Monitoring Report

CARBON OFFSET UNIT (CoU) PROJECT

Title: Agriwaste Biogas Project at APMC in Vadodara, Gujarat

Version 1.0

Date 24/09/2021

First CoU Issuance Period: 7 years, 0 months

Date: 01/01/2014 to 31/12/2020

Monitoring Report (MR)
CARBON OFFSET UNIT (CoU) PROJECT

Monitoring Report	
Title of the project activity	Agriwaste Biogas Project at APMC in Vadodara, Gujarat
UCR Project Registration Number	001
Version	1
Completion date of the MR	24/09/21
Monitoring period number and duration of this monitoring period	Monitoring Period Number: 1 Duration of this monitoring Period: (first and last days included (01/01/2014 to 31/12/2020)
Project participants	Aryan Associates, Vadodara, Gujarat, India
Host Party	India
Applied methodologies and standardized baselines	AMS.I.C. Thermal energy production with or without electricity UCR Protocol Standard Baseline AMS-III.AO Methane recovery through controlled anaerobic digestion
Sectoral scopes	SECTORAL SCOPE - 01 Energy industries (Renewable/NonRenewable Sources) 13 Waste handling and disposal
Estimated amount of GHG emission reductions for this monitoring period in the registered PCN	2014: 1859 CoUs
	2015: 3376 CoUs
	2016: 4636 CoUs
	2017: 9333 CoUs
	2018: 13287 CoUs
	2019: 16531 CoUs
	2020: 19227 CoUs
Total:	**68249 CoUs (68249 tCO_{2eq})**

SECTION A. Description of project activity

A.1. Purpose and general description of project activity >>

a) Purpose of the project activity and the measures taken for GHG emission reductions >>

The project **Agriwaste Biogas Project at APMC in Vadodara, Gujarat** is located in near Ajwa Rd, NH-8, Nehru Chacha Nagar, Sayaji Park Society, City Vadodara, State Gujarat, India.

The purpose of the project activity is the set up 3 (three) independent biogas plants (digesters) of 85m^3 capacity. In the absence of the project activity, biomass and other organic matter (including manure where applicable) would be left to decay within the project boundary and methane would be emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass and other organic matter.

Further, by using the captured biogas for electricity generation for captive usage, the project activity avoids carbon emissions related to the the baseline scenario in which electricity would be imported from the local coal fired dominated grid.

b) Brief description of the installed technology and equipment>>

The purpose of the project activity is the set up 3 (three) independent biogas plants (digesters) of 85m^3 capacity each for serving the captive electricity and energy needs at the facility using agricultural waste at the facility.

By using the biogas captured from the digesters the project activity generates power for captive use. The project activity is the controlled biological treatment of biomass or other organic matters through anaerobic digestion in closed reactors equipped with biogas recovery for electricity generation and a combustion/flaring system.

The technical specifications of the KVIC model bio-digesters are as follows:

Specification	Value
Capacity per unit	85 m^3
Mixing Proportion	(Water: Waste) 1:1
Number of units (digesters)	3
Feed Material	Agricultural /Food/Vegetable/Fruit Waste
Biogas Power Engine Capacity	12 kwh
Working Days	340
Calorific Value Biogas	20 MJ/m^3

c) Relevant dates for the project activity (e.g. construction, commissioning, continued operation periods, etc.)>>

Date of UCR Project Authorization: 23/09/2021

Start Date of Crediting Period: 01/01/2014

Project Commissioned: 01/06/2012

Commissioning dates of digesters:

Digester # 1 ($85m^3$)	Digester # 2 ($85m^3$)	Digester # 3 ($85m^3$)
01/06/2012	01/01/2017	01/03/2018

Total Biogas Units in the monitoring period: 3

This is the first monitoring report for the first crediting period for the period 01 January 2014 to 31st December 2020.

