WASTE TO ENERGY PROJECTS BY MAHINDRA WASTE TO ENERGY SOLUTIONS LIMITED

Document Prepared by (infinite Solutions)

Project Title	*Waste to Energy Projects by Mahindra Waste to Energy Solutions Limited*
Version	*05*
Report ID	*2093_MP-2*
Date of Issue	*28-February-2024*
Project ID	*2093*
Monitoring Period	*01-January-2021 to 31-December-2021*
Prepared By	*Infinite Solutions*
Contact	*Address: 214-215 Milinda Manor, Opp. Next Treasure Island, 2 RNT Marg, Indore, India – 452001*

CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Mahindra Waste to Energy Solutions Private Limited has installed Bio-gas Plants of 110 TPD capacity at Maharashtra and Andhra Pradesh in India. Biogas technology provides an alternate source of energy in India, and is hailed as an archetypal appropriate technology that meets the basic need for cooking fuel in rural and urban areas. Using local resources, viz. food waste, cattle waste, vegetable and other organic wastes, energy and manure are derived.

The main purpose of the project is to incorporate competent biogas technology and implementation to support in the country by setting up to field scale biogas plant; to be located based on the continuous availability of raw materials. Anaerobic digestion is the prominent technology used for degradation of biodegradable organic waste.

The project activity involves the establishment of biogas plants in various cities, municipal corporations to generate energy out of waste, thereby solving two major issues for the country. The biogas generated shall be used for various thermal applications such as use in vehicles or bottled for use. The project activity is producing Biogas for supply in Domestic market of the country. In the absence of the project activity, the accordant amount of CNG (fossil Fuel based) would have been delivered through the current supply mix of the country, leading to carbon dioxide emissions.

The details of Project capacity and location details for all the project instances are as follows:

Sl. No.	Project Instance	Plant location	Technology	Capacity (TPD)	Usage	Commissioning Date
1	Mahindra Waste to Energy Solutions Ltd.	Aurangabad - Maharashtra	Bio Methanation	30	CNG Sale	01-May-2019
2		Tirupati – AP	Bio Methanation	40	CNG Sale	01-September-2019
3		Piduguralla – AP	Bio Methanation	20	CNG Sale	01-June-2019
4		Adoni - AP	Bio Methanation	20	CNG Sale	01-March-2019

During the Current Monitoring Period from 01-January-2021 to 31-December-2021 (First and last date included) the project activity has contributed 15,900 tCO_2e GHG reductions.

Audit Type	Period	Program	VVB Name	Number of years
Validation + Verification	(01-May-2019 -- 31-December-2020)	Verified Carbon Standard	LGAI Technological Center, S.A. (Applus+)	1.8 Years
Verification	(01-January-2021 – 31-December-2021)	Verified Carbon Standard	TUV SUD South Asia Pvt.Ltd.	1 Year
Total	**02**	**Verified Carbon Standard**	-	**2.8 Years**

1.2 Sectoral Scope and Project Type

Sectoral Scope : 01 - Energy industries (renewable-/non-renewable sources), and

13 – Waste handling & Disposal

Project Type : I - Renewable Energy Projects

Project is neither an AFOLU project nor a grouped project.

1.3 Project Proponent

Organization name	Mahindra Waste to Energy Solutions Ltd.
Contact person	Mr. B. Gowdhaman
Title	Plant in charge
Address	Mahindra Towers, Dr. GM Bhosale Marg, Worli, Mumbai – 400018
Telephone	-
Email	info@mahindra.com

1.4 Other Entities Involved in the Project

Organization name	Infinite Solutions
Role in the Project	Project Consultant
Contact person	Mr. Jimmy Sah
Title	Head – Sustainability

Address	Address: 214-215 Milinda Manor, Opp. Next Treasure Island, 2 RNT Marg, Indore - 452001, India
Telephone	+91-9644130430
Email	jimmy@infisolutions.org

1.5 Project Start Date

Project Start Date: 01-May-2019;

The project activity at Aurangabad site was commissioned and started operation on 01-May-2019. Hence the project start date is defined as the earliest commissioning date within all the units.

1.6 Project Crediting Period

Project crediting period: Renewal crediting period

Start date of Crediting period: 01-May-2019

End date of crediting period: 30-April-2026

Total number of years: 7

The project activity adopts renewable crediting period of 7 years which can be renewed for maximum 2 times.

1.7 Project Location

This is a grouped project activity and geographical boundary of the project activity is Fixed as India only. Hence, all the project instances shall be located within the India only.

