6	11.0	16.0
Nursing sows	6.4	18.0	27.0
Boar pig	3.0	6.0	9.0
Piglet	0.35	0.95	1.4

Source: PNMA-II – Projeto de Controlo da Degradação Ambiental Decorrente da Suinocultura em Santa Catarina, coordenado pelo Sr. Paulo Armando Vitoria de Oliveira, Concordia – SC, EMBRAPA Suínos e Aves, 2004 (Environmental Degradation Control Project ,in Suine Farms Santa Catarina, coordinated by . Paulo Armando Vitoria de Oliveira, Concordia – SC, EMBRAPA Suines and Birds 2004);

http://www.cnpsa.embrapa.br/sgc/sgc_publicacoes/publicacao_n3r85f3h.pdf

Socio-Economic Sustainability

- Improvement in air quality (e.g. – reduction of Volatile Organic Compounds [VOCs]) and worker safety;
- Elimination of odors in surrounding areas, improving the living standards of neighbours' communities;
- Proper handling of the animal waste ensuring an adequate level of protection of human health and the environment;
- By improving the waste management system at the farm, the project will support the continued production of pork in order to meet the consumption needs of the growing global population.

Economic Sustainability

- An increase in local employment of skilled labour for the manufacturing, installation, Operation and maintenance of equipment;
- Additional employment opportunities in the agro-industrial sector, specifically from the use of recycled water from the waste management system on the farms for agricultural activities in surrounding land;
- Infrastructure improvement is in direct alignment with the national goals and objectives for agriculture, livestock, rural development, fishing and nutrition.

Environmental Sustainability

- An overall decrease in the amount of Greenhouse Gases (GHGs) emitted into the atmosphere;
- Improvement in the quality of the water used in the waste management system and its potential use as water for irrigation;
- Avoiding potential dumping of waste into clean sources of water.http://www.cnpsa.embrapa.br/sgc/sgc_publicacoes/publicacao_n3r85f3h.pdf

1.17.2 Sustainable Development Contributions Activity Monitoring

The project is not required to report sustainable development contributions.

1.18 Additional Information Relevant to the Project

Leakage Management

According with the methodology applied and also with the tool Project and leakage emissions from anaerobic digesters" (version 02) Methodological Tool: "Project emissions from flaring" (version 04), there is no leakage in the project activity.

Commercially Sensitive Information

Not Applicable.

Further Information

Not Applicable.

2 SAFEGUARDS

2.1 No Net Harm

The project is being developed by a company (Brascarbon) which has had in the past similar projects in the same cities, so the company work ethics, its values and its quality are well known through the project sites cities.

As it will be further detail in this current section, the project only has positive environmental and social impacts in the project facilities as well as in the surrounding areas to the sites. Also, it presents very risks both in terms of the construction as in the operation. Regardless, the project activity sites (within the swine production by the project site owners) are only accessed by Brascarbon technicians or by trained personnel from the farms.

The project has quite a positive impact environmentally but also, since it is developed in already operating sites, being a complementary activity to the main operation of the site owners, presents zero negative impacts. Also, being an addition, in terms of water treatment, to the required in the legislation (open lagoons – baseline scenario), the site owners also have a positive impact in the renewal of their operational license since they are doing a more advanced treatment than the one required by law.

Regardless, due to the vast experience of Brascarbon, we have identified possible risks and the needed action to corrected them:

Possible clogging of the Biodigester and may cause leakage and contamination of the soil.

Action Taken: installation of Bay Pass for diversion of the residue to secondary pond in the case of clogging, continuous evaluation of the effluent, and when necessary is done the internal recirculation of the bio and with this the dilution of the material and improvement of the biodigestion and consequently the best fluidity of the material.

Possible hole of the lower canvas caused by drilling material from the farm and may cause lower contamination of the soil by leakage.

Possible action to be taken: Training of pig workers regarding the care of the perforating materials used in the work routine of the pig farm and installation of barriers in the exit box of the farm to prevent this type of material from being transported to the Biodigester through the pipe.

Possible excess pressure caused by increased gas generation and with this possible rupture in the upper coating released gas into the atmosphere.

Possible action to be taken: installation of mechanical safety valve to relieve excess pressure when and if it occurs.

2.2 Local Stakeholder Consultation

Brascarbon has sent an invitation to all the stakeholders mentioned in section 2.2 of version 01 of the PD. The invitation letter was sent by email due to the pandemic situation, in May 12th of 2020. With the local producer, Brascarbon has met individually to clarify the project, answer their questions and sign the contract related to the ownership of the carbon project. That visit occurred in the week of May 23rd to 27th of 2020.

The public consultation started in the day Brascarbon sent the letter and has the channel open (phone and email) until the present day.

Until now we have not received any comment. One of the main reasons for that to happen is that Brascarbon has developed several other carbon projects is the surrounding regions and therefore both the company and the project are well known by all stakeholders.

The procedures or methods used for documenting the outcomes of the local stakeholder consultation.

Until now we have not received any comment from external stakeholders and the producers questions were answered during Brascarbon visit.

The mechanism for on-going communication with local stakeholders.

Phone and email included in the invite letter in order to receive all possible comments (which didn't occur until the present day).

How due account of all and any input received during the consultation has been taken. Include details on any updates to the project design or justify why updates are not appropriate.

We did not receive any comments from the stakeholders. The producers have made comments, especially regarding the biodigestor location in order to better assist the flow and therefore the supply of the biodigestor, which were attended by Brascarbon.

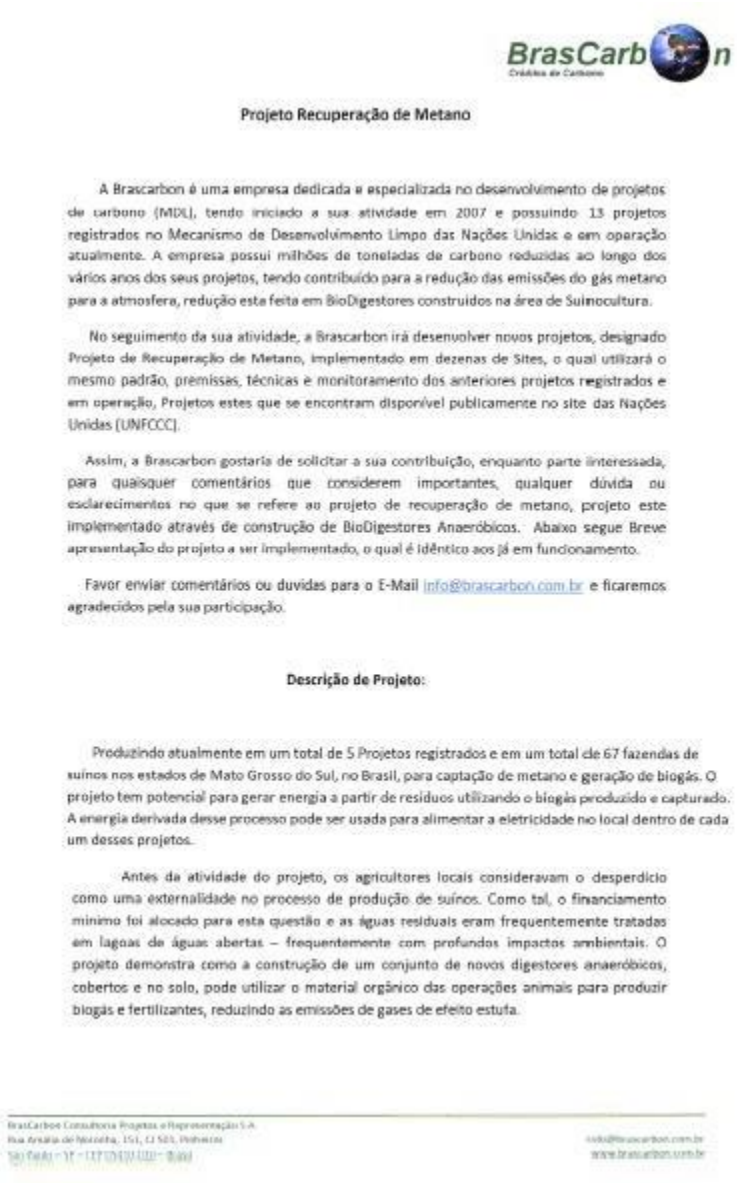
The main stakeholders considered in this project are:

- Project Site owners;
- Secretaria da Sustentabilidade Glória de Dourados;
- Sindicato Rural Jatei;
- Secretaria do Meio Ambiente Jatei;
- Câmara Municipal Glória de Dourados;

Due to the worldwide Corona Virus pandemic that was established in 2020, security and protection measures had to be taken to carry out the consultation with stakeholders. To contain new cases and avoid agglomerations, stakeholder consultation was carried out remotely. Thus, the Stakeholder consultation was divided in two steps: an online request for comments (opened

until nowadays without any comments) with all the project site owner's participant in the project and a local consultation with the relevant entities and other potential interested community stakeholders which was addressed through email to all the entities above and requested to leave their comments in our dedicated email.

The invitation letter sent by email is presented below.



BrasCarbon

Projeto Recuperação de Metano

A Brascarbon é uma empresa dedicada e especializada no desenvolvimento de projetos de carbono (MDL), tendo iniciado a sua atividade em 2007 e possuindo 13 projetos registrados no Mecanismo de Desenvolvimento Limpo das Nações Unidas e em operação atualmente. A empresa possui milhões de toneladas de carbono reduzidas ao longo dos vários anos dos seus projetos, tendo contribuído para a redução das emissões do gás metano para a atmosfera, redução esta feita em BioDigestores construídos na área de Suinocultura.

No seguimento da sua atividade, a Brascarbon irá desenvolver novos projetos, designado Projeto de Recuperação de Metano, implementado em dezenas de Sites, o qual utilizará o mesmo padrão, premissas, técnicas e monitoramento dos anteriores projetos registrados e em operação, Projetos estes que se encontram disponível publicamente no site das Nações Unidas (UNFCCC).

Assim, a Brascarbon gostaria de solicitar a sua contribuição, enquanto parte interessada, para quaisquer comentários que considerem importantes, qualquer dúvida ou esclarecimentos no que se refere ao projeto de recuperação de metano, projeto este implementado através de construção de BioDigestores Anaeróbicos. Abaixo segue Breve apresentação do projeto a ser implementado, o qual é idêntico aos já em funcionamento.

Favor enviar comentários ou duvidas para o E-Mail info@brascarbon.com.br e ficaremos agradecidos pela sua participação.

Descrição de Projeto:

Produzindo atualmente em um total de 5 Projetos registrados e em um total de 67 fazendas de suínos nos estados de Mato Grosso do Sul, no Brasil, para captação de metano e geração de biogás. O projeto tem potencial para gerar energia a partir de resíduos utilizando o biogás produzido e capturado. A energia derivada desse processo pode ser usada para alimentar a eletricidade no local dentro de cada um desses projetos.

Antes da atividade do projeto, os agricultores locais consideravam o desperdício como uma externalidade no processo de produção de suínos. Como tal, o financiamento mínimo foi alocado para esta questão e as águas residuais eram frequentemente tratadas em lagoas de águas abertas – frequentemente com profundos impactos ambientais. O projeto demonstra como a construção de um conjunto de novos digestores anaeróbicos, cobertos e no solo, pode utilizar o material orgânico das operações animais para produzir biogás e fertilizantes, reduzindo as emissões de gases de efeito estufa.

BrasCarbon Créditos de Carbono

A base do projeto é a digestão anaeróbica, pela qual os microrganismos quebram material biodegradável na ausência de oxigênio. Como parte de um sistema integrado de gestão de resíduos, ocorre a captura e a destruição do gas metano em um sistema de flare desenhado para este fim, reduzindo assim a emissão de gases de efeito estufa na atmosfera, temos então um biogás rico em teor de metano e adequado para a produção de energia, que pode ser usado para substituir combustíveis fósseis. Os sólidos ricos em nutrientes deixados após a digestão são usados como fertilizante e o melhor manejo de águas residuais permite mais água para irrigação.

Desenvolvimento Sustentável: Benefícios socio-econômicos

O principal benefício deste projeto é a redução da quantidade de gases de efeito estufa emitidos na atmosfera em cerca de 55.000 toneladas de CO2 equivalente por ano por projeto. Outras vantagens dos projetos incluem:

- A criação de empregos, incluindo trabalhadores de campo, funcionários operacionais e colaboradores agrícolas
- Redução dos Compostos Orgânicos Voláteis (VOCs) transportados pelo ar como resultado do uso de digestores de águas residuais cobertas para armazenar efluentes das fazendas. Essa melhoria na qualidade do ar aumenta o padrão de vida tanto para os agricultores quanto para as comunidades locais
- O melhor manuseio dos resíduos animais garante um melhor nível de proteção à saúde humana e ao meio ambiente;
- Melhoria na qualidade da água no sistema de gestão de resíduos e seu potencial uso como água para irrigação;
- Uma melhoria nas condições de vida dos suínos, pois os produtores devem cumprir as diretrizes de Boas Práticas para participar do projeto.

BrasCarbon Consultoria projetos e Representação S/A

Brascarbon has sent an invitation to all the stakeholders mentioned in section 2.2 of version 01 of the PD. The invitation letter was sent by email due to the pandemic situation, in May 12th of 2020. With the local producer, Brascarbon has met invidually to clarify the project, answer their questions and sign the contract related to the ownership of the carbon project. That visit occurred in the week of May 23rd to 27th of 2020.

The public consultation started in the day Brascarbon sent the letter and has the channel open (phone and email) until the present day.

Brascarbon has not received any comment during the entire period where the project was under public consultation. One of the main reasons for that to happen is that Brascarbon has developed

several other carbon projects is the surrounding regions and therefore both the company and the project are well known by all stakeholders.

Brascarbon procedure, if and/or when any communication should be received is:

- Realtime access to email and phone (the two ways to contact us)
- Analyze and address the questioning within 5 week days
- Way for feedback and if nothing is received, follow within one month of the response.

2.3 Environmental Impact

The project does not require an Environmental Impact Assessment study since it was implemented in already operating and fully licensed facilities and it represents an overall improvement in several aspects of the environmental sustainability both of the project sites as well as their surroundings, regarding potential water and soil contamination, diseases, insects and odors.

The project provides an improved effluent treatment, when considering the baseline scenario, through a simple civil construction process, without any impact to the environment nor surrounding communities.

Table 4 – Environmental Impacts of the project

Environmental Factor	Environmental Impact	Classification
Soil	Improvement of soil quality by assuring the prevention of soil contamination.	Positive
Air	Improvement of air quality trough the reduction of odors and insects (common in baseline scenario swine farms).	Positive
Climate	Methane Avoidance	Positive
Water Resources	Assurance of the quality water resources by preventing any water contamination.	Positive
Fauna	No fauna impacts.	Neutral
Flora	No flora suppression.	Positive
Communities	Improvement of quality of the surrounding areas and communities through the reduction of odors and insects (common in baseline scenario swine farms).	Positive

2.4 Public Comments

Brascarbon has sent an invitation to all the stakeholders mentioned in section 2.2 of version 01 of the PD. The invitation letter was sent by email due to the pandemic situation, in May 12th of 2020. With the local producer, Brascarbon has met invidually to clarify the project, answer their questions and sign the contract related to the ownership of the carbon project. That visit occurred in the week of May 23rd to 27th of 2020.

The public consultation started in the day Brascarbon sent the letter and has the channel open (phone and email) until the present day.

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2.5 AFOLU-Specific Safeguards

Not Applicable.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The methodology applied in the project is AMS-III.D – "Methane recovery in animal manure management systems" (Version 21.0)

For more information on this methodology, please refer to the link: http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

The following tools were also used:

- Methodological Tool: "Project and leakage emissions from anaerobic digesters" (version 02)
- Methodological Tool: "Project emissions from flaring" (version 04)

3.2 Applicability of Methodology

The choice of the selected simplified methodology is considered to be appropriate because the project activity meets each applicability conditions of the selected methodology AMS III-D (Version 21.0).

a) The livestock population in the farm is managed under confined conditions:

All farms included in this project activity are managed under confined conditions confirmed by the obligatory environmental licenses whose document releases the Confined Animals Feed Operation business. The environmental licenses can be found at Brascarbon and it´s available for validation and verification.

b) The manure, after treatment, will not be discharged into natural water resources:

The environmental legislation does not approve any manure or manure after treatment discharging into the natural water resources. Before releasing the environmental licenses by the Environmental Department, the Confined Animal Feed Operation activity is checked to confirm that all effluent after treatment is not discharged into the natural water resources. According item a) above, the environmental licenses can be found at Brascarbon an available for validation and verification.

c) The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5°C:

The annual average temperature verified in city of reference to the Mato Grosso do Sul state is 23-25°C, so higher than what the methodology states as a minimum: 5°C. This

information can be verified through on INPE (National Institute of Space Research) web site.

d) In the baseline scenario the retention time of manure waste in the anaerobic treatment system is greater than one month, and if anaerobic lagoons are used in the baseline, their depths are at least 1 m:

The retention time of waste in open anaerobic open lagoons has proven to be more than 1 month as recommended by EMBRAPA (from 30 to 40 days) . The depth was higher than 1 meter, and has been verified by measurements taken on each farm. This information is available for validation and verification.

e) No methane recovery and destruction by flaring, combustion or gainful use takes place in the baseline scenario;

The baseline scenario for all farms in this PD is a Confined Animal Feed Operation with open anaerobic lagoons for the manure treatment system. No methane recovery and destruction by flaring, combustion or gainful use takes place in the baseline scenario, which can be verified in each farm during validation. The project is new and does not involve capacity additions to the baseline scenario. This complies with para 7 and 8 of AMS-III.D version 21.0.

The project will also satisfy the following conditions:

a) The residual waste from the animal manure management system shall be handled aerobically, otherwise the related emissions shall be taken into account as per relevant procedures of AMS-III.AO “Methane recovery through controlled anaerobic digestion”. In case of soil application, proper conditions and procedures (not resulting in methane emissions) must be ensured.

The final sludge will be handled aerobically. It will be applied in the soil, according with the proper conditions and procedures, being assured that no methane emissions are resulting from this application. The project involves the use of treated effluent for irrigation in farms and application of stabilized sludge on crops irrigation in farms, without any anaerobic conditions. The practice is to distribute the sludge over the field according the usual practice to improve the field fertilization. This complies with para 4(a) of AMS-III.D version 21.0.

b) Technical measures will be used ensuring that all biogas produced by the digester is used or flared:

The project involves facilities to burn (flaring) the biogas generated by the digester. This complies with para 4(b) of AMS-III.D version 21.0. An enclosed flare will be used in the

project and also sized to support high temperatures. A continuous sparkling system is installed in the combustion chamber of the flare.

c) The storage time of the manure after removal from the animal barns, including transportation, will not exceed 45 days before being fed into the anaerobic digester:

This situation is assured due to the fact that the barns are directly connected to the biodigesters and considering the common farms practices where each day the barn is washed and all waste is removed by the water flushing system sent to the digester. This complies with para 4(c) of AMS-III.D version 21.0. The Confined Animal Feed Operation Practices follows recommendations from EMBRAPA (Empresa Brasileira de Agricultura e Agropecuária) to get high standards of sanitary conditions in the confined operations. These recommendations can be found at EMBRAPA web site where all producers use as a guideline.