The operational domestic biogas units are in continuous operation after installation, with minor and major repairs as and when are reported by the project owner. Since the UCR protocol for biogas systems is based on a conservative 340 days a year operation, the project activity was never non-operational for a period of 25 days or more during any year of the monitoring period, since this is the main wholesale market supplying fruits and vegetables to the city of Vadodara.

d) Total GHG emission reductions achieved or net anthropogenic GHG removals by sinks achieved in this monitoring period>>

The total GHG emission reductions achieved in this monitoring period is as follows:

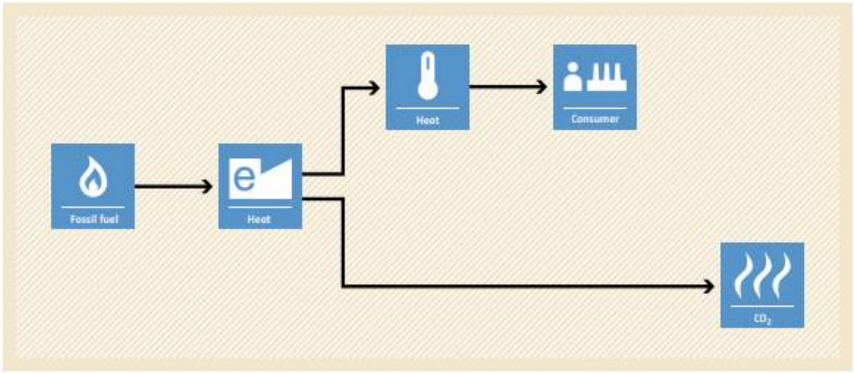
Summary of the Project Activity and ERs Generated for the Monitoring Period	
Start date of this Monitoring Period	01/01/2014
Carbon credits claimed up to	31/12/2020
Total ERs generated (tCO_{2eq})	68249 tCO_{2eq}
Leakage	NA

The baseline scenario identified is:

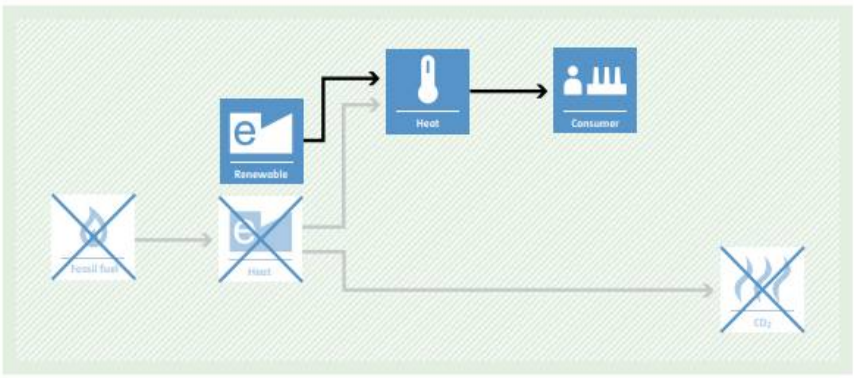
- the situation where, in the absence of the project activity, biomass and other organic matter (including manure where applicable) are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass and other organic matter.

- the fuel consumption of the technologies that would have been used in the absence of the project activity, times an emission factor for the fossil fuel displaced. Hence the baseline scenario is also electricity imported from a grid in the absence of the project activity.

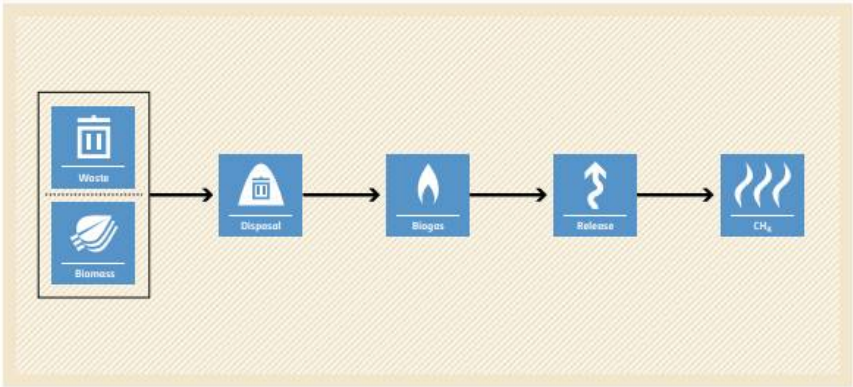
BASELINE SCENARIO
Energy generation (thermal heat and / or electricity) by more-carbon-intensive technologies based on fossil fuel. In case of retrofits or capacity addition, operation of existing renewable power units without retrofit and capacity addition.