The grouped projects are located across the country. The geological coordinates are as follows;

Project Instance	Location	Technology	Capacity	Plant Location	Latitude & Longitude
1	Aurangabad	Bio Methanation	30	Aurangabad Industrial Area	19° 54' 3.7"N 75° 21' 8.9" E
2	Tirupati		40	Temple city, Tirupati	13°37'23" N 79°29'14" E
3	Piduguralla		20	Piduguralla town, Guntur District	16° 29′ 50" N 79° 53′ 21" E
4	Adoni		20	Adoni town, Kurnool District	15° 37′ 18" N 77°16′ 51" E

Figure 1: Project Location across the country

1.8 Title and Reference of Methodology

Methodology: ACM0022 Project Type

Title: Alternative waste treatment processes[1]

Version Number: 02.0

The methodology refers to following CDM tools:

- Tool-03, Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion[2], Version 3.0, EB 96, Annex 4
- Tool-04, Emissions from solid waste disposal sites[3], Version 08.0, EB 94, Annex 7

[1] https://cdm.unfccc.int/methodologies/DB/YINQ0W7SUYOO2S6GU8E5DYVP2ZC2N3

[2] https://cdm.unfccc.int/methodologies/DB/YINQ0W7SUYOO2S6GU8E5DYVP2ZC2N3

[3] am-tool-04-v8.0.pdf (unfccc.int)

- Tool-05, Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation[4], Version 03.0, EB 96, Annex 5
- Tool-14, Project and leakage emissions from anaerobic digesters[5], Version 2.0, EB 96, Annex 7

1.9 Participation under other GHG Programs

The Project has not participated in any other GHG programs.

1.10 Other Forms of Credit and Supply Chain (Scope 3) Emissions

Net GHG emission reductions or removals generated by the Project will not be used for compliance with an emissions trading program or to meet binding limits on GHG emissions in any Emission Trading program or other binding limits.

Also, the Project has no intent to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under the VCS Program. The initial project activity instances are neither has nor intends to generate any other form of GHG related environmental credit for GHG emission reductions or removals claimed under the VCS Program.

1.11 Sustainable Development Contributions

The National CDM Authority (NCDMA), which is the Designated National Authority (DNA) for the Government of India (GOI) under the Ministry of Environment, Forest and Climate Change (MoEFCC), has mentioned four indicators for the sustainable development in the interim approval guidelines for Clean Development Mechanism (CDM) projects from India. Thus, the project's contribution towards sustainable development has been addressed based on the following sustainable development aspects:

Social well being

The project activity will provide job opportunity to local people during erection, commissioning and maintenance of the project. This directly and indirectly positively effects the economy of nearby populace.

Environmental well being

Bio CNG generation is one of the cleanest renewable energy powers and does not involve any fossil fuel. There are no GHG emissions. The impact on land, water, air and soil is negligible. Thus,

[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf

[5] am-tool-14-v2.pdf (unfccc.int)

the project activity contributes to environmental well-being without causing any negative impact on the surrounding environment.

Further the project leads to generation of energy from waste thus solving a major environmental concern for waste management.

Economic well being

The project activity generates permanent and temporary employment opportunity within the vicinity of the project.

Technological well being

The Project will also contribute towards achieving sustainable waste management in the city. The design and operation of this project, in conjunction with the avoidance of methane emissions and production of compost as a soil amendment, will serve as an example to many other urban areas in the country that are facing similar waste management challenges.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	1.1	1.1.1 Proportion of population below the international poverty line	Implemented activities to decrease	No further changes this monitoring period	The project has increased the 65 participants' total daily income from 1.20 USD/day to 2.57 USD/day, bringing them above the international poverty line
2)	3.2	3.3.3 Malaria incidence per 1,000 population	Implemented activities to decrease	Lowered the malaria incidence per 1,000 to 98 by distributing 200 additional bed nets and conducted malaria prevention workshops.	Lowered the malaria incidence per 1,000 from 157 to 98
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	The project has avoided emission of 15,900 tCO_2e in the atmosphere.	Since commissioning the project has avoided emissions of 28,733 tCO_2e in the atmosphere.
4)	6.1	Proportion of the rural population who have easy access to a safe water supply	Implemented activities to increase	Completed construction of 4 additional improved wells to provide potable water to 230 people	Provided at least 10 liters of potable water per day to 1,200 people, a 40% increase in the catchment area, over the project lifetime by constructing improved wells

2 SAFEGUARDS

2.1 No Net Harm

There was no harm identified form the project and hence no mitigations measures are applicable.