Finally, the project doesn't involve any landfill activity. The project activity recovers methane generated in the treatment of swine manure by installing methane recovery and combustion systems (biodigester). This complies with paragraph 5 of AMS-III.D version 21.0.

Regarding the tools applied, the project also uses the Methodological Tool: "Project and leakage emissions from anaerobic digesters" (version 02), the tool is used (and further detailed) in the section 4.2 Project emissions for the calculation of the project emissions of the project activity in site, which is applicable after its implementation. Finally, the tool Project and leakage emissions from anaerobic digesters" (version 02) which states that the leakage emissions associated with the anaerobic digester (LEAD,y) depend on how the digestion is managed. Since the storage of digested or the composting of digested is occurring within the project boundary, these emissions were considered as part of the project emissions.

3.3 Project Boundary

According to version 21.0 of the AMS-III.D methodology, the project boundary is defined as the physical, geographical site of the livestock, of the manure generation and management systems and of the equipment installed which recover and flare the methane. This is described in Figure 3 in a schematic format. As there is the future possibility to install electricity generator for in site electricity supply, this component is also included (dotted) within the project boundary.

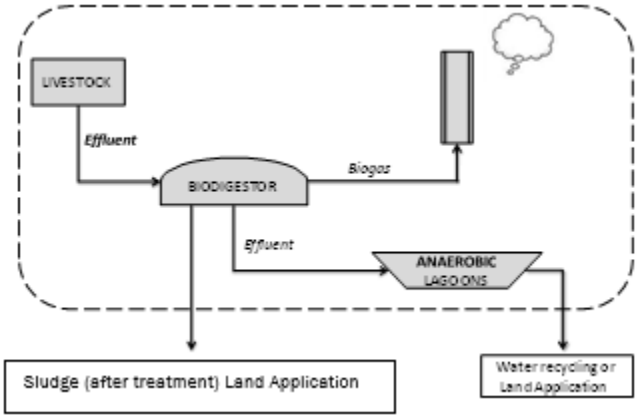


Figure 3 – Project Boundary

As it was stated in section 1, the baseline scenario, prior to the implementation of the project activity consists in gathering and collection of the wastewater that results from the confined animal production (fresh water mixed with manure and urine that accumulates in pits under or beside the barns) into an open lagoon for evaporation.

The project boundary consists, as the figure 3 illustrates, of the barns where the livestock is held, the biodigestor which was built within the barns and the open lagoons (which already existed as baseline scenario prior to the project implementation), the monitoring system and flare and finally the open lagoons.

The organic material degraded in the primary treatment lagoon is digested, thereby producing significant amounts of methane. These systems emit methane (CH4) resulting from anaerobic decomposition process. Since the baseline treatment process is, as stated, open lagoons, all the methane production, resulting from the organic matter decomposition is, in the baseline scenario, emitted to the atmosphere.

Hence, the source of the project emissions, in the baseline scenario, is the wastewater resultant from the cleaning of the barns where the animals are held. This effluent, heavily charged with organic matter, would be conducted, prior to the project activity, to the open lagoons, where the organic matter would be decomposed, originating methane emissions directly to the atmosphere. With the project activity, this methane emission is avoided through the flaring of the biogas.

Baseline	Emissions from the open lagoons	CO_2	No	CO2 emissions from the decomposition of organic waste are not accounted
		CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N2O emissions from the decomposition of organic waste are not accounted
		Other	N/A	N/A
Project	Emissions from the open lagoons	CO_2	No	Excluded for simplification. This emission source is considered to be very small
		CH_4	No	Excluded for simplification. This emission source is considered to be very small
		N_2O	No	Excluded for simplification. This emission source is considered to be very small
		Other	N/A	N/A
	Emissions from on-site electricity use	CO_2	Yes	No electricity is consumed in the project activity
		CH_4	No	No electricity is consumed in the project activity
		N_2O	No	No electricity is consumed in the project activity
		Other	N/A	N/A
	Emissions from flaring	CO2	Yes	CO2 emissions from the methane detruction are accounted according with the tool “Project emissions from flaring” (version 04)
		CH4	Yes	The enclosed flare has a default efficiency of 80% as according by the “Project emissions from flaring” (version 04)
		N2O	No	N2O emissions from the decomposition of organic waste are not accounted

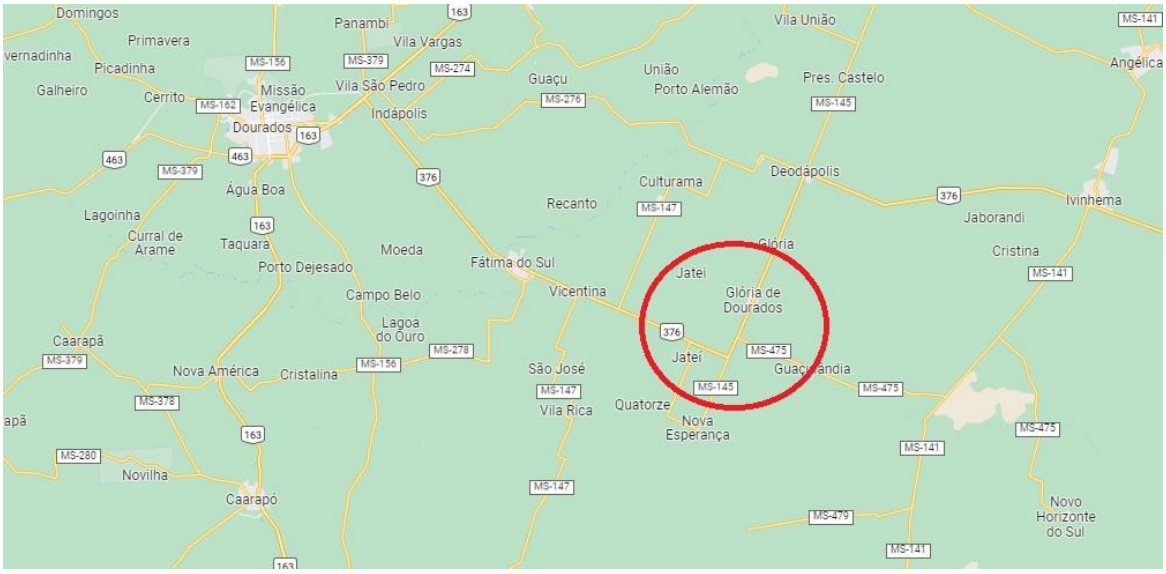


Figure 4 – State of Mato Grosso do Sul, Brazil – city location of the project sites

3.4 Baseline Scenario

This section is based on the equations used on the approved methodology AMS.III.D version 21.0 and data from 2006 IPCC Guidelines for National GHG Inventories, volume 4, chapter 10.

The amount of methane that would be emitted to the atmosphere in the absence of the project activity can be estimated by referring to the equation 1 – Baseline emissions from manure management, according to the methodology AMS.III.D – version 21.0.

The final draft of this baseline section was completed on 25/03/2020. The name of entity determining the baseline is Brascarbon which was a project participant at this time, as well as the project developer.

The baseline for this project activity is defined as the amount of methane that would be emitted to the atmosphere during the crediting period in the absence of the project activity.

3.5 Additionality

In the absence of the project activity the methane resulting from the decomposition of animal wastes in the anaerobic lagoons is released into the atmosphere. Hence, without this project activity, the swine producers would not change their animal waste management system practices. They have no motivations nor financial resources to implement a different waste treatment as

open anaerobic lagoons. The swine waste storage and treatment systems in Brazil consists in open tanks, open digesting process and ponds (anaerobic lagoons), due to the most economic and viable system approved to manage the manure in confined animal feed operations. Also, the approved waste treatment used in the farms involves less technology, as open lagoons, and need less employees and technicians for operation and maintenance.

Economic barriers are very common in the confined animals feed operations because producers invest only in the confined feed operations to be more competitive in the market. Financial resources are always used to maintain the confined feed operation working. This is one of the reasons of the additionality of the project activity.

The proposed project activity intends to improve current animal waste management system practices. These changes will result in the mitigation of anthropogenic GHG emissions by controlling the lagoon's decomposition processes and collecting and combusting the biogas. Also, the proposed project activity will be sized to accommodate each farm's maximum expected animal capacity.

Investment Barrier:

In the economic point of view, Brazilian pork producers face the same challenges as farmers in other nations due to increased worldwide pork production and low operating margins. Farm owners focus on the bottom line and odour benefits and water quality enhancements are rarely a strong motive to upgrade to an expensive advanced animal waste management system. Also, in the producer´s point of view the animal waste is outside of the production process and has difficult financing challenges that should be undertaken. Even banks have been unwilling to finance such activities without government guarantees or other incentives. The anaerobic digester requires a much higher investment than an anaerobic lagoon. Therefore, this last one is the most likely alternative and can be considered as the baseline scenario.

To demonstrate the existence of an investment barrier, that prevents the implementation of the project without the revenue of the carbon credits, the project proponent has undertaken an investment analysis of the project activity (without the revenue of the carbon credits), considering two scenarios:

- I: Baseline Scenario: the installation of an anaerobic lagoon;
- II: Project Scenario: the installation of the anaerobic digester with flare.

The results of the financial analysis for the two scenarios are presented in tables 5. and 6. The values presented are dated from 10/03/2020. In the Baseline scenario (Table 5) and in the Project scenario (Table 6) there are only negatives cash flows, as no revenue will be expected from the implementation of the project activity.

Table 5 – Financial Analysis for Baseline Scenario (open lagoon) (US$)

ID	Site ID	Site	Equipment costs and installation costs (R$)	Other costs (operation, consultancy, engineering, etc.)	Maintenance costs			Revenues from other project related products, when applicable			NPV (R$) (10,75% discount rate)	IRR (%)
					2020	year n	year n+1	2020	year n	year n+1		
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	$20.350,70	0	$2 442,08	$2 442,08	$2 442,08	0	0	0	$-47 603,98	UNDEFINED
2	BCA-317MS1-18	Lote 11, Quadra 27	$14 816,67	0	$1 778,00	$1 778,00	$1 778,00	0	0	0	$-34 658,87	UNDEFINED
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	$20 262,98	0	$2 431,56	$2 431,56	$2 431,56	0	0	0	$-47 398,79	UNDEFINED
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	$14 816,67	0	$1 778,00	$1 778,00	$1 778,00	0	0	0	$-34 658,87	UNDEFINED
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	$39 330,35	0	$4 719,64	$4 719,64	$4 719,64	0	0	0	$-92 000,82	UNDEFINED
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	$14 816,67	0	$1 778,00	$1 778,00	$1 778,00	0	0	0	$-34 658,87	UNDEFINED
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	$14 816,67	0	$1 778,00	$1 778,00	$1 778,00	0	0	0	$-34 658,87	UNDEFINED

Table 6 – Financial Analysis for Project Scenario (digester + flare) (R$)

ID	Site ID	Site	Equipment costs and installation costs (R$)	Other costs (operation, consultancy, engineering, etc.)	Maintenance costs			Revenues from other project related products, when applicable			NPV (R$) (10,75% discount rate)	IRR (%)
					2020	year n	year n+1	2020	year n	year n+1		
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	$57 999,50	0	$6 959,94	$6 959,94	$6 959,94	0	0	0	$-91 337,80	UNDEFINED
2	BCA-317MS1-18	Lote 11, Quadra 27	$42 227,50	0	$5 067,30	$5 067,30	$5 067,30	0	0	0	$-66 500,00	UNDEFINED
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	$57 749,50	0	$6 929,94	$6 929,94	$6 929,94	0	0	0	$-90 944,09	UNDEFINED
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	$42 227,50	0	$5 067,30	$5 067,30	$5 067,30	0	0	0	$-66 500,00	UNDEFINED
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	$112 091,50	0	$13 450,98	$13 450,98	$13 450,98	0	0	0	$-176 522,05	UNDEFINED
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	$42 227,50	0	$5 067,30	$5 067,30	$5 067,30	0	0	0	$-66 500,00	UNDEFINED
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	$42 227,50	0	$5 067,30	$5 067,30	$5 067,30	0	0	0	$-66 500,00	UNDEFINED

In the Table 7 the summary of the investment analysis for each farm is presented and it can be seen that the Baseline scenario (anaerobic lagoon) appears as the most attractive option.

Table 7 – NPV Comparison for the two scenarios (US$)

ID	Site ID	FARM/SITE	NPV (1st SCENARIO) Open Lagoon	NPV (2nd SCENARIO) DIGESTER + FLARE
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	$-47 603,98	$-91 337,80
2	BCA-317MS1-18	Lote 11, Quadra 27	$-34 658,87	$-66 500,00
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	$-47 398,79	$-90 944,09
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	$-34 658,87	$-66 500,00
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	$-92 000,82	$-176 522,05
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	$-34 658,87	$-66 500,00
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	$-34 658,87	$-66 500,00

From the 2 Scenarios considered, the installation of the open anaerobic lagoon (baseline scenario) is the most economic option to the swine producers. Both the investment and maintenance cost are inferior to the other scenarios considered and this is an option approved by the environment department. The negative cash flows and present value indicate that the farm producers would not engage and invest in any implementation of anaerobic digester plus flare with or without generator. Continuation of the actual practices, anaerobic lagoon, would be the most attractive course of action because it requires less investment (especially since all the producers already have an anaerobic lagoon under place) and this practice is compliant with the environmental legislation. The installation of an anaerobic lagoon is the option with higher GHG emissions.

Technological Barrier:

There is no technology requested for the waste management system, by the environment department, to be implemented in the confined animals feed operations. The actual and approved waste treatment system is open anaerobic lagoons considered also the most economic system to be installed.

The Brascarbon proposal is the installation of the anaerobic digester technology with biogas recovery and destruction.

Anaerobic digester systems must have sized properly to handle the projected animal/effluent volumes with a Hydraulic Retention Time (HRT) consistent with extracting most/all CH4 from the

manure. Variables such as temperature, pressure, methane concentration and density of the biogas have to be determinate or calculated to maintain the lifecycle of the project.

Special equipment such a biogas analyzer, to determine the concentration of the methane in the biogas, has to be acquired to verify the performance of the digester. An enclosed flare has also to be installed to capture and destroy the biogas produced in the digester. Many other instruments such thermo coupling, solar cells, batteries, flow meters, programmable logic controller (to save the temperature information) have also to be installed to perform and control the biogas production.

Also, to the adequate operation of the digesters operational procedures have to be followed and managed by an expertise technician. Brascarbon will be responsible for implementing an external support without interfering in the confined animal feed operation because the local animal producers do not have staff available to perform these tasks.

Moreover, operations and maintenance requirements involved with this technology, including a detailed monitoring program to maintain system performance levels, must also be considered.

Worldwide, few anaerobic digesters have achieved long-term operations, due primarily to inappropriate operations and maintenance.

The proposed animal waste management system represents the most advanced technology in the farm. The proposed project activity mitigates GHG emissions with associated environmental co-benefits.

Barrier Due to Prevailing Practice (National Policies and Circumstances)

According to researchers of Embrapa Swine and Poultry (CNPSA), the common practice regarding swine waste storage and treatment systems in the Brazil consist of open tanks (esterqueiras), open digesting (bioesterqueiras), ponds (anaerobic, variable and aerobic), cesspit, storage or treatment of compost (in solid form). Very few bio-digesters exist. The material is normally distributed by pumps or gravity and applied to crops and pastures.

In order to clarify the actual circumstances regarding to confined animal operations in Brazil and the serious environmental problems that can occur due the bad animal waste management system, EMBRAPA stimulated by the Expansion and Waste Treatment Program of the State of Santa Catarina published a Good Practices Manual with instructions and publications to help the producers and agro- industries to implement projects or systems to control the animal waste management protecting the eco- system1. This idea was supported by officers of national swine producers association (ABCS).

Although the installation of an animal waste management system will, by itself, provide the producers with some external benefits as it was stated before, the project itself could not be

developed without the revenues from the CERs. CDM funding will help to alleviate the identified barrier by providing the financial means which are necessary to implement the project activity.

3.6 Methodology Deviations

Not Applicable.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

This section is based on the equations used on the approved methodology AMS.III.D – Version 21.0 – "Methane recovery in animal manure management systems" and data from 2006 IPCC Guidelines for National GHG Inventories, volume 4, chapter 10.

The project emissions for this project activity are defined as the amount of methane that would be emitted to the atmosphere during the crediting period due to the project activity. In this case an anaerobic digester is considered the project activity and estimated emissions are determined as follows:

Step 1: Emission Reductions.

Equation 1

$$ER_{y,estimated} = BE_y - PE_y$$

Where:

ERy – Emission reductions in t CO2e/year

BEY – The annual baseline methane emissions in t CO2e/year PE Y = project emissions in t CO2e/year

The emission reductions which will be achieved by the project activity ex post will be determined through direct measurement of the amount of methane flared. The emission reductions achieved in any year will be the lowest value of the following:

Equation 1.1

$$ER_{y,ex\text{-}post} = min[(BE_{y,ex\text{-}post} - PE_{y,ex\text{-}post}),(MD_y - PE_{power,y,ex\text{-}post})]$$

Where:

ERy,ex-post – Emission reductions achieved by the project activity based on monitored values for year y (tCO2e)

BEy ex post –Baseline emissions calculated using equation 1 (of the document, 5 of the methodology) (for projects using option in paragraph 17(a)) using ex post monitored values of NLT,y and if applicable VSLT,y. For projects using option in paragraph 17(b), the ex post monitored values for Qmanure,j,LT,y and SVSj,LT,y are used

Project emissions calculated using Equation 6 (equation 7 of the meth) using ex post monitored values of NLT,y,MS% i,y, MS% I, AII, Qres waste,y and if applicable VSLT,y

MDy – Methane captured and destroyed or used gainfully by the project activity in year y (tCO2e)

PEpower,y,ex post – Emissions from the use of fossil fuel or electricity for the operation of the installed facilities based on monitored values in the year y (tCO2e)

The flaring/combustion MDy will be measured using the conditions of the flaring process and according the following equation:

Equation 1.2

$$MD_y = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4}$$

Where:

BGburnt, y – Biogas flared or combusted in year y (m3)

WCH4, y – Methane content in biogas in the year y (volume fraction)

FE – Flare efficiency in the year y (fraction)

GWPCH4 – Global Warming Potential (GWP) of CH4 (28)

DCH4 – Density of methane at the temperature and pressure of the biogas in the year “y” (t/m3).

The baseline for this project activity is defined as the amount of methane that would be emitted to the atmosphere during the crediting period in the absence of the project activity. In this case an open anaerobic lagoon is considered as the baseline and estimated emissions are determined as follows:

Step 1: Animal Population.

Animal populations for the project activity sites are described in this section (table 8).

Step 2: Baseline Emissions.

Baseline emissions (BEy) are calculated by using one of the following two options:

(a) Using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC tier 2 approach (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). For this calculation, information about the characteristics of the manure and of the management systems in the baseline is required. Manure characteristics include the amount of volatile solids (VS) produced by the livestock and the maximum amount of methane that can be potentially produced from that manure (Bo);

(b) Using the amount of manure that would decay anaerobically in the absence of the project activity based on direct measurement of the quantity of manure treated together with its specific volatile solids (SVS) content.

Option a) was chosen.

Equation 2

$$BE_y = GWP_{CH4} \times D_{CH4} \times UF_b \times \sum_{j,LT} MCF_j \times B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{Bl,j}$$

Where:

BEy Baseline emissions in year "y" (tCO2e)

GWPCH4 Global Warming Potential (GWP) of CH4 (28)

DCH4 CH4density (0.00067 t/m3 at room temperature (20 °C) and 1 atm pressure).