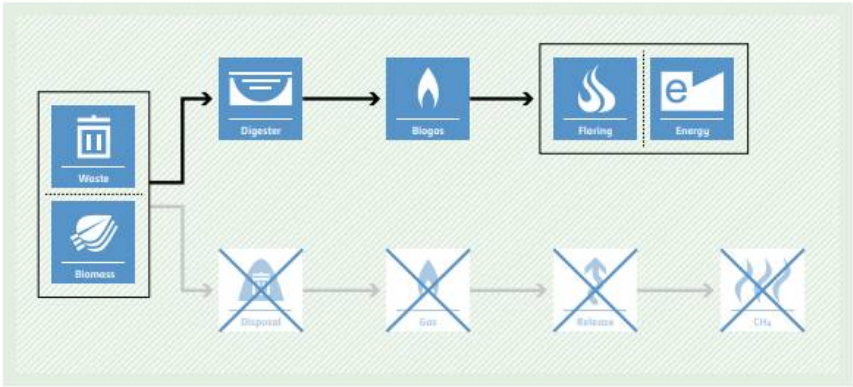
PROJECT SCENARIO
Energy generation by installation of new renewable energy generation units, by retrofitting or replacement of existing renewable energy generation units as well as by switch from fossil fuel to biomass in modified existing facilities.



BASELINE SCENARIO
Biomass or other organic matter would have otherwise been left to decay anaerobically.



PROJECT SCENARIO
Biological treatment of biomass or other organic matters through anaerobic digestion in closed reactors equipped with biogas recovery and a combustion/flaring system.



A.2. Location of project activity>>

Country: India.
District: Vadodara
Village: Vadodara
Landmark: Ajwa Rd, NH-8
State: Gujarat
Code: 390019


Mehsana
Bhuj
GUJARAT
Ahmedabad
Ratlam
Mundra
Morbi
Godhra
Dahod
A.P.M.C. Vadodara
Wholesale market
selling fresh produce
Jamnagar
Rajkot
Dwarka
Bhavnagar
Bharuch
Porbandar
Amreli
Junagadh
Surat
Veraval
Dhule

A.3. Parties and project participants >>

Party (Host)	Participants
India	Aryan Associates, Vadodara, Gujarat, India

A.4. References to methodologies and standardized baselines >>

SECTORAL SCOPE - 01 Energy industries (Renewable/Non-renewable sources)
13 Waste handling and disposal

TYPE I - Renewable Energy Projects

CATEGORY- ***AMS-I.C.: Thermal energy production with or without electricity***

AMS III.AO. Methane recovery through controlled anaerobic digestion

A.5. Crediting period of project activity >>

Type: Renewable
State date: 01-01-2014
Length of the crediting Period corresponding to this monitoring period: 7 years - 01 Jan 2014 - 31 Dec 20

A.6. Contact information of responsible persons/entities >>

Nutan P., Gram Vikas Trust
Email: gvtbiogas@gmail.com
Phone: +91 9898062970

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity >>

a) Provide information on the implementation status of the project activity during this monitoring period in accordance with UCR PCN>>