2.2 Local Stakeholder Consultation

The Local Stakeholder Meetings were organized at the project sites.

Project Instance	Project Proponent	Plant	Invitation Notice Dates	LSHM Meetings Date
1	Mahindra Waste to Energy Solutions Ltd.	Bio Methanation -30 TPD (Aurangabad)	02-October-2018	25-October-2018
2		Bio Methanation -40 TPD (Tirupati)	26-October-2018	14-November-2018
3		Bio Methanation -20 TPD (Piduguralla)	29-November-2018	19-December-2018
4		Bio Methanation -20 TPD (Adoni)	14-June-2018	08-July-2018

The following are the stakeholders for the project activity:

- Local community
- Local village administration
- Technology suppliers
- Local vendors
- Local Municipal bodies

The Minutes of LSH meeting along with List of Attendees and other supporting's has been submitted to the DOE.

Project representatives explained the project benefits and how project would help to fight Against climate change and no any negative comments received during the local stakeholder round. The Minutes of meeting with commenting sheet from LSH, invitation letter receipt copy is submitted to the DOE for further check. Few queries raised during local stakeholder consultation are addressed satisfactorily. The PP also placed a grievance register onsite in where the stakeholder

can put down his/her complain and the same if found genuine will be addressed immediately. Also, regular stakeholder engagement is one the key focus at the site.

2.3 AFOLU-Specific Safeguards

Not applicable to the project activity.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project activity has been successfully commissioned by Mahindra Waste to Energy Solutions Ltd. and was registered by VCS Board subsequently (Project ID: Ref No. 2093).

The project is a grouped project activity of installation of 110 TPD capacity biogas plant in different locations of Maharashtra and Andhra Pradesh of India. The project activity involves the establishment of biogas plants in various cities, municipal corporations to generate energy out of waste, thereby solving two major issues for the country. The biogas generated shall be used for various thermal applications such as use in vehicles or bottled for use. The project activity is expected to generate approximately M3 of Biogas for supply in Domestic market of the country. In the absence of the project activity, the accordant amount of CNG (fossil Fuel based) would have been delivered through the current supply mix of the country, leading to carbon dioxide emissions.

The main purpose of the project is to incorporate competent biogas technology and implementation to support in the country by setting up to field scale biogas plant; to be located based on the continuous availability of raw materials. Anaerobic digestion is the prominent technology used for degradation of biodegradable organic waste. Anaerobic Digestion (AD) is a biological process that happens naturally when bacteria break down organic matter in environments with little or no oxygen. It is effectively a controlled and enclosed version of the anaerobic breakdown of organic waste in landfill which release methane.

3.2 Deviations

3.2.1 Methodology Deviations

There has been no methodology deviation applied during this monitoring period of the project activity.

3.2.2 Project Description Deviations

1) Deviation 1:

The parameter $EF_{FC,default}$ 'Default emission factor for fossil fuel consumed by the Bio-methanation activity per tonne of waste composted (wet basis)' (fixed at the time of validation) having data unit wrongly mentioned as "tCH_4/t", the correct data unit is "tCO_2/t"[6].

In this deviation, the typo error has been corrected. Also, this deviation does not impact on additionality and design change.

2) Deviation 2:

The registered PD of the project activity available at project's webpage[7], shows in section 4.2 of the PD, Tool-14, Project and leakage emissions from anaerobic digesters (version-2.0) has been used for project emissions calculation. Whereas, Tool-13, Project and leakage emissions from composting (version-2.0) is mentioned in section 3.1 of the registered PD.

During reported monitoring period, in this deviation, the typing error has been corrected and the terminology 'Tool-13' is corrected with 'Tool-14' with weblink. The deviation neither impact on additionality and nor on design change of the project.

3) Deviation 3:

The value of the ex-ante parameter GWP_{CH4} 'Global Warming Potential of methane' was taken as 25 during the registration of the project activity which is not in line with the guideline provided in section 3.15 of VCS standard_V-4.4.

This is the 2nd periodic verification of the project and during this verification (*i.e.*, 01-January-2021 to 31-December-2021), referring paragraph 3.15.4 of VCS standard (V-4.4), "For GHG emission reductions occurring on or after 1 January 2021, all ex-ante estimates and ex-post calculations shall be converted to CO_2e using GWP values from the IPCC Fifth Assessment Report (AR5). For GHG emission reductions occurring on or before 31 December 2020, all ex-ante estimates and ex-post calculations may be converted to CO_2e using either the GWP values from the IPCC Fourth Assessment Report (AR4) or those from AR5".