LT Index for all types of livestock

j Index for animal waste management system

MCFj Annual methane conversion factor (MCF) for the baseline animal waste management system "j"

B0,LT Maximum methane producing potential of the volatile solid generated for animal type "LT" (m3 CH4/kg dm)

NLT,y Annual average number of animals of type "LT" in year "y" (numbers)

VSLT,y Volatile solids for livestock "LT" entering the animal manure management system in year "y" (on a dry matter weight basis, kg dm/animal/year)

MS%Bl, j Fraction of manure handled in baseline animal manure management system "j"

UFb Model correction factor to account for model uncertainties (0.94)

As per definition of the methodology, "The maximum methane-producing capacity of the manure (B0) varies by species and diet. The preferred method to obtain B0 measurement values is to use data from country-specific published sources, measured with a standardised method (B0 shall be based on total as-excreted VS). These values shall be compared to IPCC default values and any significant differences shall be explained. If country specific B0 values are not available, default values from tables 10 A-4 to 10 A-9 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 can be used, provided that the project participants assess the suitability of those data to the specific situation of the treatment site".

Also, the methodology refers that the "Volatile solids (VS) are the organic material in livestock manure and consist of both biodegradable and non-biodegradable fractions. For the calculations the total VS excreted by each animal species is required. The preferred method to obtain VS is to use data from nationally published sources. These values shall be compared with IPCC default values and any significant differences shall be explained. If data from nationally published

sources are not available, country-specific VS excretion rates can be estimated from feed intake levels, via the enhanced characterisation method (tier 2) described in section 10.2 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10. If country specific VS values are not available IPCC default values from 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4, chapter 10 table 10 A-4 to 10 A-9 can be used provided that the project participants assess the suitability of those data to the specific situation of the treatment site particularly with reference to feed intake levels"

Brazil does not have any national published values nor sources to obtain the default values need. Hence, the VS values chosen for the current project were the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4, chapter 10 table 10 A-7 and 10 A-8 for the Region Western Europe since they have proven to be the more suitable for the specific situation of the treatment site particularly with reference to feed intake levels.

The genetics used in the project are originally from that region and the values presented are the more similar when compared with the specific project site values. The same situation occurs with the feed intake level, which is than reflected in the specific animal weight, being the IPCC values for Western Europe swine the more adjusted and suited to the project sites.

Therefore, the parameter VSLl,y will be calculated according with the following methodology consideration "In case default IPCC values for VS are adjusted for a site-specific average animal weight, it shall be well explained and documented.".

Where:

VSLT,y can be determinate by scaling default IPCC values to adjust for a site-specific average animal weight.

Equation 3

$$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}} \right) * VS_{default} * nd_y$$

Where:

Wsite Average animal weight of a defined livestock population at the project site (kg)

Wdefault Default average animal weight of a defined population, this data is sourced from IPCC 2006 (kg)

VSdefault Default value for the volatile solid excretion rate per day on a dry-matter basis for a defined livestock population (kg dm/animal/day)

ndy Number of days in year "y" where the treatment plant was operational.

According to paragraph 17 (d) from AMS-III.D version 21.0, B0 or VS values applicable to developed countries can be used provided the following four conditions are satisfied:

The genetic source of the livestock originates from an Annex I Party;

Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association) – http://www.abcs.org.br/ and also at ASSUGLORIA (Associação de Suinoclutores de Glória de Dourados).

The genetic source of the livestock is therefore in compliance with this methodology requirement, which can be confirmed and verified by the genetic documents of the animals of each farm. These evidences were provided and assessed to assure their applicability to this requirement.

The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;

The formulated feed rations are created according with the characteristics of the animals, their stage of growth, category, weight gain and genetics. Each farm possesses their FFR composition according with the type of animal(s) accommodated, which was confirmed and verified. These evidences were provided and assessed to assure their applicability this requirement.

The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);

The formulated feed rations are part of the management system of the farms and therefore, each site possesses on-farm records which attest the FFR used. These evidences are also monitored on a monthly basis, according monitoring plan for the parameter FFR, as described in section 5.2, and the PP internal procedure POP 14.

The project specific animal weights are more similar to developed country IPCC default values.

The Wsite value considered for each category of swine is the result of an average weight of the animals of all farms included in the project, and this value was applied in the baseline calculation.

Finishers is the animal category that represents the totality of all animals from the farms included in this PD. Finishers are considered to be “market swine” and presented an average weight of 90kg among all farms included in the PD by the time of the project’s registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (50 kg) – the values form Latin America (28 kg), where the project is located, is even lower than Western Europe’s.

This situation is also observed for the remaining four categories of swine (nursery and boars for market swine, guilts and sows for breeding swine): the values are more similar to those adopted in Western Europe than in Latin America, especially regarding the Breeding Swine (guilts and sows) and in the Market Swine (boars) which presented an average weight of 210kg and 230 kg

respectively, among all farms included in the PD by the time of the project's registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (198kg for Breeding Swine and 50 kg for Market Swine) – the values form Latin America (28kg for both classes of Breeding and Market Swine), where the project is located, is much lower than Western Europe's. Only in the category nursery (also Market Swine), which roughly represents 30% of all animals from the farms included in this PD, have an average weight of 20 kg, closer to the Latin America values than the Western Europe values.

Therefore, is fair to consider that "the project specific animal weights are more similar to developed country IPCC default values" condition is fulfilled and that the VS adopted values for developed counties is in full compliance with the methodology requirements.

And,

NLT,y , the annual average number of animals can be determinate as follows:

Equation 4

$$N_{LT,y} = N_{da,y} * (N_{p,y}/365)$$

Where:

Nda,y Number of days animal is alive in the farm in the year "y" (numbers)

Np,y Number of animals produced annually of type "LT" for the year "y" (numbers)

Table 8 – Parameters and factors for the applying baseline equations

Parameter/ Factor	Value	Source/Comment
$VS_{default}$	0.46 for breeding swine (sows, gilts) 0.3 for market swine (nursery, boars and finishers)	Obtained from IPCC2006, vol 4, chapter 10, Tables 10A-7 and 10A-8. Values for Western Europe
GWP_{CH4}	28	IPCC Fifth Assessment Report: Climate Change 2014
$B_{0,LT}$	0.45	Obtained from 2006 IPCC, Table 10A-7, p.10.80 and Table 10A-8, p.10.81. Values for Western Europe
D_{CH4}	0.00067	CH_4 density at room temperature 20ºC and 1 atm pressure.
MCF_j	79%	Obtained from 2006 IPCC, Chp.10 vol 4 - Table 10.17, p.10.45
$N_{LT,y}$	Table 6	Annual average number of animals of type "LT " in year "y"(numbers)
$MS\%_{BI,j}$	100%	Fraction of manure handled in system "j".
$W_{default}$	198 kg breeding and 50 kg market	Obtained from IPCC2006, vol 4, chapter 10, Tables 10A-7 and 10A-8.
UF_B	0.94	Model correction factor to account for model uncertainties.

Table 9 – Parameters and factors for the specific animal category

ID	Site ID	Farm/Site	Animal Category – NLT					Total
			Sows	Finishers	Nursery/Weaners	Boars	Gilts	
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	-	4,900	-	-	-	4,900
2	BCA-317MS1-18	Lote 11, Quadra 27	-	6,800	-	-	-	6,800
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	-	4,900	-	-	-	4,900
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	-	4,900	-	-	-	4,900
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	4,530	23,000	18.600	46	1.365	47,541
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	-	4,900	-	-	-	4,900
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	-	9,800	-	-	-	9,800
TOTAL			4,530	38,500	18.600	46	1.365	83,741

According to the Equation 2

Table 10 – Baseline emissions for the year *y*

ID	Site ID	Farm/Site	Baseline Emissions – year *y*					Total
			Sows	Finishers	Nursery/Weaners	Boars	Gilts	
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	-	6,055	-	-	-	6,055
2	BCA-317MS1-18	Lote 11, Quadra 27	-	8,402	-	-	-	8,402
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	-	6,055	-	-	-	6,055
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	-	6,055	-	-	-	6,055
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	5,286	28,419	6,895	152	1.514	42,266
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	-	6,055	-	-	-	6,055
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	-	12,109	-	-	-	12,109
TOTAL			5,286	73,150	6,895	152	1.514	86,997

Table 11 – Total baseline emission per year

ID	Site ID	Farm/Site	Baseline Emissions per year, in t CO_2e / year								Total
			2022	2023	2024	2025	2026	2027	2028	2029	
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	6,038	6,055	6,055	6,055	6,055	6,055	6,055	17	42,285
2	BCA-317MS1-18	Lote 11, Quadra 27	8,379	8,402	8,402	8,402	8,402	8,402	8,402	23	58,814
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	6,038	6,055	6,055	6,055	6,055	6,055	6,055	17	42,385
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	6,038	6,055	6,055	6,055	6,055	6,055	6,055	17	42,385
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	42,150	42,266	42,266	42,266	42,266	42,266	42,266	116	295,862
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	6,038	6,055	6,055	6,055	6,055	6,055	6,055	17	42,385
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	12,076	12,109	12,109	12,109	12,109	12,109	12,109	33	84,763
Total baseline emissions			86,759	86,997	86,997	86,997	86,997	86,997	86,997	239	608,979

4.2 Project Emissions

Step 3: Project Emissions.

According to the simplified baseline and monitoring methodology for a small-scale CDM project Type-III (AMS.III.D – version 21.0), project emissions consist of:

(a) Physical leakage of biogas in the manure management systems which includes production, collection and transport of biogas to the point of flaring/combustion or gainful use (PEPL,y);

(b) Emissions from flaring or combustion of the gas stream (PEflare,y);

(c) CO2emissions from use of fossil fuels or electricity for the operation of all the installed facilities (PEpower,y).

(d) CO2 emissions from incremental transportation distances (PEtransp,y)

(e) Emissions from the storage of manure before being fed into the anaerobic digester (PEstorage,y)

Equation 5 (equation 6 of the meth)

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} + PE_{transp,y} + PE_{storage,y}$$

Where:

PEy – Project emissions in year "y" (tCO2e)

PEPL,y – Emissions due to physical leakage of biogas in year "y" (tCO2e)

PEflare,y – Emissions from flaring or combustion of the biogas stream in the year "y" (tCO2e)

PEpower,y – Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year "y" (tCO2e)

PEtransp,y – Emissions from incremental transportation in the year y (tCO2e), as per relevant paragraph in AMS-III.O

PEstorage,y – Emissions from the storage of the manure in the year "y" (tCO2e)

Where:

(A) missions due to physical leakage of biogas can be determinate as follows:

Equation 6 (equation 7 of the meth)

$$PE_{PL,y} = 0.10 \times GWP_{CH4} \times D_{CH4} \times \sum_{i,LT} B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y}$$

Where:

PEPL,y – Emissions due to physical leakage of biogas in year "y" (tCO2e)

GWPCH4 – Global Warming Potential (GWP) of CH4 (28)

DCH4 – CH4 density (0.00067 t/m3 at room temperature (20 ºC) and 1 atm pressure).

LT – Index for all types of livestock

J – Index for animal waste management system

B0,LT – Maximum methane producing potential of the volatile solid generated for animal type "LT" (m3 CH4/kg dm)

NLT,y – Annual average number of animals of type "LT" in year "y" (numbers)

VSLT,y – Volatile solids for livestock "LT" entering the animal manure management system in year "y" (on a dry matter weight basis, kg dm/animal/year)

MS%i,y – Fraction of manure handled in system "i" in year "y"

(B) Emissions from flaring determinate as follows:

According with the tool Project emissions from flaring version 4, the calculation procedure in this tool determines the project emissions from flaring the residual gas (PEflare,y) based on the flare efficiency (ηflare,m) and the mass flow of methane to the flare (FCH4,RG,m). The flare efficiency is determined for each minute m of year y based either on monitored data or default values.

The project emissions calculation procedure is given in the following steps:

(a) STEP 1: Determination of the methane mass flow of the residual gas;

(b) STEP 2: Determination of the flare efficiency;

(c) STEP 3: Calculation of project emissions from flaring.

Step 1: Determination of the methane mass flow in the residual gas

The "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" shall be used to determine the following parameter

The following requirements apply:

(a) The gaseous stream tool will be applied to the residual gas;

(b) The flow of the gaseous stream will be measured continuously;

(c) CH4 is the greenhouse gas i for which the mass flow will be determined;

(d) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and

(e) The time interval t for which mass flow should be averaged is every minute m.

According with the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 03, The mass flow of a greenhouse gas i in a gaseous stream (Fi,t) is determined through measurement of the flow and volumetric fraction of the gaseous stream.

Option A was chosen

The flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. According with the tool, there are two ways to do this:

(a) Measure the moisture content of the gaseous stream (CH2O,t,db,n) and demonstrate that this is less or equal to 0.05 kg H2O/m3 dry gas; or

(b) Demonstrate that the temperature of the gaseous stream (Tt) is less than 60ºC (333.15 K) at the flow measurement point.

(c) The temperature of the biogas is less than 60ºC, and that will be demonstrated during the monitoring of the parameter, according with the MP.

Step 2: Determination of flare efficiency

The flare efficiency depends on the combustion efficiency of in the flare and the time that the flare is operating. For determining the efficiency of enclosed flares project participants shall choose to determine the efficiency based on monitored data or the option to apply a default value. For open flares a default value must be applied. The time the flare is operating is determined by using a flame detector and, for the case of enclosed flares, in addition the

monitoring requirements provided by the manufacturer's specifications for operating conditions shall be met.

In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute m (ηflare,m) and shall document in the CDM-PD which option is selected:

(a) Option A: Apply a default value for flare efficiency;

(b) Option B: Measure the flare efficiency.

Option A was chosen

Option A: Default value

The flare efficiency for the minute m (ηflare,m) is 90% when the following two conditions are met to demonstrate that the flare is operating:

(a) The temperature of the flare (TEG.m) and the flow rate of the residual gas to the flare (FRG,m) is within the manufacturer's specification for the flare (SPECflare) in minute m; and

(b) The flame is detected in minute m (Flamem).

Otherwise ηflare,m is 0%.

It is important to highlight that the flares are considered a low height so, in line with the tool, a conservative approach should be applied, and 10 percentile points should be subtracted to the flare efficiency. Hence the flare efficiency adopted in the current PD will be the default value of 80%.

In line with the monitoring plan, if any minute of any hour presents a temperature value below 500ºC the entire hour will be discount form the CER calculation. This discount will be applied to the volume of that specific hour since it is a more conservative approach than to discount in the average of the flare efficiency percentage.

Step 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute m in year y, based on the methane mass flow in the residual gas (FCH4,RG,m) and the flare efficiency (ηflare,m), as follows:

Equation 7 (equation 15 of the Tool 6)

$$PE_{flare\,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare\,m}) \times 10^{-3}$$

Where:

PEflare,y – Project emissions from flaring of the residual gas stream in year y, tCO 2e

GWPCH4 – Global Warming Potential of methane valid for the commitment period, tCO2e/tCH4

FCH4,RG,m – Mass flow rate of methane in the residual gas in the minute m, kg/m

ηflare, m – Flare efficiency in the minute m

(A) Emissions from use of fossil fuels or electricity for the operation:

No fossil fuel or electricity will be used in the project, therefore, PEpower,y = zero.

(B) Emissions from incremental transportation

No incremental transportation will occur in the project activity, and therefore, PEtransp,y = 0

(C) Emissions from storage of the manure:

The manure will not be stored in the entire project. Each day all the manure is washed and sent to the digester, therefore, PEstorage,y = 0.

According to the project emissions description in the current section and equation 5:

Table 12 – Total project activity emissions for the year *y*

ID	Site ID	Farm/Site	Project Emissions – year *y*					Total
			Sows	Finishers	Nursery/Weaners	Boars	Gilts	
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	-	2,026	-	-	-	2,026
2	BCA-317MS1-18	Lote 11, Quadra 27	-	2,811	-	-	-	2,811
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	-	2,026	-	-	-	2,026
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	-	2,026	-	-	-	2,026
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	1,769	9,511	2,307	50	507	14,144
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	-	2,026	-	-	-	2,026
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	-	4,053	-	-	-	4,053
TOTAL			1,769	24,479	2,307	50	507	29,112

Table 13 – Total project activity emissions per year

ID	Site ID	Farm/Site	Project Emissions Emissions per year, in t CO2e / year								Total
			2022	2023	2024	2025	2026	2027	2028	2029	
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	2,020	2,026	2,026	2,026	2,026	2,026	2,026	6	14,182
2	BCA-317MS1-18	Lote 11, Quadra 27	2,803	2,811	2,811	2,811	2,811	2,811	2,811	8	19,677
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	2,020	2,026	2,026	2,026	2,026	2,026	2,026	6	14,182
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	2,020	2,026	2,026	2,026	2,026	2,026	2,026	6	14,182
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	14,105	14,144	14,144	14,144	14,144	14,144	14,144	39	99,008
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	2,020	2,026	2,026	2,026	2,026	2,026	2,026	6	14,182
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	4,042	4,053	4,053	4,053	4,053	4,053	4,053	11	28,371
Total project emissions			29,030	29,112	29,112	29,112	29,112	29,112	29,112	82	203,784

4.3 Leakage

According with the methodology AMS.III.D version 21.0, the leakage should be determined by following the relevant procedure in the methodological tool "Project and leakage emissions from anaerobic digesters".

Leakage should be measured according with the following equation:

$$LE_{AD,y} = LE_{storage,y} + LE_{comp,y}$$

Where:

$LE_{AD,y}$ – Leakage emissions associated with the anaerobic digester in year y (t CO2e)

$LE_{storage,y}$ – Leakage emissions associated with storage of digestate in year y (t CO2e)

$LE_{comp,y}$ – Leakage emissions associated with composting digestate in year y (t CO2e)

According with the paragraph 25 of this tool, leakage emissions associated with the anaerobic digester (LEAD,y) depend on how the digestion is managed. Since the storage of digested or the composting of digested is occurring within the project boundary, these emissions were considered as part of the project emissions.

4.4 Estimated Net GHG Emission Reductions and Removals

According to the project emissions reduction in the current section, the results of the estimation of the emissions reduction, equation 1 are summarized in the following table. All the ex-ante calculation were provided in sections 4.1 to 4.3 and are here now systematized. As stated previously:

Step 1: Emission Reductions.