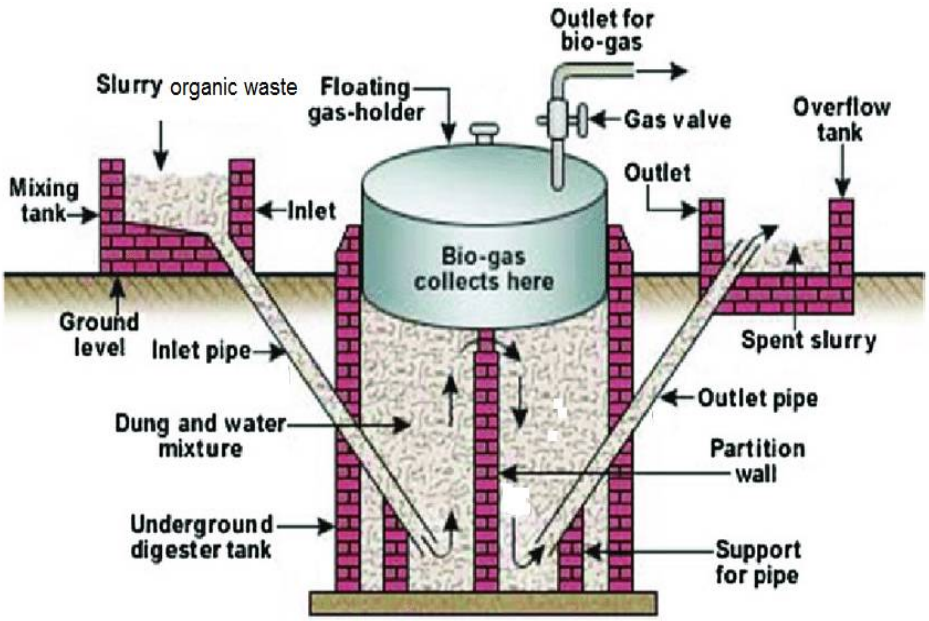
The purpose of the project activity is the set up 3 (three) independent biogas plants (digesters) of 85m^3 capacity each for serving the captive electricity and energy needs at the facility using agricultural waste at the facility.

Between 2 tons per day (TPD) (2000kgs/d) of agricutural waste was generated at the project site between the years 2014-2016 and 6 TPD (6000kg/d) daily between 2017-2020. Hence the project proponent added biogas units to treat the additional waste that was generated for the period post 2016.

Digester # 1 (85m^3)	Digester # 2 (85m^3)	Digester # 3 (85m^3)
01/06/2012	01/01/2017	01/03/2018

By using the biogas captured from the digesters the project activity generates power for captive use. The project activity is the controlled biological treatment of biomass or other organic matters through anaerobic digestion in closed reactors equipped with biogas recovery for electricity generation and a combustion/flaring system.

b) For the description of the installed technology(ies), technical process and equipment, include diagrams, where appropriate>>



Biogas is a mixture of methane and carbon dioxide. It also has traces of hydrogen sulphide (3%), ammonia, oxygen, hydrogen, water vapour etc., depending upon feed materials and other conditions. Biogas is generated by fermentation of cellulose rich organic matter under anaerobic conditions. In anaerobic conditions, the methane-producing bacteria become more active. Thus, the gas produced becomes rich in methane.

The optimum utilization depends upon the successful physical installations, which in turn depend upon plant design and its selection. The basic conversion principle is that when a non-ligneous biomass is kept in a closed chamber for a few days, it ferments and produces an inflammable gas. The anaerobic digestion consists of three stages: I Hydrolysis; II Acid formation and III Methane fermentation. The processes are carried out by two sets of bacteria namely acid forming bacteria and methane formers. The acidogenic phase I is the combined hydrolysis and acid formation stages in which the organic wastes are converted mainly into acetate, and phase II is the methanogenic phase in which methane and carbon dioxide are formed. The better the three stages merge with each other, the shorter the digestion process.

The technical specifications of the KVIC model bio-digesters are as follows:

Specification	Value
Capacity per unit	85 m^3
Mixing Proportion	(Water: Waste) 1:1
Number of units (digesters)	3
Feed Material	Agricultural /Food/Vegetable/Fruit Waste
Biogas Power Engine Capacity	12 kwh
Working Days	330
Calorific Value Biogas	20 MJ/m^3




B.2 Do no harm or Impact test of the project activity>>

There are social, environmental, economic and technological benefits which contribute to sustainable development.

- **Social benefits:**
- The project contributes in improving the environmental condition in the region of by hygienic treatment of agricultural waste resulting in improvement of health standard in the city.
- The project provides employment opportunity to the local rag pickers who can collect the recyclables from the plant and ensure that only organic waste is treated.
- The project would provide both direct and indirect employment opportunity to the people of the region.
- Reduces outdoor air pollution, thus eliminating health hazards for traders in the vicinity.
- The project provides security of energy supply since it generates biogas based electricity
- It leads to better waste management thus keeping the surroundings clean and reduce some of the disease causing pathogens

- **Environmental benefits:**
- Curbs methane emission as well as any leachate that would otherwise have been generated from the current practice of unscientific waste disposal.
- The land requirement used for a disposal site is removed as also is the area for dumping of equivalent amount of waste. This indirectly enables region towards a better way of land utilisation, like construction of housing, hospital etc.
- Further, by generating electricity through utilising the biogas, the project helps in replacing fossil fuel intensive power generation from the local grid.