"Projects that complete validation on or before 31 July 2021 may use GWP values from AR4 for ex-ante emission reduction estimates, though such projects shall use GWP values from AR5 for ex-post calculations", the GWP_{CH4} value of 28 is used in all calculations for GHG emission reductions conducted during the period from January 1, 2021, to April 30, 2026. This value is associated with the crediting period of the project activity.

[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-13-v2.pdf

[7] Verra Search Page

4) Deviation 4:

The value of the monitoring parameter $DOC_{f,y}$ 'default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS' was mistakenly taken as 0.9 during registration of the project activity which is not in line with the default value present in the methodology.

During this verification, the value of $DOC_{f,y}$ is corrected as 0.5 which is a default value present in the tool04 'Emissions from solid waste disposal sites'. The change in the value lead to the change in estimated ERs but did not lead to scale change, design change and also not impacting additionality.

Estimated ERs at time of registration is 47,359 but due to this deviation estimated ERs are 25,440 which is conservative and appropriate.

Parameters		Value	Estimated Emissions Reductions (tCO2e/year)	Actual Emissions Reductions (tCO2e)
Estimated value as per Approved PD	$DOC_{f,y}$	0.9	47,359	28,790
As per deviation requested	$DOC_{f,y}$	0.5	25,440	15,900

3.3 Grouped Projects

The project is a grouped project activity by Mahindra Waste to Energy Solutions Ltd. Mahindra with their engineering prowess has proved the benefits and unexplored potentials of biogas utilisation by installing biogas plant with purification system to produce bio-CNG gas which is equal to CNG gas in terms of quality and calorific value.

The project activity involves the establishment of biogas plants in various cities, municipal corporations to generate energy out of waste, thereby solving two major issues for the country. The biogas generated shall be used for various thermal applications such as use in vehicles or bottled for use. Biogas technology provides an alternate source of energy in India, and is hailed as an archetypal appropriate technology that meets the basic need for cooking fuel in rural and urban areas. Using local resources, viz. food waste, cattle waste, vegetable and other organic wastes, energy and manure are derived. Realization of this potential and the fact that India supports the largest cattle wealth led to the promotion of National Biogas Programme in a major way in the late 1970s as an answer to the growing fuel crisis. As an extension of technology, Mahindra in the process of developing alternate fuel technologies for rural and urban India for quite long time.

The details of Project capacity and location details for all the project instances are as follows:

S. No.	Project Instance	Plant location	Technology	Capacity (TPD)	Usage	Commissioning Date
1	Mahindra Waste to Energy Solutions Ltd.	Aurangabad - Maharashtra	Bio Methanation	30	CNG Sale	01-May-2019
2		Tirupati – AP	Bio Methanation	40	CNG Sale	01-September-2019
3		Piduguralla – AP	Bio Methanation	20	CNG Sale	01-June-2019
4		Adoni - AP	Bio Methanation	20	CNG Sale	01-March-2019

The main purpose of the project is to incorporate competent biogas technology and implementation to support in the country by setting up to field scale biogas plant; to be located based on the continuous availability of raw materials. Anaerobic digestion is the prominent technology used for degradation of biodegradable organic waste.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	φ_y
Data unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	Default values, CDM Methodological tool 04, V 8.0
Value applied	0.85
Justification of choice of data or description of measurement methods and procedures applied	Default values is selected based on the waste disposal sites waste disposal sites B of the tool and the climatic condition of the project site is Humid/wet conditions.
Purpose of Data	Calculation of Baseline Emission
Comments	This parameter is fixed ex-ante for the entire crediting period.

Data / Parameter	$DOC_{f,y}$
Data unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories

Value applied:	0.5
Justification of choice of data or description of measurement methods and procedures applied	The factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the solid waste disposal site.
Purpose of data	Calculation of Baseline Emission
Comments	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS.

Data / Parameter	DOC_j
Data unit	-
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)
Source of data	Tool 04, Emissions from solid waste disposal site, Version 08.0, EB 94, Annex 7
Value applied:	0.15
Justification of choice of data or description of measurement methods and procedures applied	The factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the solid waste disposal site. The IPCC 2006 default value (cited above) has been used.
Purpose of data	Calculation of Baseline Emission
Comments	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide.