Equation 1

$$ER_{y,estimated} = BE_y - PE_y$$

Where:

- ERy – Emission reductions in t CO2e/year
- BEY – The annual baseline methane emissions in t CO2e/year PE Y = project emissions in t CO2e/year

The emission reductions which will be achieved by the project activity ex post will be determined through direct measurement of the amount of methane flared. The emission reductions achieved in any year will be the lowest value of the following:

Equation 1.1

$$ER_{y,ex\text{-}post} = min[(BE_{y,ex\text{-}post} - PE_{y,ex\text{-}post}),(MD_y - PE_{power,y,ex\text{-}post})]$$

Where:

ERy,ex-post – Emission reductions achieved by the project activity based on monitored values for year y (tCO2e)

BEy ex post – Baseline emissions calculated using equation 2 and using ex post monitored values of NLT,y and if applicable VSLT,y for year y (tCO2e)

PEy,ex post – Project emissions calculated using Equation 5 (equation 6 of the meth) using ex post monitored values of NLT,y ,MS%i,y and if applicable VSLT,y for year y (tCO2e)

MDy – Methane captured and destroyed or used gainfully by the project activity in year y (tCO2e)

PEpower,y,ex post – Emissions from the use of fossil fuel or electricity for the operation of the installed facilities based on monitored values in the year y (tCO2e)

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2022	86,759	29,030	0	57,729
2023	86,997	29,112	0	57,885
2024	86,997	29,112	0	57,885
2025	86,997	29,112	0	57,885
2026	86,997	29,112	0	57,885
2027	86,997	29,112	0	57,885
2028	86,997	29,112	0	57,885
2029	239	82	0	157
Total	**608,979**	**203,784**	**0**	**405,195**

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	MCFj
Data unit	%
Description	Annual methane conversion factor for the baseline animal waste management system “j”.
Source of data	Obtained from IPCC2006, vol 4, chapter 10, Tables 10.17.
Value applied:	79%
Justification of choice of data or description of measurement methods and procedures applied	Average temperature of southwest region, mainly where the project sites are located is 23 to 25 Celsius during the year, according to CPTEC/INPE/EMBRAPA http://satelite.cptec.inpe.br/PCD/
Purpose of Data	Calculation of Baseline Emissions
Comments	No comments

Data / Parameter	MS%Bl,j
Data unit	Fraction
Description	Fraction of manure handled in baseline animal manure management system “j”.
Source of data	Project proponents
Value applied:	1
Justification of choice of data or description of measurement methods and procedures applied	100% of the manure will be handled per category T, system S and climate region k.
Purpose of Data	Calculation of Baseline Emissions
Comments	No comments

Data / Parameter	$VS_{default}$
Data unit	kg dry matter/animal/day
Description	Default value for the volatile solid excretion rate per day on a dry-matter basis for a defined livestock population
Source of data	Obtained from IPCC2006, vol 4, chapter 10, Tables 10A-7 and 10A-8.
Value applied:	0.3 for Market Swine (finishers, nursery/weaners, boars) 0.46 for Breeding Swine (guilts, sows)
Justification of choice of data or description of measurement methods and procedures applied	Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association). http://www.abcs.org.br/ The genetic source of production operation is originated from Annex I; The farm uses formulated feed rations optimized for the various stages of growth and animals category; The formulated feed rations

	can be validated through on farm record keeping; The project specific animal weights are more similar to developed country IPCC default values. Used of factors as defined in IPCC2006, chapter 10, volume 4, since that there is no national data for the default value for the volatile solid excretion rate per day on a dry-matter basis for a defined livestock population.
Purpose of Data	Calculation of Baseline Emissions
Comments	The four conditions to apply VS value of developed countries are fully applicable to developed countries can be used provided the following four conditions are satisfied: - *The genetic source of the livestock originates from an Annex I Party;* Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association) – http://www.abcs.org.br/ and also at ASSUGLORIA (Associação de Gória de Dourados). The genetic source of the livestock is therefore in compliance with this methodology requirement, which can be confirmed and verified by the genetic documents of the animals of each farm. These evidences were provided and assessed to assure their applicability to this requirement. - *The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;* The formulated feed rations are created according with the characteristics of the animals, their stage of growth, category, weight gain and genetics. Each farm possesses their FFR composition according with the type of animal(s) accommodated, which was confirmed and verified. These evidences were provided and assessed to assure their applicability this requirement. - *The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);* The formulated feed rations are part of the management system of the farms and therefore, each site possesses on-farm records which attest the FFR used. These evidences are also monitored on a monthly basis, according monitoring plan for the parameter FFR, as described in section 5.3., and the PP internal procedure POP 14. - *The project specific animal weights are more similar to developed country IPCC default values.* The W_{site} value considered for each category of swine is the result of an average weight of the animals of all farms included in the project, and this value was applied in the baseline calculation. Finishers is the animal category that represents the totality of all animals from the farms included in this PD. Finishers are considered to be “market

	swine" and presented an average weight of 90kg among all farms included in the PD by the time of the project's registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (50 kg) – the values form Latin America (28 kg), where the project is located, is even lower than Western Europe's. This situation is also observed for the remaining four categories of swine (nursery and boars for market swine, guilts and sows for breeding swine): the values are more similar to those adopted in Western Europe than in Latin America, especially regarding the Breeding Swine (guilts and sows) and in the Market Swine (boars) which presented an average weight of 210kg and 230 kg respectively, among all farms included in the PD by the time of the project's registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (198kg for Breeding Swine and 50 kg for Market Swine) – the values form Latin America (28kg for both classes of Breeding and Market Swine), where the project is located, is much lower than Western Europe's. Only in the category nursery (also Market Swine), which roughly represents 30% of all animals from the farms included in this PD, have an average weight of 20 kg, closer to the Latin America values than the Western Europe values. Therefore, is fair to consider that "the project specific animal weights are more similar to developed country IPCC default values" condition is fulfilled and that the VS adopted values for developed counties is in full compliance with the methodology requirements.

Data / Parameter	$GWPCH_4$
Data unit	tCO_2e/tCH_4
Description	Global warming potential of CH_4
Source of data	IPCC Fifth Assessment Report: Climate Change 2014
Value applied:	28
Justification of choice of data or description of measurement methods and procedures applied	Conversion factor for metric tons of CH_4 to metric tons of CO_2 equivalent.
Purpose of Data	Calculation of Baseline Emissions and Project Emissions
Comments	No comments.

Data / Parameter	$B_{0,LT}$
Data unit	m^3 CH_4/kg dm
Description	Maximum methane producing potential of the volatile solid generated for animal type “LT”.
Source of data	IPCC 2006, Tables 10-A7 and 10-A8.
Value applied:	0.45
Justification of choice of data or description of measurement methods and procedures applied	Default value according to IPCC 2006 in western Europe region. Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association). http://www.abcs.org.br/ The genetic source of production operation is originated from Annex I; The farm uses formulated feed rations optimized for the various stage of growth and animals category; The formulated feed ratings can be validated through on farm record keeping; The project specific animal weights are more similar to developed

	country IPCC default values. Used of factors as defined in IPCC2006, chapter 10, volume 4, since that there is no national data for the Maximum methane producing potential of the volatile solid generated for animal type "LT"
Purpose of Data	Calculation of Baseline Emissions
Comments	The four conditions to apply B0 value of developed countries are fully applicable to developed countries can be used provided the following four conditions are satisfied: - *The genetic source of the livestock originates from an Annex I Party;* Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association) – http://www.abcs.org.br/ and also at ASSUGLORIA (Associação de Gória de Dourados). The genetic source of the livestock is therefore in compliance with this methodology requirement, which can be confirmed and verified by the genetic documents of the animals of each farm. These evidences were provided and assessed to assure their applicability to this requirement. - *The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;* The formulated feed rations are created according with the characteristics of the animals, their stage of growth, category, weight gain and genetics. Each farm possesses their FFR composition according with the type of animal(s) accommodated, which was confirmed and verified. These evidences were provided and assessed to assure their applicability this requirement. - *The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);* The formulated feed rations are part of the management system of the farms and therefore, each site possesses on-farm records which attest the FFR used. These evidences are also monitored on a monthly basis, according monitoring plan for the parameter FFR, as described in section 5.3., and the PP internal procedure POP 14. - *The project specific animal weights are more similar to developed country IPCC default values.* The W_{site} value considered for each category of swine is the result of an average weight of the animals of all farms included in the project, and this value was applied in the baseline calculation. Finishers is the animal category that represents the totality of all animals from the farms included in this PD. Finishers are considered to be "market swine" and presented an average weight of 90kg among all farms included in the PD by the time of the project's registration (and this was the value

	adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (50 kg) – the values form Latin America (28 kg), where the project is located, is even lower than Western Europe's. This situation is also observed for the remaining four categories of swine (nursery and boars for market swine, guilts and sows for breeding swine): the values are more similar to those adopted in Western Europe than in Latin America, especially regarding the Breeding Swine (guilts and sows) and in the Market Swine (boars) which presented an average weight of 210kg and 230 kg respectively, among all farms included in the PD by the time of the project's registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (198kg for Breeding Swine and 50 kg for Market Swine) – the values form Latin America (28kg for both classes of Breeding and Market Swine), where the project is located, is much lower than Western Europe's. Only in the category nursery (also Market Swine), which roughly represents 30% of all animals from the farms included in this PD, have an average weight of 20 kg, closer to the Latin America values than the Western Europe values. Therefore, is fair to consider that "the project specific animal weights are more similar to developed country IPCC default values" condition is fulfilled and that the B0 adopted values for developed counties is in full compliance with the methodology requirements.

Data / Parameter	$W_{default}$
Data unit	kg
Description	Default average animal weight of a defined population at the project site.
Source of data	IPCC 2006, Tables 10-A7 and 10-A8.
Value applied:	Sows (breeding swine): 198 kg Finishers (market swine): 50 kg Nursery (market swine): 50 kg Boars (market swine): 50 kg Gilts (breeding swine): 198 kg
Justification of choice of data or description of measurement methods and procedures applied	Default value according to IPCC 2006 in western Europe region. Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association). http://www.abcs.org.br/ The genetic source of production operation is originated from Annex I; The farm uses formulated feed rations optimized for the various stage of growth and animals category; The formulated feed ratings can be validated through on farm record keeping; The project specific animal weights are more similar to developed country IPCC default values. Used of factors as defined in IPCC2006, chapter 10, volume 4, since that there is no national data for the Maximum methane producing potential of the volatile solid generated for animal type "LT"
Purpose of Data	Calculation of Baseline Emissions
Comments	The four conditions to apply WDEFAULT value of developed countries are fully applicable to developed countries can be used provided the following four conditions are satisfied: - *The genetic source of the livestock originates from an Annex I Party;* Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association) – http://www.abcs.org.br/ and also at ASSUGLORIA (Associação de Gória de Dourados). The genetic source of the livestock is therefore in compliance with this methodology requirement, which can be confirmed and verified by the genetic documents of the animals of each farm. These evidences were provided and

assessed to assure their applicability to this requirement.

- *The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;*

The formulated feed rations are created according with the characteristics of the animals, their stage of growth, category, weight gain and genetics. Each farm possesses their FFR composition according with the type of animal(s) accommodated, which was confirmed and verified. These evidences were provided and assessed to assure their applicability this requirement.

- *The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);*

The formulated feed rations are part of the management system of the farms and therefore, each site possesses on-farm records which attest the FFR used. These evidences are also monitored on a monthly basis, according monitoring plan for the parameter FFR, as described in section 5.3., and the PP internal procedure POP 14.

- *The project specific animal weights are more similar to developed country IPCC default values.*

The W_{site} value considered for each category of swine is the result of an average weight of the animals of all farms included in the project, and this value was applied in the baseline calculation.

Finishers is the animal category that represents the totality of all animals from the farms included in this PD. Finishers are considered to be “market swine” and presented an average weight of 90kg among all farms included in the PD by the time of the project’s registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (50 kg) – the values form Latin America (28 kg), where the project is located, is even lower than Western Europe’s.

This situation is also observed for the remaining four categories of swine (nursery and boars for market swine, guilts and sows for breeding swine): the values are more similar to those adopted in Western Europe than in Latin America, especially regarding the Breeding Swine (guilts and sows) and in the Market Swine (boars) which presented an average weight of 210kg and 230 kg respectively, among all farms included in the PD by the time of the project’s registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (198kg for Breeding Swine and 50 kg for Market Swine) – the values form Latin America (28kg for both classes of Breeding and Market Swine), where the project is located, is much lower than Western Europe’s. Only in the category nursery (also Market Swine), which roughly represents 30% of all animals from the farms

	included in this PD, have an average weight of 20 kg, closer to the Latin America values than the Western Europe values. Therefore, is fair to consider that "the project specific animal weights are more similar to developed country IPCC default values" condition is fulfilled and that the WDEFAULT adopted values for developed counties is in full compliance with the methodology requirements.

Data / Parameter	UF_b
Data unit	Fraction
Description	Model correction factor to account for model uncertainties
Source of data	FCCC/SBSTA/2003/10/Add.2, page 25.
Value applied:	0.94
Justification of choice of data or description of measurement methods and procedures applied	Default value according to methodology AMS-III.D
Purpose of Data	Calculation of Baseline Emissions
Comments	No comments.

Data / Parameter	$SPEC_{flare}$
Data unit	Temperature - °C Flow rate or heat flux - kg/h or m3/h Maintenance schedule - number of days
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare manufacturer
Value applied:	The flare optimal conditions are, according the manufacturers specifications: Flow: between + 40% of the estimated flow (in m3/h) for any giving farm; Temperature: between 500ºC and 800ºC Maintenance: Annually, recommended by the manufacturer. The PP preforms monthly maintenance, both preventive and corrective, if needed.
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of Data	N/A
Comments	The maintenance schedule is not required if Option A is selected to determine flare efficiency of an enclosed flare

5.2 Data and Parameters Monitored

Data / Parameter	T_f
Data unit	°.C
Description	Combustion temperature of the flare
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Every 1 minute measurement and registration by a Control Logic Program (CLP)
Frequency of monitoring/recording	Every 1 minute measurement and registration by the PLC. Data is collected monthly from the field by the use of the pen drive. According to the Monitoring Operational Procedure POP-01
Value applied:	N/A
Monitoring equipment	Monitoring equipment type: Standard Thermocouple from ALUTAL Accuracy class: ± 1.5 °C or ± 0.25% Calibration frequency: Every year of continuous operation (counted from the date of installation)
QA/QC procedures applied	Check the data for more accurate information.
Purpose of data	Calculation of Baseline Emissions and Project Emissions
Calculation method	Monitoring operational procedure POP-01 can be found at the Brascarbon Operational Procedure Manual
Comments	Check the data for more accurate information.

Data / Parameter	W_{site}
Data unit	kg
Description	Average animal weight of a defined livestock population at the project site in year
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	The data collection is realized quarterly by each farm owner, together with ASSUGLORIA (Cooperativa de Gória de Dourados) and provided to the PP. ASSUGLORIA is the Pig Producers Association to whom the farms contained in the PD are associated; its main role is to act as a third party responsible for the assurance of all the logistics associated with the swine producers, providing the animal nutrition, genetics and all the overall animal weight.
Frequency of monitoring/recording	Quarterly (based on sampling following ASSUGLORIA's internal procedure) and at full weight of the batch of pigs every time it leaves the farms (each batch stays around 5 to 6 months per farm).
Value applied:	Sows: 220 kg Finishers: 90 kg Nursery: 20 kg Boars: 240 kg Gilts: 220 kg
Monitoring equipment	N/A
QA/QC procedures applied	Check of the site records and documents. The values of the quarterly weights presented by ASSUGLORIA's (following the association's internal procedures) to the PP are cross-checked against two different credible sources: - reference figures from EMBRAPA (an undisputed Brazilian Agricultural Research Corporation nationally recognized for these scope) for each category; and - the figures provided by ASSUGLORIA when each of the swine batches exits each farm (each batch stays around 5 to 6 months per farm), as explained below. Here ASSUGLORIA provides invoices with 100% of the animals weight (and number), allowing a full cross-check with the weight values provided and assuring that all the

	information is accurate. - If the PP verifies during the cross-check any discrepancy between the values provided quarterly and the full weighting and counting of the animals in the invoices provided by ASSUGLORIA's each time any batch exits a giving farm, those values will be updated accordingly with these real figures.
Purpose of data	Calculation of Baseline Emissions and Project Emissions
Calculation method	The current practice of swine farms in Brazil is that each farm receives new batches of animals every 5 to 6 months (which is also the average time that a batch stays in a farm) and the producer, together with ASSUGLORIA, performs regular and periodical visits to each farm in order to assess and evaluate the correct development of each batch in terms of growing/weighting of the animals (according with what is expected at each growing stage of a given batch). It is important to highlight that both the farm owners ASSUGLORIA rely on the quality of the values measured since their sole professional occupation is the pig production and, therefore, it is within their best interests to have a correct and reliable way to assess the weighting of the animals (which is their business) based on their experience and internal procedures. Every 5 to 6 months (depending on each batch and farm), the animal batches leave the farms and they are, in this specific situation, 100% weighted by the producers, together with ASSUGLORIA – this weighting is undertaken to the totality of animal presented in the batch since the profits associated with the animal production are weight based. According with ASSUGLORIA a possible range of +/- 5kg within the animal growing is considered a normal fluctuation and therefore admissible. Each time a batch exits a farm, ASSUGLORIA provides the invoices to attest the feasibility of the figures adopted, allowing a complete and thorough cross-check by PP of all the data used for this parameter. Monitoring operational procedure POP-016
Comments	Check the data for more accurate information.

Data / Parameter	SITE INSPECTION
Data unit	N/A
Description	Inspection on the site considering relevant regulation and the infra-structure of the site
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Annual follow-up of the documentation to check the expiration date, changes in the production lay-out and surroundings of the digester. Actions within the property and around the biodigesters should be taken both by the contractor and the client Brascarbon. Photos should be attached to the annual inspection report to prove that the system of wastewater management has not changed namely regarding the following items: pipes, gutters, roofs, fences, trees, control panel, flare, terminal boxes and general cleaning. Use of the annex attached at the operational procedure POP-02
Frequency of monitoring/recording	Annually
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	A copy of the documents is submitted to the central office to the Quality Coordinator, who will verify the data, controlling it through an electronic system and ensuring its integrity.
Purpose of data	Calculation of Baseline Emissions and Project Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-02 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	$N_{LT,y}$
Data unit	Number
Description	Annual average number of animals of type “LT” in year “y”
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Checking of the documentation located at the confined animal production and use of the table annexed at the operational procedure POP-03. Use of the Equation 4 established in the section 4 step 2 item B – determination of the annual average number of animals.
Frequency of monitoring/recording	Monthly
Value applied:	See table 6
Monitoring equipment	N/A
QA/QC procedures applied	A copy of the documents is submitted to the central office to the Quality Coordinator, who will verify the data, controlling it through an electronic system and ensuring its integrity.
Purpose of data	Calculation of Baseline Emissions and Project Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-03 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	$BG_{burnt,y}$
Data unit	m^3
Description	Biogas flared or used as a fuel in the year y.
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Minute by minute measurement and cumulative registration by a Control Logic Program (CLP). Monthly the registered data will be recovered in the data logger (CLP) of the volume in the local control panel according to the operational procedure POP-04
Frequency of monitoring/recording	Continuously recording. Every 1 minute measurement and registration by the PLC. Data is collected monthly from the field.
Value applied:	N/A
Monitoring equipment	Monitoring equipment type: Endress+Hauser thermal mass flow meter t-trend - ATT12 Accuracy class: ± 5% of factory full scale Calibration frequency: Every 2 years of continuous operation (counted from the date of installation)
QA/QC procedures applied	Check the monthly registers sent from the field to proceed with the emissions reductions calculation. The registers are read and stored every minute continuously in the CLP. The data is recovered from the CLP every month. The QA/QC also controls and assures the calibration program of the flow meter.
Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-04 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	W_{CH_4}
Data unit	%
Description	Methane content in biogas in the year "y"
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Use of methane concentration analysis instrument on dry basis in the sampling point at piping to the flare.
Frequency of monitoring/recording	Periodical. To assure. that the monitoring frequency provides a 90% confidence level and 10% precision. The adequate frequency will be determined through a statistical analysis of the methane fraction variation, based on methane fraction data gathered on a group of farms per region during a certain period time. According with the data/parameter table 6 of the methodology AMS III.D version 21.0, The fraction of methane in the biogas should be measured with a continuous analyser (values are recorded with the same frequency as the flow) or, with periodical measurements at a 90/10 confidence/precision level by following General guidelines for sampling and surveys for SSC project activities, or, alternatively a default value of 60% methane content can be used The option chosen was periodical measurements at a 90/10 confidence/precision level. For details, please see Section regarding the Sampling Plan.
Value applied:	N/A
Monitoring equipment	Monitoring equipment type: — Biogas Check Portable Digital Analyzer from Geotech/Landtech Accuracy class: — • **CH4:** ± 0.5% from 0-5% CH4 content; ± 1.0% from 5-15% CH4 content; ± 3.0% from 15%-full scale CH4 content • **Temperature:** ± 0.2ºC (Biogas check analyzer accuracy) ± 0.5ºC (temperature probe accuracy) • **Pressure**: ± 4mbar typically and ±15 mbar maximum Calibration frequency: — Every 6 months
QA/QC procedures applied	Check the registers in the generated documents. Control and assure the calibration program of the instrument.

Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring frequency to be determined to attend 90% confidence level and 10% precision. To assure that the monitoring frequency provides a 90% confidence level and 10% precision, the adequate frequency will be determined through a statistical analysis of the methane fraction variation, based on methane fraction data gathered on a group of farms per region during a certain period time. The results will be analyzed to guarantee that the required confidence/precision level has been met and the monitoring frequency will be, at least, monthly. For details, please see Section regarding the Sampling Plan. The equipment used can directly measure methane content in the biogas. The methane content measurement will be carried out close to a location in the system where a biogas flow measurement takes place, and on the same basis (wet or dry) as required by the methodology. Monitoring operational procedure POP-05 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	T_{biogas}
Data unit	°C
Description	Temperature of the biogas at operation conditions
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Measurement with a local thermometer, with the same equipment as the methane content and at the same time, in the sampling point at piping to the flare. Measurement according with Operational Procedure POP-06.
Frequency of monitoring/recording	Periodical. To assure. that the monitoring frequency provides a 90% confidence level and 10% precision. The adequate frequency will be determined through a statistical analysis of the methane fraction variation, based on methane fraction data gathered on a group of farms per region during a certain period time. According with the data/parameter table 6 of the methodology AMS III.D version 21.0, The fraction of methane in the biogas should be measured with a continuous analyser (values are recorded with the same frequency as the flow) or, with periodical measurements at a 90/10 confidence/precision level by following General guidelines for sampling and surveys for SSC project activities, or, alternatively a default value of 60% methane content can be used The option chosen was periodical measurements at a 90/10 confidence/precision level. For details, please see Section regarding the Sampling Plan.
Value applied:	N/A
Monitoring equipment	Monitoring equipment type: Biogas Check Portable Digital Analyzer from Geotech/Landtech Accuracy class: • **CH4:** ± 0.5% from 0-5% CH4 content; ± 1.0% from 5-15% CH4 content; ± 3.0% from 15%-full scale CH4 content • **Temperature:** ± 0.2°C (Biogas check analyzer accuracy) ± 0.5°C (temperature probe accuracy) • **Pressure**: ± 4mbar typically and ±15 mbar maximum Calibration frequency: Every 6 months
QA/QC procedures applied	Check the registers in the generated documents and thermometer calibration

Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring frequency to be determined to attend 90% confidence level and 10% precision. To assure that the monitoring frequency provides a 90% confidence level and 10% precision, the adequate frequency will be determined through a statistical analysis of the methane fraction variation, based on methane fraction data gathered on a group of farms per region during a certain period time. The results will be analyzed to guarantee that the required confidence/precision level has been met and the monitoring frequency will be, at least, monthly. For details, please see Section regarding the Sampling Plan. The equipment used can directly measure methane content in the biogas. The methane content measurement will be carried out close to a location in the system where a biogas flow measurement takes place, and on the same basis (wet or dry) as required by the methodology. Monitoring operational procedure POP-05 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	$D_{CH4,y}$
Data unit	t/m^3
Description	Density of the methane combusted
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Calculation according to the Operational Procedure POP-07. Use of the formula considering pressure, temperature and molecular mass of methane
Frequency of monitoring/recording	Monthly
Value applied:	0.00067
Monitoring equipment	N/A
QA/QC procedures applied	Check and approve the density value calculation.
Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-07 can be found at the Brascarbon Operational Procedure Manual. Reference: Tool to determine project emissions from flaring gases containing methane.

Data / Parameter	Q_{DM}
Data unit	N/A
Description	Sludge soil application
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Supervision in the field
Frequency of monitoring/recording	Defined according to the digester performance
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	Check the registers in the generated documents.
Purpose of data	N/A
Calculation method	N/A
Comments	Monitoring operational procedure POP-09 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	FE or $\eta_{flare,\,h}$
Data unit	%
Description	Enclosed Flare Efficiency
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Enclosed flare (low height) is used in the entire project. Brascarbon registers the gas flow sent to the flares and the combustion temperature of the flares every minute. A 80% efficiency for a specific hour is considered if the following conditions are met for all minutes in that specific hours: (i) all temperature records are above or equal to 500° Celsius and (ii) the temperature of the flare (TEG.m) and the flow rate of the residual gas to the flare (FRG,m) are within the manufacturer's specification for the flare (SPECflare). (iii) The flame is detected in minute m (Flamem). Otherwise, a 0% efficiency for the specific hour is applied if at any minute the records of temperature measurement are below 500° Celsius or the flare is operating outside of the manufacturer's specification (SPECflare). This discount will be applied to the volume of that specific hour since it is a more conservative approach than to discount in the average of the flare efficiency percentage for any giving hour.
Frequency of monitoring/recording	Every 1 minute measurement and registration by a CLP of flare temperature and biogas flow rate. Data is recovered monthly for Flare Efficiency hourly calculation
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	Check the registers in the generated documents. The enclosed flare will regularly undergo a maintenance process subject to the appropriate industrial standards and/or manufacturer´s specifications in order to ensure measurement accuracy.

	The Monitoring Operational Procedure POP-08 was developed to calculate the flare efficiency and it can be found at the Brascarbon Operational Procedure Manual.
Purpose of data	Calculation of Baseline Emissions and Project Emissions
Calculation method	N/A
Comments	The Monitoring Operational Procedure POP-08 was developed to calculate the monthly efficiency and it can be found at the Brascarbon Operational Procedure Manual.

Data / Parameter	$ER_{y,ex\text{-}post}$
Data unit	t CO2e
Description	Ex-post emission reductions achieved by the project activity based on monitored values for the year “y”.
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Comparison of the baseline with the actual measured data according to the operational procedure POP-17. The minimum value between the $BE_{ex\text{-}post}$ and MD_y will be chosen for the calculation of the $ER_{y\ ex\text{-}post}$.
Frequency of monitoring/recording	Yearly
Value applied:	2022: 57,729 2023: 57,885 2024: 57,885 2025: 57,885 2026_57,885 2027: 57,885 2028: 57,885 2029: 157
Monitoring equipment	N/A
QA/QC procedures applied	Check the ER calculation and the registers in the generated documents.
Purpose of data	N/A
Calculation method	According with the formulas presented in the current Section
Comments	Used to cap the maximal emission reduction in any year. Monitoring operational procedure POP-17 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	FFR
Data unit	N/A
Description	Formulated Feed Rations
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	According to the Operational Procedure POP-14
Frequency of monitoring/recording	Monthly
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	Check the registers and/or food purchases records on the farm.
Purpose of data	Calculation of Baseline Emissions (to validate B0 and VS values used)
Calculation method	N/A
Comments	Monitoring operational procedure POP-14 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	P_{biogas}
Data unit	mbar
Description	Pressure of the biogas at operation conditions
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Measurement with portable local pressure gauge, with the same equipment as the methane content and at the same time, in the sampling point at piping to the flare. Measurement according with Operational Procedure POP-13.
Frequency of monitoring/recording	Periodical. To assure. that the monitoring frequency provides a 90% confidence level and 10% precision. The adequate frequency will be determined through a statistical analysis of the pressure variation, based on pressure data gathered on a group of farms per region during a certain period time. According to the data/parameter table 6 of the methodology AMS III.D version 21.0, the pressure of the biogas at the flow measurement site is not measured by a continuous analyser, the frequency of periodical measurements at a 90/10 statistical confidence/precision level shall be determined following the "Standard for sampling and surveys for CDM project activities and programme of activities". The minimum sample size required would be dependent on the variability in the values of pressure, which will be determined in the sampling plan. For details, please see Section regarding the Sampling Plan.
Value applied:	N/A
Monitoring equipment	Monitoring equipment type: — Biogas Check Portable Digital Analyzer from Geotech/Landtech Accuracy class: — • **CH4:** ± 0.5% from 0-5% CH4 content; ± 1.0% from 5-15% CH4 content; ± 3.0% from 15%-full scale CH4 content • **Temperature:** ± 0.2ºC (Biogas check analyzer accuracy) ± 0.5ºC (temperature probe accuracy) • **Pressure**: ± 4mbar typically and ±15 mbar maximum Calibration frequency: — Every 6 months
QA/QC procedures applied	Check the registers in the generated documents and equipment for measurement calibration

Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring frequency to be determined to attend 90% confidence level and 10% precision. To assure that the monitoring frequency provides a 90% confidence level and 10% precision, the adequate frequency will be determined through a statistical analysis of the methane fraction variation, based on methane fraction data gathered on a group of farms per region during a certain period time. The results will be analyzed to guarantee that the required confidence/precision level has been met and the monitoring frequency will be, at least, monthly. For details, please see Section regarding the Sampling Plan. The equipment used can directly measure methane content in the biogas. The methane content measurement will be carried out close to a location in the system where a biogas flow measurement takes place, and on the same basis (wet or dry) as required by the methodology. Monitoring operational procedure POP-05 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	GENETIC SOURCE
Data unit	N/A
Description	Genetic source from annex I party
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Data and records from the confined feed animal operation. According Operational Procedure POP-15
Frequency of monitoring/recording	Annually
Value applied:	Western Europe
Monitoring equipment	N/A
QA/QC procedures applied	Check data and records from the farm operation
Purpose of data	Calculation of Baseline Emissions (to validate Bo and VS values used)
Calculation method	N/A
Comments	Monitoring operational procedure POP-15 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	$MS_{\%\ i,y}$
Data unit	Fraction
Description	Fraction of manure handled in project emissions in system "i", year "y".
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	During the site inspection, checking if changes in the adopted waste management system and surroundings of the digester was modified from the original proposal project activity. Use of the annex attached at the operational procedure POP-02
Frequency of monitoring/recording	Annually, based on daily measurement and monthly aggregation
Value applied:	1
Monitoring equipment	N/A
QA/QC procedures applied	A copy of the documents is submitted to the central office to the Quality Coordinator, who will verify the data, controlling it through an electronic system and ensuring its integrity.
Purpose of data	Calculation of Project Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-02 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	$N_{da,y}$
Data unit	Number
Description	Number of days animal is alive in the farm, in year “y”
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Checking of the documentation located at the confined animal production and use of the operational procedure POP-03
Frequency of monitoring/recording	Annually, based on monthly records
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	Information is cross-checked with the documents available at the confined feed operation including, when available, animal purchase and sale records or information on food purchase records.
Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-03 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	Np,y
Data unit	Number
Description	Number of animals produced annually of type “LT” in year “y”
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Checking of the documentation located at the confined animal production and use of the table annexed at the operational procedure POP-03
Frequency of monitoring/recording	Annually, based on monthly records
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	Information is cross-checked with the documents available at the confined feed operation including, when available, animal purchase and sale records or information on food purchase records.
Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-03 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	nd_y
Data unit	Number
Description	Number of days in year "y" where the treatment plant was operational
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	The number of days the animal manure management system is operational can be determined by the POP 24 – days of functioning, where it is monitored the number of days in a year "y" that the treatment plant has operated. According to the operational procedure POP-24
Frequency of monitoring/recording	Annually, based on daily records and monthly aggregation
Value applied:	365
Monitoring equipment	N/A
QA/QC procedures applied	The documentation should be sent to the central office to the Quality Coordinator, who will verify the data, controlling and ensuring its integrity.
Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	Monitoring operational procedure POP-24 can be found at the Brascarbon Operational Procedure Manual

Data / Parameter	$VS_{LT,y}$
Data unit	kg dry matter/animal/year
Description	Volatile solids for livestock *LT* entering the animal manure management system in year *y*
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	N/A
Frequency of monitoring/recording	Annually
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	Check the registers in the generated documents. Control and assure the correct calculation of the parameter.
Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	The four conditions to apply B0 value of developed countries are fully applicable to developed countries can be used provided the following four conditions are satisfied: - *The genetic source of the livestock originates from an Annex I Party;* Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association) – http://www.abcs.org.br/. The genetic source of the livestock is therefore in compliance with this methodology requirement, which can be confirmed and verified by the genetic documents of the animals of each farm. These evidences were provided and assessed to assure their applicability to this requirement. - *The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;*

The formulated feed rations are created according with the characteristics of the animals, their stage of growth, category, weight gain and genetics. Each farm possesses their FFR composition according with the type of animal(s) accommodated, which was confirmed and verified. These evidences were provided and assessed to assure their applicability this requirement.

- The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);

The formulated feed rations are part of the management system of the farms and therefore, each site possesses on-farm records which attest the FFR used. These evidences are also monitored on a monthly basis, according monitoring plan for the parameter FFR, as described in section 5.3, and the PP internal procedure POP 14.

- The project specific animal weights are more similar to developed country IPCC default values.

The Wsite value considered for each category of swine is the result of an average weight of the animals of all farms included in the project, and this value was applied in the baseline calculation.

Finishers is the animal category that represents the totality of all animals from the farms included in this PD. Finishers are considered to be “market swine” and presented an average weight of 90kg among all farms included in the PD by the time of the project’s registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (50 kg) – the values form Latin America (28 kg), where the project is located, is even lower than Western Europe’s.

This situation is also observed for the remaining four categories of swine (nursery and boars for market swine, guilts and sows for breeding swine): the values are more similar to those adopted in Western Europe than in Latin America, especially regarding the Breeding Swine (guilts and sows) and in the Market Swine (boars) which presented an average weight of 210kg and 230 kg respectively, among all farms included in the PD by the time of the project’s registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (198kg for Breeding Swine and 50 kg for Market Swine) – the values form Latin America (28kg for both classes of Breeding and Market Swine), where the project is located, is much lower than Western Europe’s. Only in the category nursery (also Market Swine), which roughly represents 30% of all animals from the farms included in this PD, have an average weight of 20 kg, closer to the Latin America values than the Western Europe values.

Data / Parameter	$Q_{manure,LT,y}$
Data unit	Tonnes DM/year
Description	Quantity of manure treated from livestock type *LT* at animal manure management system *j*
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Supervision in the field, performed during the regular site visit of the regional techicians as part of the operation assessment of the biodigestor, to each farm. Use of the annex attached at the operational procedure POP-02
Frequency of monitoring/recording	Annually, based on daily measurement and monthly aggregation
Value applied:	N/A
Monitoring equipment	N/A
QA/QC procedures applied	Check the registers in the generated documents.
Purpose of data	Calculation of Baseline Emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$SVS_{j,LT\ ,y}$
Data unit	tonnes VS/tonnes DM
Description	Specific volatile solids content of animal manure from livestock type *LT* and animal manure management system *j* in year *y*
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	This parameter and the parameter $VS_{LT,y}$ are the same. Please refer to the monitoring frequency from the parameter $VS_{LT,y}$
Frequency of monitoring/recording	This parameter and the parameter $VS_{LT,y}$ are the same. Please refer to the QA/QC procedures from the parameter $VS_{LT,y}$
Value applied:	This parameter and the parameter $VS_{LT,y}$ are the same. Please refer to the value applied from the parameter $VS_{LT,y}$
Monitoring equipment	This parameter and the parameter $VS_{LT,y}$ are the same. Please refer to the monitoring equipment from the parameter $VS_{LT,y}$
QA/QC procedures applied	This parameter and the parameter $VS_{LT,y}$ are the same. Please refer to the QA/QC procedures from the parameter $VS_{LT,y}$
Purpose of data	Calculation of Project Emissions
Calculation method	This parameter and the parameter $VS_{LT,y}$ are the same. Please refer to the calculation method from the parameter $VS_{LT,y}$
Comments	This parameter and the parameter $VS_{LT,y}$ are the same. Please refer to the comments from the parameter $VS_{LT,y}$

Data / Parameter	AI_l
Data unit	Days
Description	Annual average interval between manure collection and delivery for treatment at a given storage device l
Source of data	N/A
Description of measurement methods and procedures applied	Supervision in the field
Frequency of monitoring/recording	Annually, based on monthly records
Value applied:	N/A
Monitoring equipment	
QA/QC procedures applied	Check the registers in the generated documents.
Purpose of data	Calculation of Project Emissions
Calculation method	N/A
Comments	No comments

Data / Parameter	$Flame_m$
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data	Brascarbon Monitoring Report System
Description of measurement methods and procedures applied	Measure will be made using a fixed installation optical flame detector
Frequency of monitoring/recording	Once per minute.
Value applied:	ON/OFF
Monitoring equipment	Ultraviolet flame sensor Model C7035
QA/QC procedures applied	Check the registers in the generated documents. The enclosed flare will regularly undergo a maintenance process subject to the appropriate industrial standards and/or manufacturer´s specifications in order to ensure measurement accuracy. The Monitoring Operational Procedure POP-08 was developed to calculate the flame and it can be found at the Brascarbon Operational Procedure Manual.
Purpose of data	Calculation of Project Emissions
Calculation method	N/A
Comments	No comments.

5.3 Monitoring Plan

The methodology applied to this project activity is AMS-III.D./version 21.0, Methane recovery in animal manure management systems. The simplified monitoring methodologies are applicable to this project activity because they provide a method to accurately measure and record the GHG emissions that will be captured and combusted by the project activity.

Each individual farm will be monitored independently according with the parameters described in the following section 5.3 and monitored according with the monitoring plan described in the section 5.4.

All data monitored and required for verification and issuance is kept for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later. All parameters are deeply controlled by operational procedures developed by Brascarbon. A list and the procedures contained in the Brascarbon Operational Procedures Manual are mentioned in this section.

Brascarbon trained several regional technicians who will be responsible for the maintenance and the monitoring system based in ISO 9001 (Brascarbon Operational Procedure Manual).

a) Sampling design

According to methodology AMS-III.D version 21.0 requirements, the parameter methane content in biogas will be measured with periodical measurements to attend 90% confidence level and 10% precision level.

Since the biogas is flowing continuously, the study population can be thought of as all the possible methane content measurements in a certain period – so large as to be almost infinite. The sampling method to be applied will be systematic sampling with a random start date which is appropriate for this type of population.

The sample size/adequate frequency of measurements will be determined using data from ex-ante methane content measurements gathered on a group of farms located in the same region during a certain period time and will be done in accordance with the Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities. The collected data will be analyzed in order to assess compliance with the 90/10 confidence/precision level.

The monitoring plan will concentrate on ensuring the emission reductions are accurately accounted within the project boundary. Brascarbon introduced operational procedures, from the Brascarbon Operational Procedures Manual, to facilitate the monitoring system of the parameters described in the the following table presents the monitoring plan followed by Brascarbon in order to achieve certified emissions reductions, after each validation and verification process.