- Avoids local environmental air pollution through better waste management
- Leads to soil improvement by providing high quality manure to farmers
- Reduces outdoor air pollution, and increases use of manure rather than chemical fertilizers.
- Using biogas as an energy resource contributes to clean environment.
- Agricultural waste is transformed into high-quality enriched bio-manure/fertilizer.
- Hygienic conditions are improved through reduction of pathogens by utilizing the organic wastes in the bio-digesters.
- Bio manure is a source of organic matter that stimulates biological activity

- **Economic and Technological benefits:**
- The project has a wastewater recycling facility that is powered by the biogas and reuses the water in the digester, hence conserving water.
- Provides employment to local communities through construction and maintenance of biogas units.
- The project is among the few the region than captures biogas and uses the same for the generation of electricity for captive uses at the project site.
- Agricultural waste is transformed into high-quality enriched bio-manure/fertilizer which is supplied at a lower cost than would normally be available at the retail marketplace, thus providing better soil enrichment for farmers and their crops.
- The revenue from carbon credits will showcase such efforts undertaken to make the agricultural markets environmentally sustainable by making them responsive toward the recycling of waste and maintaining the energy of ecosystem of market.

B.3. Baseline Emissions>>

The baseline scenario identified at the PCN stage of the project activity is:

- the situation where, in the absence of the project activity, biomass and other organic matter (including manure where applicable) are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass and other organic matter.

- the fuel consumption of the technologies that would have been used in the absence of the project activity, times an emission factor for the fossil fuel displaced. Hence the baseline scenario is also electricity imported from a grid in the absence of the project activity.

B.4. Debundling>>

This micro scale project is not a debundled component of a larger project activity.

SECTION C Application of methodologies and standardized baselines

C.1. References to methodologies and standardized baselines >>

SECTORAL SCOPE - 01 Energy industries (Renewable/Non-renewable sources)
13 Waste handling and disposal

TYPE I - Renewable Energy Projects

CATEGORY- ***AMS-I.C.: Thermal energy production with or without electricity***

This methodology comprises renewable energy technologies that supply users i.e. residential, industrial or commercial facilities with thermal energy that displaces fossil fuel use. These units include technologies such as energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.

AMS III.AO. Methane recovery through controlled anaerobic digestion

This methodology comprises measures to avoid the emissions of methane to the atmosphere from biomass or other organic matter that would have otherwise been left to decay anaerobically in a solid waste disposal site (SWDS), or in an animal waste management system (AWMS), or in a wastewater treatment system (WWTS). In the project activity, controlled biological treatment of biomass or other organic matters is introduced through anaerobic digestion in closed reactors equipped with biogas recovery and combustion/flaring system.

C.2. Applicability of methodologies and standardized baselines >>

This project activity comprises measures to avoid the emissions of methane to the atmosphere from biomass or other organic matter that would have otherwise been left to decay anaerobically in a solid waste disposal site (SWDS).
In the project activity, controlled biological treatment of biomass or other organic matters is introduced through anaerobic digestion in closed reactors equipped with biogas recovery and combustion/flaring system. Co-digestion of multiple sources of biomass substrates, e.g. Fruit and vegetable waste, where those organic matters would otherwise have been treated in an anaerobic treatment system without biogas recovery.
Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually under AMS III. AO.
All three biogas units are of $85m^3$ capacity and distinct from each other.
Biogas is used for renewable power generation for captive use.
The total installed electrical energy generation capacity of the project equipment does not exceed 15 MW
The annual average temperature of the biogas site is located is higher than 5°C
Residual waste from the digestion is handled aerobically and submitted to local farmers for soil application.
The storage time of the agricultural waste does not exceed 45 days before being fed into the digesters.
The outflow from the digestion is recycled and reused within the biogas digester.
The project activity does not recover or combust landfill gas from the disposal site, does not undertake controlled combustion of the waste that is not treated biologically in a first step and does not recover biogas from wastewater treatment.
This is a small scale project with total electricity capacity of 0.012 MW which is not greater than small scale thresholds defined by the applied methodology I.C. under Type I – renewable energy project activity, i.e. the total installed electrical energy generation capacity of the project equipment does not not exceed 15 MW.