Table 14 – Monitoring Plan

ID	DATA	Data Type	Data Unit	Data Variable	Frequency	Measured(m) Calculated(c) Estimated(e) Documented(d)	Proportion of the data to be monitored	How will the data be archived?	For how long is archived data to be kept?	Comment
1	T_f	Temp	°C	Flare Temperature	Every 1 minute	M	100%	electronic	Until end of CP + 2 years	Use for flare efficiency
2	Site Inspection	Document	----	----	Annually	D	100%	electronic	Until end of CP + 2 years	General Site Inspection
3	$N_{LT,y}$	Number	-	Nr, Of heads	Monthly	C	100%	electronic	Until end of CP + 2 years	Used to quantify the methane generation potential
4	$BG_{burnt,y}$	Volume	m^3	Biogas produced	Every 1 minute	M	100%	electronic	Until end of CP + 2 years	Cumulative biogas production
5	W_{CH4}	Fraction	%	Methane content	TBD(*)	M	100%	electronic	Until end of CP + 2 years	Concentration in wet basis
6	T_{biogas}	Temp	°C	Biogas Temperature	TBD(*)	M	100%	electronic	Until end of CP + 2 years	Use to biogas density calculation
7	D_{CH4}	Mass	$tonne/m^3$	Density	Monthly	C	100%	electronic	Until end of CP + 2 years	Density
8	FE	Efficiency	%	Temperature and flare operation parameters	every 1 minute data	C	100%	electronic	Until end of CP + 2 years	Efficiency determined by the burning temp and flare operation parameters
9	QDM	Supervision	--	---	Every Batch Disposed	E	100%	electronic	Until end of CP + 2 years	Sludge disposed outside project boundary
10	W_{site}	Mass	kg	Average Animal weight	Quarterly	D	100%	electronic	Until end of CP + 2 years	Average Animal weight
11	$ER_{y,ex\text{-}post}$	Mass	tonne	CO_2e	Annually	C	100%	electronic	Until end of CP + 2 years	Yearly methane potential generation
12	FFR	------	---	Feed Formulation	Monthly	D	100%	electronic	Until end of CP + 2 years	Feed Formulation Rations
13	P_{biogas}	Pressure	mbar	Biogas Pressure	TBD(*)	M	100%	electronic	Until end of CP + 2 years	Biogas pressure
14	Genetic Source	Document	-------	genetic	Annually	D	100%	electronic	Until end of CP + 2 years	Genetic Source
15	$MS_{\%i,y}$	fraction	%	Manure handled	Annually, based on daily measurement and monthly aggregation	E	100%	electronic	Until end of CP + 2 years	General Site Inspection
16	$N_{da,y}$	number	days	days	Annually, based on monthly records	M	100%	electronic	Until end of CP + 2 years	Nr. Of days animal is alive
17	$N_{p,y}$	number	heads	Nr of heads	Annually, based on Monthly records	M	100%	electronic	Until end of CP + 2 years	Nr. Of heads per category annually

18	ndy	number	Days	days	Annually, based on daily records and monthly aggregation	M	100%	electronic	Until end of CP + 2 years	Number of days the treatment plant was operational
19	VSLT,y	Mass	kg	Volatile solids for livestock	Annually	C	100%	electronic	Until end of CP + 2 years	Volatile solids for livestock LT entering the animal manure management system in year y
20	Qmanure LT,y	Mass	ton	Manure handled	Annually, based on daily measurement and monthly aggregation	E	100%	electronic	Until end of CP + 2 years	Quantity of manure treated from livestock type LT at animal manure management system j
21	SVSjLT,y	Mass	ton	Specific volatile solids content of animal manure	Annually	C	100%	electronic	Until end of CP + 2 years	Specific volatile solids content of animal manure from livestock type LT and animal manure management system j in year y
22	Flamem	On/Off	N/A	Flame detection of flare in the minute m	Every minute	M	100%	electronic	Until end of CP + 2 years	Flamem is measured every minute and assesses if the flame is on or off.

(*)TBD: to be determined to attend 90% confidence level and 10% precision. The monitoring frequency will be, at least, monthly.

The following table presents the explanation of the QA/QC procedures of the monitoring plan followed by BRASCARBON in order to achieve certified emission reductions, after each validation and verification process:

Table 15 – QA/QC procedures of the monitoring plan

ID	DATA VARIABLE	UNCERTAINTY LEVEL	DATA UNIT	DATA ORIGIN
1	T_f	Low	°C	Register from the measurement system, information managed by Brascarbon,
2	Site Inspection	Low	-----	Register information managed by Brascarbon
3	$N_{LT,y}$	Low	Nr, Of heads by category	Register from the measurement system, information managed by Brascarbon,
4	$BG_{burned,y}$	Low	m^3	Register from the measurement system, information managed by Brascarbon,
5	W_{CH4}	Low	%	Register from the measurement system, information managed by Brascarbon,
6	T_{biogas}	Low	°C	Register from the measurement system, information managed by Brascarbon,
7	D_{CH4}	Low	t/m^3	Register from the measurement system, information managed by Brascarbon,
8	FE	Low	%	Register information managed by Brascarbon,
9	QDM	Low	---	Register from the measurement system, information managed by Brascarbon,
10	W_{site}	Low	Kg	Register from the measurement system, information managed by Brascarbon,
11	$ER_{y,ex\text{-}post}$	Low	t CO_2e	Register from the measurement system, information managed by Brascarbon,
12	FFR	Low	-----	Register from the measurement system, information managed by Brascarbon,
13	P_{biogas}	Low	mbar	Register information managed by Brascarbon.
14	Genetic Source	Low	-----	Register information managed by Brascarbon.
15	$MS_{\%i,y}$	Low	%	Register information managed by Brascarbon.
16	$N_{da,y}$	Low	days	Register information managed by Brascarbon.
17	$N_{p,y}$	Low	Nr, Of heads by category	Register information managed by Brascarbon.
18	ndy	Low	days	Register information managed by Brascarbon.
19	$VS_{LT,y}$	Low	kg	Register information managed by Brascarbon.
20	$Q_{manure\ LT,y}$	Low	ton	Register information managed by Brascarbon.
21	$SVSj_{LT,y}$	Low	ton	Register information managed by Brascarbon.
22	$Flame_m$	Low	ON/OFF	Register information managed by Brascarbon.

BRASCARBON has implemented the Operation Procedures Manual and forms to capture and report monitored data and maintenance activities throughout the project lifecycle. On-site assessment, supplier production data, task tracking, and post-implementation auditing tools have been developed to ensure accurate, consistent, and complete data gathering and project implementation.

By coupling these capabilities with an ISO-based quality and environmental management system, BRASCARBON enables transparent data collection and verification.

Procedures from Brascarbon Operation Procedures Manual to ensure accurate and consistent data for monitoring system have been developed as indicated in the following table:

Table 15 – Procedures from Brascarbon Operation Procedures Manual

ID	DATA /PARAMETERS/TITLE	RESPONSIBLE	PROCEDURE	COMENTS
1	T_f	TR	POP 1	Flare Temperature
2	SITE INSPECTION MS% i,y $VS_{LT,y}$ $SVS_{jLT,y}$	TR	POP 2	General site Inspection
3	$N_{LT,y}$ $N_{aa,y}$ $N_{p,y}$	TR	POP 3	Number of heads
4	$BG_{burnt,y}$ F	TR	POP 4	Biogas produced and burnt
5	W_{CH4}	TR	POP 5	Methane content
6	T_{biogas}	TR	POP 6	Biogas Temperature
7	D_{CH4}	QC	POP 7	Methane Density
8	FE $Flame_m$	TR	POP 8	Flare Efficiency Flame on or Flame off
9	QDM Q_{manure}	TR	POP 9	Sludge Mass
10	TRAINING	QC	POP 11	General training of procedures and safety issues
11	MAINTENANCE	OM	POP 12	Up-date of the maintenance activities
12	P_{biogas}	TR	POP 13	Biogas pressure
13	FFR	TR	POP 14	Formulated Feed Rations
14	GENETIC SOURCE	TR	POP 15	Genetic source
15	W_{site}	TR	POP 16	Average animal weight
16	$ER_{ex-post}$	QC	POP 17	Yearly emissions reductions ex-post
17	Ndy	QC	POP 24	Number of days the treatment plant was operational

Legend:

- A: Annually
- Q: Quarterly
- M: Monthly
- S: Semesterly
- TR: Regional Technician
- QC: Quality Control
- TBD: to be determined to attend 90% confidence level and 10% precision. The monitoring frequency will be, at least, monthly.
- OM: Operation Manger

Monitoring of the Flare Temperature

The temperature of the flare will be controlled by a logic system, able to store the flare temperature continuously. The sensor - thermo coupling - is installed in the flare body.

The signal from the thermocouple is sent to the PLC where the information of the temperature is recorded every each minute.

The file information from the logic system will be recovered monthly, by using a pen drive and the file will be sent to the QA/QC officer to manage the information for further verification. Then, a spreadsheet in excel will be available from the system to show the temperature per minute per day. The system PLC and the thermocouple will be powered by solar cell – no use of energy from the grid. A 12 volts battery is also included in the system to save energy to be used during the night or days lack of sun. The battery capacity is for 240 hours.

In the operational procedure POP 1 is the form 01.001 where the temperature information is managed according to the specification mentioned above. All QA/QC procedures are described in the operational procedure related to the maintenance and/or calibration of the equipment.

PEN DRIVE

PLC

Site Inspection.

A check list included in the procedure POP 2 – Site Inspection - number 02.001 is the basic orientation to guide the technicians during inspection in the field to follow all items related to the project activity installation.

Attached on it, the MS% i,y - Fraction of manure handled in the system during the year, is included to be inspected during the each farm visit.

No changes in the manure managing system will be permitted during the project activity. Variables to be monitored: SITE INSPECTION and MS%i,y.

Average number of animals.

To calculate the average number of animals per category LT in the year y (NLT,y) the operational procedure has the forms 03.003 and 03.001 in the operational procedure POP 3 (average number of animals) where it takes into account of the number of days the animal is alive in the year y (Nda,y) and the number of animals produced per category LT in the year y (Np,y).

The days of animals alive and the total animal produced is also monitored with the same procedure and the formulary 03.003.

The formula used to the calculation is indicated in the PD section B.4, step 2, equation 4. Variables to be monitored: N LT,y, N day,y and N p,y.

Measurement of the volumetric flow rate of the biogas and residual gas.

The operational procedure POP 4- Measurement of the biogas flow rate, is a guide that explains to the technicians how to obtain the biogas flow rate.

The control of the flow rate is by a PLC (see picture in the POP 1 description above) installed in the control panel in the project activity site.

The panel is equipped with solar cells that supply energy to the system. A battery (capacity for 10 days lack of sun) and the flow rate transmitter device to receive information from the thermal mass meter. The flow meter used in the project activity is a thermal mass flow meter.

The system is very reliable and supplied by Endress+hauser, leader of measurement system of liquids and gases. Example of the meter used in the project activity:

The information recorded in the PLC is recovered by the use of a pen drive and the file containing the information will be send to the QA/QC officer to manage information for further verification. A spreadsheet in excel is available from the system to show the flow rate per minute per day.

The variables measured with this procedure are: BG burnt,y and FV RG,h..

The data monitored is controlled in the form 04.001 attached in the operational procedure POP 04.

Methane content determination.

The POP 5- Methane content was prepared to guide the technicians how to obtain the methane content using electronic equipment.

The methane content is obtained by BIOGAS or TESTO electronic equipment.

The concentration of methane is measured in few seconds before starting the measurement button.

The equipment operation and the devices to be used are described in the operational procedure, as well as in the equipment manual.

Both equipment are able to measure the methane concentration in the biogas or in the flare residual gas.

The variables measured with this equipment are: WCH4 and fvCH4,RG,y.

All QA/QC procedures are described in the operational procedure related to the maintenance and/or calibration of the equipment.

The data monitored is controlled in the form 04.001.

Biogas temperature measurement.

The biogas temperature is obtained by an electronic equipment BIOGAS.

The methane temperature is measured in few seconds after inserting the thermocouple in the biogas line device.

The equipment operation and the devices to be used are described in the operational procedure, as well as in the equipment manual.

All QA/QC procedures are described in the operational procedure related to the maintenance and/or calibration of the equipment.

The variable measured with this equipment is: T biogas.

The data monitored is controlled in the form 04.001 described in the operational procedure POP 6 – Biogas temperature measurement.

Density of the methane determination.

The POP 7- Density of the Methane - is a guide to calculate the methane density. The form 07.001 attached in the operational procedure shows the data to be filled to make the calculation. The methane density calculation is in accordance with the Tool to determine the mass flow of a greenhouse gas in a gaseous stream version 3.0

The variable monitored with this procedure: DCH4.

Flare efficiency.

According with the of version 04 of the tool Project emissions from flaring, in its step 2 – Determination of flare efficiency, for determining the efficiency of combustion of enclosed flares there is the option to apply a default value or determine the efficiency based on monitored data. The operational procedure POP 8 – Flare efficiency was developed to monitor and calculate the flare efficiency.

In the case of enclosed flares, project participants may choose between two options to determine the flare efficiency for minute m (ηflare,m). The PP has chosen Option A – Apply a default value for flare efficiency.

The flare efficiency for the minute m (ηflare,m) is 90% when the following two conditions are met to demonstrate that the flare is operating:

The temperature of the flare (TEG.m) and the flow rate of the residual gas to the flare (FRG,m) is within the manufacturer's specification for the flare (SPECflare) in minute m; and

The flame is detected in minute m (Flamem).

Otherwise ηflare,m is 0%.

All the flares in the project are considered, as per definition of the tool as low height, hence a default value of 80% flare efficiency is applied to the entire project. All data and parameters that are required to monitor whether the flare operates within the range of operating conditions according to manufacturer´s specifications will be continuously monitored. The temperature and biogas flow rate will be monitored minute by minute by a sensor installed in the enclosed flare and are registered by a CLP. The data stored in the CLP is recovered monthly by the use of a pen drive and the file containing the information will be sent to the QA/QC officer to manage the information. Brascarbon developed the formulary 08.001 in the operational procedure to monitor the hourly flare efficiency according to the criteria above mentioned.

The variable monitored with this procedure: FE.

Biogas pressure.

The biogas pressure is obtained by an electronic equipment BIOGAS and procedures described in the operational procedure POP 13- Biogas pressure.

The operating pressure of the biodigestor is atmospherically.

The equipment operation and the devices to be used are described in the operational procedure, as well as in the equipment manual.

All QA/QC procedures are described in the operational procedure related to the maintenance and/or calibration of the equipment.

The variable measured with this equipment is: P biogas. The data monitored is controlled in the form 04.001.

Formulated feed rations.

Monitoring and controlling of the formulated feed rations used per animal category per confined feed animal operation.

The variable monitored: FFR.

Reference of the operational procedure: POP 14 – formulated feed rations monitoring.

Genetic Source.

Monitoring and controlling of the genetic source in the project activity per farm. The variable monitored: GENETIC SOURCE.

Reference of the operational procedure: POP 15 – Genetic Source Monitoring.

Animal weight.

The data collection is realized quarterly by each farm owner, together with ASSUGLORIA (Associação de Suinocultores de Glória de Dourados e Região) and provided to the PP. ASSUGLORIA is the Pig Producers Association to whom the farms contained in the PD are associated; its main role is to act as a third party responsible for the assurance of all the logistics associated with the swine producers, providing the animal nutrition, genetics and all the overall animal weight.

The quarterly weight of the animals for each producer of the PD is made following ASSUGLORIA's internal procedure, that is not under the PP's control – the association selects the animals based on a random sampling approach applied in each category, since it is infeasible to weight each

animal individually in the farms belonging to the project (these farms can more than 5,000 animals each). In addition, each project site presents the actual animal weight by using Brascarbon form 16.001 after a cross-check by the PP, using the real information after each batch of animals exits each farm; the template was designed to quarterly report animal weight per category.

The values of the quarterly weights presented by ASSUGLORIA (following the association's internal procedures) to the PP are cross-checked against two different credible sources:

Reference figures from EMBRAPA (an undisputed Brazilian Agricultural Research Corporation nationally recognized for these scope) for each category; and

Figures provided by ASSUGLORIA when each of the swine batches exits each farm (each batch stays around 5 to 6 months per farm), as explained below. Here ASSUGLORIA provides invoices with 100% of the animals weight (and number), allowing a full cross- check with the weight values provided and assuring that all the information is accurate.

If the PP verifies during the cross-check any discrepancy between the values provided quarterly and the full weighting and counting of the animals in the invoices provided by ASSUGLORIA each time any batch exits a giving farm, those values will be updated accordingly with these real figures.

The current practice of swine farms in Brazil is that each farm receives new batches of animals every 5 to 6 months (which is also the average time that a batch stays in a farm) and the producer, together with ASSUGLORIA, performs regular and periodical visits to each farm in order to assess and evaluate the correct development of each batch in terms of growing/weighting of the animals (according with what is expected at each growing stage of a given batch). It is important to highlight that both the farm owners ASSUGLORIA rely on the quality of the values measured since their sole professional occupation is the pig production and, therefore, it is within their best interests to have a correct and reliable way to assess the weighting of the animals (which is their business) based on their experience and internal procedures.

Every 5 to 6 months (depending on each batch and farm), the animal batches leave the farms and they are, in this specific situation, 100% weighted by the producers, together with ASSUGLORIA – this weighting is undertaken to the totality of animal presented in the batch since the profits associated with the animal production are weight based. The results are cross-checked against reference figures from EMBRAPA (the Brazilian Agricultural and Livestock Research Corporation, a recognized federal institution responsible for studies and research in these scopes). According with ASSUGLORIA a possible range of +/- 5kg within the animal growing, related to the figures from EMBRAPA, is considered a normal fluctuation and therefore admissible.

Each time a batch exits a farm, ASSUGLORIA provides the invoices to attest the feasibility of the figures adopted, allowing a complete and thorough cross-check by PP of all the data used for this parameter.

Quarterly the data from the feed operations are checked and transferred to the form.

Records available in the feed operations will be copied and filed at Brascarbon office and attached with the form 16.001.

The variable monitored: W site.

Methane mass flow rate in the residual gas.

The residual mass flow rate can be determinate by the POP 17 – Emissions reductions ex-post, where it calculates all parameters to determine the emissions reductions ex-post.

To be calculated according to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream version 3.0". An operational procedure POP 17 includes the instruction to the calculation.

According with the step 1 – Determination of the methane mass flow in the residual gas of this tool, this parameter should be determined using another tool, namely Tool to determine the mass flow of a greenhouse gas in a gaseous stream. In second tool, there are several options to determine the Mass flow rate of methane in the residual gaseous stream. Option 2 - Simplified calculation without measurement of the moisture content was chosen by the PP.

Within this option, option A will be applicable by the demonstration that the gaseous stream is dry. The PP will demonstrate that the temperature of the gaseous stream (Tt) is less than 60ºC (333.15 K) at the flow measurement point.

Hence this parameter will be calculated according with Equations 5 and 6 of the tool. This means:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$ Equation (5)

With:

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t}$$ Equation (6)

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/m^3 gas *i*)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i	=	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)

The formulary 17.001 (CER spreadsheet) is used to determine the variables above mentioned.

Number of days the treatment plant was operational

The number of days the treatment plant was operational can be determinate by the POP 24 – days of functioning, where it is monitored the number of days in a year "y" that the treatment plant has operated.

The variables monitored with this procedure: ndy

Volatile solids

The four conditions to apply B0 value of developed countries are fully applicable to developed countries can be used provided the following four conditions are satisfied:

The genetic source of the livestock originates from an Annex I Party;

Genetics and nutrition adopted for these farms as so as in western Europe. More details or information of the genetics can be obtained at the producers or at the Associação Brasileira dos Criadores de Suinos (Brazilian Swine Association) – http://www.abcs.org.br/.

The genetic source of the livestock is therefore in compliance with this methodology requirement, which can be confirmed and verified by the genetic documents of the animals of each farm. These evidences were provided and assessed to assure their applicability to this requirement.

The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;

The formulated feed rations are created according with the characteristics of the animals, their stage of growth, category, weight gain and genetics. Each farm possesses their FFR composition according with the type of animal(s) accommodated, which was confirmed and verified. These evidences were provided and assessed to assure their applicability this requirement.

The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.);

The formulated feed rations are part of the management system of the farms and therefore, each site possesses on-farm records which attest the FFR used. These evidences are also monitored on a monthly basis, according monitoring plan for the parameter FFR, as described in section B.7.1, and the PP internal procedure POP 14.

The project specific animal weights are more similar to developed country IPCC default values.

The Wsite value considered for each category of swine is the result of an average weight of the animals of all farms included in the project, and this value was applied in the baseline calculation.

Finishers is the animal category that represents majority of all animals from the farms included in this PD, around 60% of the total number of animals (only three farms have other types of animals but not as significant as finishers). Finishers are considered to be "market swine" and presented an average weight of 90kg among all farms included in the PD by the time of the project's registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (50 kg) – the values form Latin America (28 kg), where the project is located, is even lower than Western Europe's.

This situation is also observed for the remaining four categories of swine (nursery and boars for market swine, guilts and sows for breeding swine): the values are more similar to those adopted in Western Europe than in Latin America, especially regarding the Breeding Swine (guilts and sows) and in the Market Swine (boars) which presented an average weight of 210kg and 230 kg respectively, among all farms included in the PD by the time of the project's registration (and this was the value adopted for the parameter Wsite). Taking into account the figures presented in Tables 10 A-7 and 10 A-8 from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, chapter 10, the weights that are more similar to the project situation are those from the Western Europe region (198kg for Breeding Swine and 50 kg for Market Swine) – the values form Latin America (28kg for both classes of Breeding and Market Swine), where the project is located, is much lower than Western Europe's. Only in the category nursery (also Market Swine), which roughly represents 30% of all animals from the farms included in this PD, have an average weight of 20 kg, closer to the Latin America values than the Western Europe values.

Therefore, is fair to consider that "the project specific animal weights are more similar to developed country IPCC default values" condition is fulfilled and that the VS adopted values for developed counties is in full compliance with the methodology requirements.

Monitoring System

The monitoring system will be followed according to the Brascarbon Operations Procedures Manual, detailed to attend all necessary controls in the site.

Operational / Monitoring Procedures

Operational / Monitoring procedures listed above.

Quality Assurance/Control: QA/QC

The measuring instruments will be calibrated by the manufacturers' representatives on a manufacturer recommendation basis. The certification of calibration will be controlled by QA/QC officer. Also, the QA/QC officer will be responsible to assure that all Brascarbon Operations Procedures will be executed based in the ISO 9001.

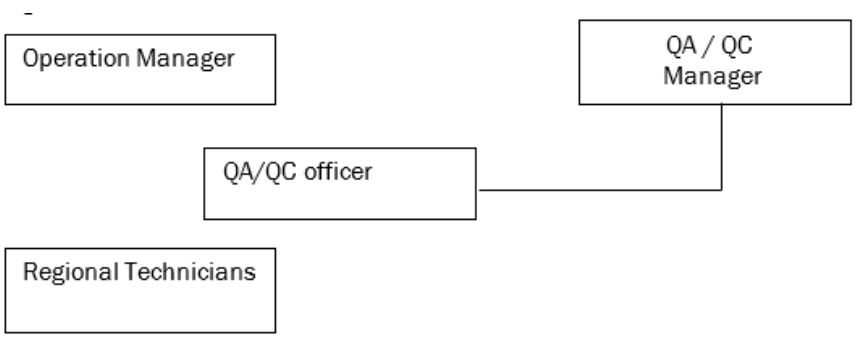
Training

The training of the technicians and all employees is provided by the Operations Manager. The topics of the training are as below:

1. General explanation of the project.
2. Explanation of the procedures of the Operations Procedure Manual.
3. Procedures and preparations for the star-up.
4. Maintenance procedures.
5. Biogas safety instructions.
6. Biogas measurement.
7. Safety Issues.

The training document and the equipment manuals are stored for easy reference in the Brascarbon office.

Organization



Operation Manager

Engineer, responsible for the project maintenance and monitoring data collection.

QA/QC Manager

Engineer, responsible for the monitoring operation and emissions for the project activity.

Regional Technicians

Technician, responsible for the monitoring and maintenance of the site projects according to the procedures in the Operations Procedure Manual.

Maintenance

For maintenance of the equipment and to attend the monitoring system, BRASCARBON will use the practices recommended by the equipment supplier for repairs, calibration, etc. The regular maintenance in the site project boundary will be according to the Brascarbon Operation Procedures Manual for all items considered in the project such as the digester, flare, measuring systems, piping, electrical parts and others.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data / Parameter	Tf
Data unit	°C
Description	Combustion temperature of the flare
Value applied:	The aggregate values of Tf (hours with Tf above 500° C and hours with Tf below 500°C) can be found in the spreadsheet calculation file "CER Calculation MR01 - BCA-BRA-18" in the folder MDy-PEpower,y,ex-post.
Monitoring Equipment	Thermocouple [4]

Farm name	Site ID	Thermocouple Serial Number [2]	Calibration Certification Number	Calibration Date	Instalation Date [3]	Expiration Date
Sitio Boa esperança parte lotes 67 e 6	BCA-316MS1-18	320362	CA 6944 21	08/11/21	03/01/22	02/01/23
		83911	CA 1701 22	08/03/22	30/12/22	29/12/23
Lote 11, Quadra 27	BCA-317MS1-18	320349	CA 6931 21	08/11/21	03/01/22	02/01/23
		83912	CA 1702 22	08/03/22	30/12/22	29/12/23
Lotes 47, 49 e 51 Quadra 28	BCA-318MS1-18	320357	CA 6939 21	08/11/21	04/01/22	03/01/23
		83914	CA 1704 22	08/03/22	02/01/23	01/01/24
Parte dos Lotes 1 e 3 Quadra 27	BCA-319MS1-18	320350	CA 6932 21	08/11/21	03/01/22	02/01/23
		83915	CA 1705 22	08/03/22	30/12/22	29/12/23
Lote 25, 27 e 29 Quadra 27	BCA-320MS1-18	320351	CA 6933 21	08/11/21	03/01/22	02/01/23
		83916	CA 1706 22	08/03/22	30/12/22	29/12/23
Lote N 9 e Lote N 11 Quadra N 24	BCA-321MS1-18	320352	CA 6934 21	08/11/21	04/01/22	03/01/23
		83919	CA 1708 22	08/03/22	02/01/23	01/01/24
Lote 54, 56, 58 Quadra 10	BCA-322MS1-18	320353	CA 6935 21	08/11/21	04/01/22	03/01/23
		83920	CA 1709 22	08/03/22	02/01/23	01/01/24

Comments	No comments

Data / Parameter	SITE INSPECTION
Data unit	N/A
Description	Inspection on the site considering relevant regulation and the infra- structure of the site
Value applied:	Annual follow-up of the documentation to check the expiration date, changes in the production lay-out and surroundings of the digester. Actions within the property and around the biodigesters should be taken both by the contractor and the client Brascarbon. Photos should be attached to the annual inspection report to prove that the system of wastewater management has not changed namely regarding the following items: pipes, gutters, roofs, fences, trees, control panel, flare, terminal boxes and general cleaning. Use of the annex attached at the operational procedure POP-02
Comments	No comments

Data / Parameter	NLT,y
Data unit	Number
Description	Annual average number of animals of type “LT” in year “y”
Value applied:	The values of NLT,y can be found in the spreadsheet calculation file “CER Calculation MR01 - BCA-BRA-18” in the folder BEy ex-post – PEy ex-post.
Comments	No comments

Data / Parameter	Nda,y
Data unit	Number
Description	Number of days animal is alive in the farm, in year “y”
Value applied:	Please see explanation in data/parameter NLT,y
Comments	No comments

Data / Parameter	Np,y
Data unit	Number
Description	Number of animals produced annually of type “LT” in year “y”
Value applied:	Please see explanation in data/parameter NLT,y
Comments	No comments

Data / Parameter	BGburnt,y
Data unit	m3
Description	Biogas flared or used as a fuel in the year y.
Value applied:	The values of BGburnt,y can be found in the spreadsheet calculation file “CER Calculation MR01 - BCA-BRA-18” in the folder MDy-PEpower,y,ex-post.
Monitoring Equipment	Flow Meter [1][2] Calibration Control
Comments	No comments

Site ID	Farm Name	Flow Meter Serial Number	Calibration Certification Number	Instalation Calibration Date [3]	Expiration Date
BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	C401423412A	EN 10204 - 2.1	03/01/22	03/01/24
BCA-317MS1-18	Lote 11, Quadra 27	D700373412A	EN 10204 - 2.1	03/01/22	03/01/24
BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	BB01133412A	EN 10204 - 2.1	04/01/22	04/01/24
BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	D700473412A	EN 10204 - 2.1	03/01/22	03/01/24
BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	D700433412A	EN 10204 - 2.1	03/01/22	03/01/24
BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	B601203412A	EN 10204 - 2.1	04/01/22	04/01/24
BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	D700443412A	EN 10204 - 2.1	04/01/22	04/01/24

Data / Parameter	WCH4,y
Data unit	Fraction
Description	Methane content in biogas in the year “y”
Value applied:	The values of WCH4,y can be found in the spreadsheet calculation file “CER Calculation MR01 - BCA-BRA-18” in the folder MDy-PEpower,y,ex-post.
Monitoring Equipment	Biogas Analyser [1][2] Calibration Control
Comments	No comments

Site ID	Farm Name	Biogas Analyser Serial Number	Calibration Certificate Number	Last Calibration Date [3]	Expiration Date
BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69		BM11042 1/1720	10/08/2021	09/02/2022
BCA-317MS1-18	Lote 11, Quadra 27	BM 11042	BM11042 3/3540	25/01/2022	24/07/2022
BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28		RBC.0902.22.rev.00	20/07/2022	19/01/2023
BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27		RBC.0025.23.rev.00	10/01/2023	09/06/2023
BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27				
BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24				
BCA-322MS1-18	Lote 54, 56, 58 Quadra 10				

Data / Parameter	Tbiogas
Data unit	°.C
Description	Temperature of the biogas at ambient conditions
Value applied:	The values of Tbiogas can be found in the spreadsheet calculation file "CER Calculation MR01 - BCA-BRA-18" in the folder MDy-PEpower,y,ex-post.
Monitoring Equipment	Biogas Analyser [1][2] Calibration Control
Comments	No comments

Site ID	Farm Name	Biogas Analyser Serial Number	Calibration Certificate Number	Last Calibration Date [3]	Expiration Date
BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69		BM11042 1/1720	10/08/2021	09/02/2022
BCA-317MS1-18	Lote 11, Quadra 27	BM 11042	BM11042 3/3540	25/01/2022	24/07/2022
BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28		RBC.0902.22.rev.00	20/07/2022	19/01/2023
BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27		RBC.0025.23.rev.00	10/01/2023	09/06/2023
BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27				
BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24				
BCA-322MS1-18	Lote 54, 56, 58 Quadra 10				

Data / Parameter	DCH4,y
Data unit	t / m3
Description	Density of the methane combusted
Value applied:	The values of DCH4,y can be found in the spreadsheet calculation file"CER Calculation MR01 - BCA-BRA-18" in the folder MDy- PEpower,y,ex-post.
Comments	No comments

Data / Parameter	FE
Data unit	%
Description	Enclosed Flare Efficiency
Value applied:	80%
Comments	No comments

Data / Parameter	QDM
Data unit	N/A
Description	Sludge soil application
Value applied:	N/A. Sludge was not removed during this monitoring period.
Comments	No comments

Data / Parameter	Wsite
Data unit	Kg
Description	Average animal weight of a defined livestock population at the project site in year
Value applied:	Annual follow-up of the documentation to check the expiration date, changes in the production lay-out and surroundings of the digester. Actions within the property and around the biodigesters should be taken both by the contractor and the client Brascarbon. Photos should be attached to the annual inspection report to prove that the system of wastewater management has not changed namely regarding the following items: pipes, gutters, roofs, fences, trees, control panel, flare, terminal boxes and general cleaning. Use of the annex attached at the operational procedure POP-02

Comments	The current practice of swine farms in Brazil is that each farm receives new batches of animals every 5 to 6 months (which is also the average time that a batch stays in a farm) and the producer, together with ASSUGLORIA, performs regular and periodical visits to each farm in order to assess and evaluate the correct development of each batch in terms of growing/weighting of the animals (according with what is expected at each growing stage of a given batch). It is important to highlight that both the farm owners and ASSUGLORIA rely on the quality of the values measured since their sole professional occupation is the pig production and, therefore, it is within their best interests to have a correct and reliable way to assess the weighting of the animals (which is their business) based on their experience and internal procedures. Every 5 to 6 months (depending on each batch and farm), the animal batches leave the farms and they are, in this specific situation, 100% weighted by the producers, together with ASSUGLORIA – this weighting is undertaken to the totality of animal presented in the batch since the profits associated with the animal production are weight based. According with ASSUGLORIA a possible range of +/- 5kg within the animal growing is considered a normal fluctuation and therefore admissible. Each time a batch exits a farm, ASSUGLORIA provides the invoices to attest the feasibility of the figures adopted, allowing a complete and thorough cross-check by PP of all the data used for this parameter. Monitoring operational procedure POP-016.

Data / Parameter	ERy,ex-post
Data unit	t CO2e
Description	Ex-post emission reductions achieved by the project activity based on monitored values for the year “y”.
Value applied:	The values of ERy,ex-post can be found in the spreadsheet calculation file “CER Calculation MR01 - BCA-BRA-18” in the folder ERy ex-post.
Comments	No comments.

Data / Parameter	FFR
Data unit	No data unit applied
Description	Formulated feed rations
Value applied:	N/A
Comments	N/A

Data / Parameter	Pbiogas
Data unit	mbar
Description	Pressure of the biogas at operation conditions
Value applied:	The values of Pbiogas can be found in the spreadsheet calculation file “CER Calculation MR01 - BCA-BRA-18” in the folder MDy-PEpower,y,ex-post.
Monitoring Equipment	Biogas Analyser [1][2] Calibration Control
Comments	No comments

Site ID	Farm Name	Biogas Analyser Serial Number	Calibration Certificate Number	Last Calibration Date [3]	Expiration Date
BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69		BM11042 1/1720	10/08/2021	09/02/2022
BCA-317MS1-18	Lote 11, Quadra 27	BM 11042	BM11042 3/3540	25/01/2022	24/07/2022
BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28		RBC.0902.22.rev.00	20/07/2022	19/01/2023
BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27		RBC.0025.23.rev.00	10/01/2023	09/06/2023
BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27				
BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24				
BCA-322MS1-18	Lote 54, 56, 58 Quadra 10				

Data / Parameter	GENETIC SOURCE
Data unit	No data unit applied
Description	Genetic source from annex I party Western Europe
Value applied:	N/A
Comments	No comments.

Data / Parameter	MS% i,y
Data unit	Fraction
Description	Fraction of manure handled in system “i”, year “y”.
Value applied:	During the site inspection, it was confirmed that no changes in the manure management system occurred and all the manure was handled in the project facilities. Value is therefore 1
Comments	No comments

Data / Parameter	ndy
Data unit	Number
Description	Number of days in year “y” where the treatment plant was operational
Value applied:	The values of ndy can be found in the spreadsheet calculation file “CER Calculation MR01 - BCA-BRA-18” in the folder BEy ex-post – PEy ex-post.
Comments	No comments.

Data / Parameter	VSLT,y
Data unit	kg dry matter/animal/year

Description	Volatile solids for livestock LT entering the animal manure management system in year y
Value applied:	The values of VSLT,y can be found in the spreadsheet calculation file “CER Calculation MR01 - BCA-BRA-18” in the folder BEy ex-post – PEy ex-post.
Comments	No comments.

Data / Parameter	$Q_{manure,\,j,LT\,,\,y}$
Data unit	Tonnes DM/year
Description	Quantity of manure treated from livestock type LT at manure management system j
Value applied:	During the site inspection, it was confirmed that no changes in the manure management system occurred and all the manure was handled in the project facilities. Value is therefore 1.
Comments	No comments

Data / Parameter	$SVS_{j,LT\,,\,y}$
Data unit	tonnes VS/tonnes DM
Description	Specific volatile solids content of animal manure from livestock type LT and animal manure management system j in year y
Value applied:	This parameter and the parameter VSLT,y are the same. Please refer to the QA/QC procedures from the parameter VSLT,y
Comments	No comments

Data / Parameter	Al l
Data unit	Days

Description	Annual average interval between manure collection and delivery for treatment at a given storage device l
Value applied:	During the site inspection, it was confirmed that no changes in the manure management system occurred and all the manure was handled in the project facilities. Value is therefore 1.
Comments	No comments

Data / Parameter	Flamem
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute m ON/OFF
Value applied:	Ultraviolet flame sensor Model C7035
Comments	No comments.

6.2 Baseline Emissions

Equation 2

$$BE_y = GWP_{CH4} \times D_{CH4} \times UF_b \times \sum_{j,LT} MCF_j \times B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{Bl,j}$$

Where:

BEy – Baseline emissions in year "y" (tCO2e)

GWPCH4 – Global Warming Potential (GWP) of CH4 (28)

DCH4– CH4 density (0.00067 t/m3 at room temperature (20 °C) and 1 atm pressure).

LT– Index for all types of livestock

J – Index for animal waste management system

MCFj – Annual methane conversion factor (MCF) for the baseline animal waste management system "j"

B0,LT – Maximum methane producing potential of the volatile solid generated for animal type "LT" (m3 CH4/kg dm)

NLT,y – Annual average number of animals of type "LT" in year "y" (numbers)

VSLT,y – Volatile solids for livestock "LT" entering the animal manure management system in year "y" (on a dry matter weight basis, kg dm/animal/year)

MS%Bl, j – Fraction of manure handled in baseline animal manure management system "j"

UFb – Model correction factor to account for model uncertainties (0.94)

Where VSLT,y can be determined by scaling default IPCC values to adjust for a site-specific average animal weight according to Equation 2:

Equation 3

$$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}} \right) * VS_{default} * nd_y$$

Where:

Wsite – Average animal weight of a defined livestock population at the project site (kg)

Wdefault – Default average animal weight of a defined population, this data is sourced from IPCC 2006 (kg)

VSdefault – Default value for the volatile solid excretion rate per day on a dry-matter basis for a defined livestock population (kg dm/animal/day)

Ndy – Number of days in year "y" where the treatment plant was operational.