C.3. Applicability of double counting emission reductions >>

Each of the biogas unit is constructed within the market facility. Each biogas unit has a unique ID, which is visible on the biogas unit. Details of the same will be provided to the UCR Verifier during verification. The project activity has not applied for carbon credits under any other GHG programs.

C.4. Project boundary, sources and greenhouse gases (GHGs)>>

The project boundary includes the physical, geographical site(s) of:

- (a) All plants generating electricity and/or thermal energy located at the project site,
- (b) Industrial, commercial or residential facility, or facilities, consuming energy generated by the system and the processes or equipment affected by the project activity;
- (c) Where the treatment of biomass or other organic matters through anaerobic digestion takes place;

	Source	GHG	Included?	Justification/Explanation
Baseline	Emissions from biomass decay	CO_2	Included	Major source of emission
		CH_4	Included	Major source of emission
	Emissions from electricity generated using fossil fuels	N_2O	Excluded	Excluded for simplification. This is conservative
Project Activity	Emissions from on-site electricity use	CO_2	Excluded	Electricity is generated from collected biogas, hence these emissions are not accounted for. CO2 emissions from the decomposition of organic waste are not accounted
	Emissions from residue from anaerobic digester composting	CH_4	Excluded	Excluded for simplification. This is conservative
		N_2O	Excluded	Excluded for simplification. This is conservative

The project activity recovers and utilizes biogas for producing electricity and applies this methodology in addition to using a Type III component of a SSC methodology, hence any incremental emissions occurring due to the implementation of the project activity is neglected.

C.5. Establishment and description of baseline scenario (UCR Protocol) >>

The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass and other organic matter. The yearly baseline emissions are the amount of methane that would have been emitted from the decay of the cumulative quantity of the waste diverted or removed from the disposal site, to date, by the project activity, calculated as the methane generation potential using the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site." For renewable energy technologies that displace

technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity, times an emission factor for the fossil fuel displaced. Hence the baseline scenario is also electricity is imported from a grid.

The project proponent was not bound to incur this investment as it was not mandatory by national and sectoral policies. Thus, the continued operation of the project activity would continue to replace fossil fuel derived grid electricity.

A "grid emission factor" refers to a CO2 emission factor (tCO2/MWh) which will be associated with each unit of electricity provided by an electricity system.

The UCR recommends an emission factor of 0.9 tCO2/MWh for the 2014-2020 years as a fairly conservative estimate for Indian projects not previously verified under any GHG program.

Estimated Annual Emission Reductions: $BE_y = BE_{y1} + BE_{grid}$

BE_y = Total Baseline Emissions in a year.

$BE_{grid} = EG_{y,grid} \times EF_{y,grid}$

BE_{grid}	=	Baseline emissions for the grid electricity displaced by the project in year y (t CO2e)
$EG_{y,grid}$	=	Amount of grid electricity displaced by project in year y (MWh)
$EF_{y,grid}$	=	Emission factor of the grid (t CO2e/MWh) = 0.9 (UCR Standard)

$BE_{y1} = BE_{swds,y} + BE_{manure,y} + BE_{WW,y} - MD_{reg,,y} \times GWP_{CH4}$

BE_{y1}	=	Baseline emissions from biomass and other organic matter left to decay within the project boundary and methane is emitted to the atmosphere
$BE_{swds,y}$	=	Baseline emission determination of digested waste that would otherwise have been disposed in stockpiles shall follow relevant procedures in AMS-III.E. This is equal to the yearly methane generation potential of the SWDS at the year y, considering all the wastes deposited in it since its beginning of operation, and without considering any removal of wastes by the project activity.
$BE_{manure,y}$	=	Baseline emissions from the manure co-digested by the project activities = 0
$BE_{WW,y}$	=	Baseline emissions from the wastewater co-digested = 0
$MD_{reg,,y}$	=	Amount of methane that would have to be captured and combusted in the year y to comply with the prevailing regulations (tonne) = 0
GWP_{CH4}	=	21 is the default IPCC value of CH_4 applicable to the crediting period ($tCO_{2e}/t\ CH_4$)

In this case the project activity treats only freshly generated wastes, hence the baseline emissions at any year y during the crediting period is calculated using the amount and composition of wastes gasified since the beginning of the project activity (2014 year “x=1”) up to the year (2020) y, using the first order decay model as referred to in the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”.

Year	2014	2015	2016	2017	2018	2019	2020
TOTAL Waste quantity (Tonnes)	680	680	680	2040	2040	2040	2040
Days/yr	330	330	330	330	330	330	330
% Food, agricultural waste	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
BE_{y1}*(tCo2)*	1825	3340	4602	9298	13202	16446	19143

Year	2014	2015	2016	2017	2018	2019	2020
Hours of power generation per day	10	10	10	10	24	24	24
MW/yr	39.6	39.6	39.6	39.6	95.04	95.04	95.04
BE_{grid} (tCo2)	35	35	35	35	85	85	85

Total baseline emission reductions (BE_y) = 68249 tCO_{2eq} (68249 CoUs)

Annual baseline emission reductions (BE_y)

Year	Emission Reductions (tCO_{2eq})
2014	1859
2015	3376
2016	4636
2017	9333
2018	13287
2019	16531
2020	19227
Total	**68249**

C.6. Prior History>>

The project activity has not applied to any other GHG program for generation or issuance of carbon offsets or credits.

C.7. Monitoring period number and duration>>

First Issuance Period: 3years, 0 months – 01/01/2014 to 31/12/2020

C.8. Changes to start date of crediting period >>

There is no change in the start date of crediting period.

C.9. Permanent changes from PCN monitoring plan, applied methodology or applied standardized baseline >>

There are no permanent changes from registered PCN monitoring plan and applied methodology

C.10. Monitoring plan>>

Data/Parameter	Date of commissioning of biogas units
Data unit	Digester # 1 (85m^3) Commissioned 01/06/2012
	Digester # 2 (85m^3) Commissioned 01/01/17
	Digester # 1 (85m^3) Commissioned 01/03/2018
Description	Commissioning Dates
Source of data Value(s) applied	Monitoring Report As and when commissioned
Measurement methods and procedures	The construction processes are maintained from its initiation to completion dates for the biogas unit. Thus the start date of each of the unit installed is recorded in the commissioning certificates that are provided to the UCR verifier.
Monitoring frequency	As and when commissioned and fixed and recorded in the monitoring report
Purpose of data	To estimate start date of baseline emissions

Data / Parameter:	Q_{waste}
Data unit:	2014: 680 tons
	2015: 680 tons
	2016: 680 tons
	2017: 2040 tons
	2018: 2040tons
	2019: 2040 tons
	2020: 2040 tons
Description:	Quantity of food and agricultural waste used in the biogas digesters each year.
Source of data:	Measured
Measurement procedures (if any):	On-site data sheets recorded monthly and daily using weigh bridge
Monitoring frequency:	Monthly-
QA/QC procedures:	Weighbridge is subject to periodic calibration (in accordance with stipulation of the weighbridge supplier)
Any comment:	Log of data entry is provided to UCR verifier

Data/Parameter	Number of Working Days for Project Activity per year
Data unit	340 days
Description	Number of working days of the biogas units in each year
Source of data Value(s) applied	Conservative estimate to offset repair and maintenance activities at the site
Measurement methods and procedures	Recorded in log books

Monitoring frequency	Recorded in log books
Purpose of data	To estimate baseline emissions

Model correction parameter, phi (φ)	0.9	IPCC default has been used.
Oxidation factor	0	IPCC default has been used.
Fraction of CH4 in LFG (F)	0.5 (Default)	IPCC default has been used.
% DOC Dissimilated in LFG (DOCf)	0.5 (Default)	IPCC default has been used.
Methane correction factor	1	IPCC default has been used.

Type of Waste	k	DOCj
Food, agriculture, C	0.185	100%