As explained in the previous section, the values used for the parameters B0 and VS are those applied for Western Europe.

Table 16. summarizes the BEy,ex post for each farm during the current monitoring period. The detailed calculations are available in the CER calculation spreadsheet (folder BEy ex-post – PEy ex-post).

Table 16. – Baseline Emissions (BEy,ex post) in the current monitoring period

ID	Site ID	Farm/Site	$BE_{y,ex\text{-}post}$ (t CO_2e)
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	5,198
2	BCA-317MS1-18	Lote 11, Quadra 27	6,877
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	5,244
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	5,253
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	42,781
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	5,213
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	10,632
TOTAL			81,197

6.3 Project Emissions

According to the simplified baseline and monitoring methodology for a small-scale CDM project Type-III (AMS.III.D – version 21.0), project emissions consist of:

(a) Physical leakage of biogas in the manure management systems which includes production, collection and transport of biogas to the point of flaring/combustion or gainful use (PEPL,y);

(b) Emissions from flaring or combustion of the gas stream (PEflare,y);

(c) CO2emissions from use of fossil fuels or electricity for the operation of all the installed facilities (PEpower,y).

(d) CO2 emissions from incremental transportation distances (PEtransp,y)

(e) Emissions from the storage of manure before being fed into the anaerobic digester (PEstorage,y)

Equation 5 (equation 6 of the meth)

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} + PE_{transp,y} + PE_{storage,y}$$

Where:

PEy – Project emissions in year "y" (tCO2e)

PEPL,y – Emissions due to physical leakage of biogas in year "y" (tCO2e)

PEflare,y – Emissions from flaring or combustion of the biogas stream in the year "y" (tCO2e)

PEpower,y – Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year "y" (tCO2e)

PEtransp,y – Emissions from incremental transportation in the year "y" (tCO2e), as per relevant paragraph in AMS-III.AO

PEstorage,y – Emissions from the storage of the manure in the year "y" (tCO2e)

(C) Emissions due to physical leakage of biogas can be determinate as follows:

Equation 6 (equation 7 of the meth)

$$PE_{PL,y} = 0.10 \times GWP_{CH4} \times D_{CH4} \times \sum_{i,LT} B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y}$$

Where:

PEPL,y – Emissions due to physical leakage of biogas in year "y" (t CO2e)

GWPCH4 – Global Warming Potential (GWP) of CH4 (28)

DCH4 – CH4 density (0.00067 t/m3 at room temperature (20 ºC) and 1 atm pressure).

LT – Index for all types of livestock

I – Index for animal waste management system

B0,LT – Maximum methane producing potential of the volatile solid generated for animal type "LT" (m3 dm)

NLT,y – Annual average number of animals of type "LT" in year "y" (numbers)

VSLT,y – Volatile solids for livestock "LT" entering the animal manure management system in year "y" (o matter weight basis, kg dm/animal/year)

MS%i,y – Fraction of manure handled in system "i" in year "y"

(D) Emissions from flaring determinate as follows:

According with the tool Project emissions from flaring version 4, the calculation procedure in this tool determines the project emissions from flaring the residual gas (PEflare,y) based on the flare efficiency (ηflare,m) and the mass flow of methane to the flare (FCH4,RG,m). The flare efficiency is determined for each minute m of year y based either on monitored data or default values.

The project emissions calculation procedure is given in the following steps:

(a) STEP 1: Determination of the methane mass flow of the residual gas;

(b) STEP 2: Determination of the flare efficiency;

(c) STEP 3: Calculation of project emissions from flaring.

Step 1: Determination of the methane mass flow in the residual gas

The "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" shall be used to determine the following parameter:

The following requirements apply:

(a) The gaseous stream tool will be applied to the residual gas;

(b) The flow of the gaseous stream will be measured continuously;

(c) CH4 is the greenhouse gas i for which the mass flow will be determined;

(d) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and

(e) The time interval t for which mass flow should be averaged is every minute m.

According with the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" version 03, The mass flow of a greenhouse gas i in a gaseous stream (Fi,t) is determined through measurement of the flow and volumetric fraction of the gaseous stream.

Option A was chosen

The flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. According with the tool, there are two ways to do this:

(a) Measure the moisture content of the gaseous stream (CH2O,t,db,n) and demonstrate that this is less or equal to 0.05 kg H2O/m3 dry gas; or

(b) Demonstrate that the temperature of the gaseous stream (Tt) is less than 60ºC (333.15 K) at the flow measurement point.

The temperature of the biogas is less than 60ºC, and that will be demonstrated during the monitoring of the parameter, according with the MP.

Step 2: Determination of flare efficiency

The flare efficiency depends on the combustion efficiency of in the flare and the time that the flare is operating. For determining the efficiency of enclosed flares project participants shall choose to determine the efficiency based on monitored data or the option to apply a default value. For open flares a default value must be applied. The time the flare is operating is determined by using a flame detector and, for the case of enclosed flares, in addition the monitoring requirements provided by the manufacturer's specifications for operating conditions shall be met.

In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute m (ηflare,m) and shall document in the PD which option is selected:

(a) Option A: Apply a default value for flare efficiency;

(b) Option B: Measure the flare efficiency.

Option A was chosen

Option A: Default value

The flare efficiency for the minute m (ηflare,m) is 90% when the following two conditions are met to demonstrate that the flare is operating:

(a) The temperature of the flare (TEG.m) and the flow rate of the residual gas to the flare (FRG,m) is within the manufacturer's specification for the flare (SPECflare) in minute m; and

(b) The flame is detected in minute m (Flamem).

Otherwise ηflare,m is 0%.

It is important to highlight that the flares are considered a low height so, in line with the tool, a conservative approach should be applied, and 10 percentile points should be subtracted to the flare efficiency. Hence the flare efficiency adopted in the current PD will be the default value of 80%.

In line with the monitoring plan, if any minute of any hour presents a temperature value below 500ºC the entire hour will be discount form the CER calculation. This discount will be applied to

the volume of that specific hour since it is a more conservative approach than to discount in the average of the fla re efficiency percentage.

Step 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute m in year y, based on the methane mass flow in the residual gas (FCH4,RG,m) and the flare efficiency (ηflare,m), as follows:

Equation 7 (equation 15 of the Tool 6)

$$PE_{flare\,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3}$$

Where:

PEflare,y – Project emissions from flaring of the residual gas stream in year y, tCO 2e

GWPCH4 – Global Warming Potential of methane valid for the commitment period, tCO2e/tCH4

FCH4,RG,m – Mass flow rate of methane in the residual gas in the minute m, kg/h

ηflare, m – Flare efficiency in the minute m

(C) Emissions from use of fossil fuels or electricity for the operation:

No fossil fuel or electricity will be used in the project, therefore, PEpower,y = zero.

(D) Emissions from incremental transportation:

No incremental transportation will occur in the project activity, and therefore, PEtransp,y = 0

(E) Emissions from storage of the manure:

The manure will not be stored in the entire project. Each day all the manure is washed and sent to the digester, therefore, PEstorage,y = 0.

Table 17 summarizes the project emissions for the current monitoring period (PEy,ex-post)and more detailed information can be obtained in the CER calculation spreadsheet (folder BEy ex-post – PEy ex- post).

Table 17 – Project Emissions (PEy,ex-post) in the current monitoring period

ID	Site ID	Farm/Site	$PE_{y,ex\text{-}post}$ (t CO_2e)
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	1.605
2	BCA-317MS1-18	Lote 11, Quadra 27	2,121
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	1,609
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	1,568
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	12,746
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	1,647
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	3,303
TOTAL			24,598

6.4 Leakage

According to the simplified baseline and monitoring methodology AMS-III.D - version 21 and the tool "Project and leakage emissions from anaerobic digesters" (version 02), no leakage calculation is required if the storage of digestate or the composting of digestate is occurring within the project boundary, these emissions will be considered as project emissions, (in line with paragraph 25 of the tool).

6.5 Net GHG Emission Reductions and Removals

The calculation of the emission reductions is based on the equations used on the approved methodology AMS.III.D – Version 21 – "Methane recovery in animal manure management systems" and data from 2006 IPCC Guidelines for National GHG Inventories, volume 4, chapter 10.

For baseline emissions calculation see Table 4 and Table 5.

The project emissions for this project activity are defined as the amount of methane that would be emitted to the atmosphere during the crediting period due to the project activity. In this case an anaerobic digester is considered the project activity and estimated emissions are determined as follows:

Step 1: Emission Reductions

Equation 1

$$ER_{y,estimated} = BE_y - PE_y$$

Where:

- ERy – Emission reductions in t CO2e/year
- BEY – The annual baseline methane emissions in t CO2e/year PE Y = project emissions in t CO2e/year

The emission reductions which will be achieved by the project activity ex post will be determined through direct measurement of the amount of methane flared. The emission reductions achieved in any year will be the lowest value of the following:

Equation 1.1

$$ER_{y,estimated} = BE_y - PE_y$$

Where:

ERy,ex-post – Emission reductions achieved by the project activity based on monitored values for year y (tCO2e)

BEy ex post – Baseline emissions calculated using equation 2 and using ex post monitored values of NLT,y and if applicable VSLT,y for year y (tCO2e)

PEy,ex post – Project emissions calculated using Equation 5 (equation 6 of the meth) using ex post monitored values of NLT,y ,MS%i,y and if applicable VSLT,y for year y (tCO2e)

MDy – Methane captured and destroyed or used gainfully by the project activity in year y (tCO2e)

PEpower,y,ex post – Emissions from the use of fossil fuel or electricity for the operation of the installed facilities based on monitored values in the year y (tCO2e)

Table 18 – Methane captured and destroyed (MD_y) in the current monitoring period

ID	Site ID	Farm/Site	MD_y (t CO_2e)
1	BCA-316MS1-18	Sitio Boa esperança parte lotes 67 e 69	3,619
2	BCA-317MS1-18	Lote 11, Quadra 27	4,778
3	BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	3,609
4	BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	3,439
5	BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	27,925
6	BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra N 24	3,776
7	BCA-322MS1-18	Lote 54, 56, 58 Quadra 10	7,482
TOTAL			54,628

Table 19 – ERy, ex-post in the current monitoring period

SITE ID:	SITE NAME	MD_y (t CO_2e)	$PE_{power,y,ex-post}$ (t CO_2e)	$MDy - PE_{power,y,ex-post}$ (t CO_2e)	$BE_{y,ex-post}$ (t CO_2e)	$PE_{y,ex-post}$ (t CO_2e)	$BE_{y,ex-post} - PE_{y,ex-post}$ (t CO_2e)	$ER_{y,ex-post}$ = min [($BE_{y,ex-post} - PE_{y,ex-post}$), ($MD_y - PE_{power,y,ex-post}$)] (t CO_2e)
BCA-316MS1-18	Sitio Boa Esperança Parte lotes 67 e 69	3 619	0	3 619	5 198	1 605	3 592	3 592
BCA-317MS1-18	Lote 11 Quadra 27	4 778	0	4 778	6 877	2 121	4 755	4 755
BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	3 609	0	3 609	5 244	1 609	3 634	3 609
BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	3 439	0	3 439	5 253	1 568	3 684	3 439
BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	27 925	0	27 925	42 781	12 746	30 035	27 925
BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra 24	3 776	0	3 776	5 213	1 647	3 566	3 566
BCA-322MS1-18	Lote 54, 56 e 58 Quadra 10	7 482	0	7 482	10 632	3 303	7 328	7 328
TOTAL		54 628	0	54 628	81 197	24 598	56 594	54 214

The Table 19 above presents all the components which are calculated for each farm in order to comply with the methodology requirements for emission reductions determination, Due to the amount of information and methodology particularities, and in order to improve the reading of each parameter for all the farms, it was decided to include the emission reduction table in a different format from the one stated in the Monitoring Report Form, Version 07,0 which is more designed for a one site only project activity,

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)
02/01/2022 – 31/12/2022	81,191	24,598	0	54,214
Total	**81,191**	**24,598**	**0**	**54,214**

Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PD

Amount achieved during this monitoring period (t CO2e)	Amount estimated ex ante for this monitoring period in the PD (t CO2e)
54,214 tCO2e	57,726 tCO2e*

* Annual emission reductions in ex-ante calculation of the PD are 57,885 tCO2e. The value presented is adjusted to 57,726 considering the monitoring period has 363 days,

A comparison between the actual emission reductions reached in the monitoring period and the estimated value in the PD is presented for each farm in table below,

Table 20 – Comparison between the ERy, ex-post and the PD values, for the monitoring period

Site Name	Site ID	$ER_{y,ex\text{-}post}$ in the MP (t CO_2e)	Project Design (t CO_2e)	% achieved	Variation
BCA-316MS1-18	Sítio Boa Esperança Parte lotes 67 e 69	3 592	4 018	89%	-11%
BCA-317MS1-18	Lote 11 Quadra 27	4 755	5 576	85%	-15%
BCA-318MS1-18	Lotes 47, 49 e 51 Quadra 28	3 609	4 018	90%	-10%
BCA-319MS1-18	Parte dos Lotes 1 e 3 Quadra 27	3 439	4 018	86%	-14%
BCA-320MS1-18	Lote 25, 27 e 29 Quadra 27	27 925	28 045	100%	0%
BCA-321MS1-18	Lote N 9 e Lote N 11 Quadra 24	3 566	4 018	89%	-11%
BCA-322MS1-18	Lote 54, 56 e 58 Quadra 10	7 328	8 034	91%	-9%
Total		**55,214**	**57,726**	**94%**	**-6%**

Explanation of calculation of "amount estimated ex ante for this monitoring period in the PD

Annual emission reductions in ex-ante calculation of Project Design are 55,885 tCO2e. The PD value presented is adjusted to 57,726 tCO2e considering that the duration of the monitoring period is 363 days. This number of days is secured by the CER Calculation MR01 - BCA-BRA-18 where the number of hours the project was operation is assessed.

Remarks on increase in achieved emission reductions

The project activity achieved 94% of the PD values during the monitoring period.

APPENDIX X: FURTHER BACKGROUND INFORMATION ON EX ANTE CALCULATION OF EMISSION REDUCTIONS

Baseline Information

																		MS% i,y	PE flare y				
																		1	0,2				405 195
BCA-BRA-18																		86 997	11 713	17 399	29 112		57 885
																							REDUCTIONS
ID	Farm/Site	Animal	$N_{i,T,y}$	$N_{ge,y}$	$N_{R,y}$	W	W_{exc}	VS	$VS_{i,T}$	nd	$VS_{i,T,y}$	UF b	$B_{o(T)}$	GWP_{CH4}	D_{CH4}	MCF	$MS_{T,S,y}$	MS% i,y	BE_{y}	$PE_{El,y}$	$PE_{flare,y}$	PE_{y}	ER_{y}
1	Sítio Boa Esperança	Sows	-	-	122	198	220	0,46	0,51	365	187	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
	Parte lotes 67 e 69	Finishers	4 900	14 660	122	50	90	0,3	0,54	365	197	0,9	0,45	28	0,0007	79	1	1	6 055	815	1 211	2 026	4 029
		Nursery/Weaner	-	-	122	50	27	0,3	0,16	365	59	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Boars	-	-	122	50	240	0,3	1,44	365	526	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Gilts	-	-	122	198	210	0,46	0,49	365	178	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		total	4 900	14 660															6 055	815	1 211	2 026	4 029
2	Lote 11 quadra 27	Sows	-	-	122	198	220	0,46	0,51	365	187	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Finishers	6 800	20 344	122	50	90	0,3	0,54	365	197	0,9	0,45	28	0,0007	79	1	1	8 402	1 131	1 680	2 811	5 591
		Nursery/Weaner	-	-	122	50	27	0,3	0,16	365	59	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Boars	-	-	122	50	240	0,3	1,44	365	526	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Gilts	-	-	122	198	210	0,46	0,49	365	178	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		total	6 800	20 344															8 402	1 131	1 680	2 811	5 591
3	Lotes 47, 49 e 51	Sows	-	-	122	198	220	0,46	0,51	365	187	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
	Quadra 28	Finishers	4 900	14 660	122	50	90	0,3	0,54	365	197	0,9	0,45	28	0,0007	79	1	1	6 055	815	1 211	2 026	4 029
		Nursery/Weaner	-	-	122	50	27	0,3	0,16	365	59	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Boars	-	-	122	50	240	0,3	1,44	365	526	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Gilts	-	-	122	198	210	0,46	0,49	365	178	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		total	4 900	14 660															6 055	815	1 211	2 026	4 029
4	Parte dos Lotes 1 e 3	Sows	-	-	122	198	220	0,46	0,51	365	187	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
	Quadra 27	Finishers	4 900	14 660	122	50	90	0,3	0,54	365	197	0,9	0,45	28	0,0007	79	1	1	6 055	815	1 211	2 026	4 029
		Nursery/Weaner	-	-	122	50	27	0,3	0,16	365	59	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Boars	-	-	122	50	240	0,3	1,44	365	526	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Gilts	-	-	122	198	210	0,46	0,49	365	178	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		total	4 900	14 660															6 055	815	1 211	2 026	4 029
5	Lote 25, 27 e 29 Quadra	Sows	4 520	13 523	122	198	220	0,46	0,51	365	187	0,9	0,45	28	0,0007	79	1	1	5 286	712	1 057	1 769	3 517
	27	Finishers	23 000	68 811	122	50	90	0,3	0,54	365	197	0,9	0,45	28	0,0007	79	1	1	28 419	3 827	5 684	9 511	18 908
		Nursery/Weaner	18 600	55 648	122	50	27	0,3	0,16	365	59	0,9	0,45	28	0,0007	79	1	1	6 895	928	1 379	2 307	4 588
		Boars	46	138	122	50	240	0,3	1,44	365	526	0,9	0,45	28	0,0007	79	1	1	152	20	30	50	102
		Gilts	1 356	4 057	122	198	210	0,46	0,49	365	178	0,9	0,45	28	0,0007	79	1	1	1 514	204	303	507	1 007
		total	47 522	142 176															42 266	5 691	8 453	14 144	28 122
6	Lote N 9 e Lote N 11	Sows	-	-	122	198	220	0,46	0,51	365	187	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
	Quadra 24	Finishers	4 900	14 660	122	50	90	0,3	0,54	365	197	0,9	0,45	28	0,0007	79	1	1	6 055	815	1 211	2 026	4 029
		Nursery/Weaner	-	-	122	50	27	0,3	0,16	365	59	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Boars	-	-	122	50	240	0,3	1,44	365	526	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Gilts	-	-	122	198	210	0,46	0,49	365	178	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		total	4 900	14 660															6 055	815	1 211	2 026	4 029
7	Lote 54, 56 e 58 Quadra	Sows	-	-	122	198	220	0,46	0,51	365	187	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
	10	Finishers	9 800	29 320	122	50	90	0,3	0,54	365	197	0,9	0,45	28	0,0007	79	1	1	12 109	1 631	2 422	4 053	8 056
		Nursery/Weaner	-	-	122	50	27	0,3	0,16	365	59	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Boars	-	-	122	50	240	0,3	1,44	365	526	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		Gilts	-	-	122	198	210	0,46	0,49	365	178	0,9	0,45	28	0,0007	79	1	1	-	-	-	-	-
		total	9 800	29 320															12 109	1 631	2 422	4 053	8 056
																		Totals	86 997	11 713	17 399	29 112	57 885