Data / Parameter	OX
Data unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste).
Source of data	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories

Value applied:	0.1
Justification of choice of data or description of measurement methods and procedures applied	Managed solid waste disposal sites which are covered with oxidizing material like soil or compost. The IPCC 2006 default value (cited above) has been used.
Purpose of Data	Calculation of Baseline Emission
Comments	When methane passes through the top-layer, part of it is oxidized by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidized to CO_2 This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data / Parameter	F
Data unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of choice of data or description of measurement methods and procedures applied	The factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the solid waste disposal site. The IPCC 2006 default value (cited above) has been used..
Purpose of Data	Calculation of Baseline Emission
Comments	Upon biodegradation

Data / Parameter	MCF_y
Data unit	-

Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	1.0
Justification of choice of data or description of measurement methods and procedures applied	The project activity has controlled placement of waste with compaction and levelling being done and are managed by the respective Municipal Corporations. Hence a value of 1 is chosen.
Purpose of Data	Calculation of Baseline Emission
Comments	-

Data / Parameter	k_j
Data unit	1/yr
Description	Decay rate for the waste type
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value applied:	0.40
Justification of choice of data or description of measurement methods and procedures applied	Site is located in tropical area with wet MAT>20°C. The MAP is greater than 1000 (weather online) and the waste is food, food waste, sewage sludge, beverages and tobacco and categorized as rapidly degrading waste.
Purpose of Data	Calculation of Baseline Emission
Comments	-

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/t CH_4

Description	Global Warming Potential of methane
Source of data	IPCC fifth assessment report (AR5)[8]
Value applied:	28
Justification of choice of data or description of measurement methods and procedures applied	Global warming potential of methane valid for the relevant commitment period.
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter	f_y
Data unit	$tCO_2e/t\ CH_4$
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
Source of data	CDM Methodological Tool 04, Version 08.0
Value applied:	0%
Justification of choice of data or description of measurement methods and procedures applied	Value shall be assigned taking into account the amount of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y comply with relevant regulations and contractual requirements of the host country. Since there exists no regulations or contractual requirement to capture and destroy the methane generated from the landfills in India, hence it has been fixed ex ante and assigned a value of 0%
Purpose of Data	Calculation Baseline Emission
Comments	-

[8] Microsoft Word - Global-Warming-Potential-Values.docx (ghgprotocol.org)

Data / Parameter	$EF_{EF,j,y}$
Data unit	tCO_2/MWh
Description	Weighted average emission factor, CO_2 Baseline Database for the Indian Power Sector, Version 16.0
Source of data	Weighted average emission factor, CO_2 Baseline Database for the Indian Power Sector, Version 16.0
Value applied:	0.83
Justification of choice of data or description of measurement methods and procedures applied	The data are obtained from "CO_2 Baseline Database for Indian Power Sector" version 16, published by the Central Electricity Authority, Ministry of Power, Government of India.
Purpose of Data	Calculation of Project Emission
Comments	This parameter is fixed ex-ante for the entire crediting period.

Data / Parameter	$EF_{FC, default}$
Data unit	$t\ CO_2 / t$
Description	Default emission factor for fossil fuel consumed by the Bio-methantion activity per tonne of waste composted (wet basis)
Source of data	Data taken from the 2006 IPCC Guidelines
Value applied:	0.0207
Justification of choice of data or description of measurement methods and procedures applied	As per CDM Methodological tool 13, version 02.0: Based on a review of fossil fuel consumption per tonne of waste composed in relevant validation reports of CDM projects and using a conservative default emission factor for diesel.
Purpose of Data	Calculation of Project Emission
Comments	

Data / Parameter	$f_{CH4,default}$
Data unit	m^3 CH_4 / m^3
Description	Default value for the fraction of methane in the biogas
Source of data	CDM Tool 14, version 02.0
Value applied:	0.6
Justification of choice of data or description of measurement methods and procedures applied	The default value was derived based on reported values from registered projects and research papers (Davidsson, 2007)
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter	φ_{CH4}
Data unit	t CH_4 / m^3 CH_4
Description	Density of methane at normal conditions
Source of data	CDM Tool 14, version 02.0
Value applied:	0.00067
Justification of choice of data or description of measurement methods and procedures applied	Data considered from the tool 'Thermophysical properties of fluids. II. Methane, Ethane, Propane, Isobutane and Normal Butane' by B.A. Younglove, J.F. Ely
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter	$EF_{CH4,default}$
Data unit	T CH_4 leaked / t CH_4 produced
Description	Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester
Source of data	IPCC (2006), Flesch et al. (2011) and Kurup (2003)
Value applied:	0.028
Justification of choice of data or description of measurement methods and procedures applied	The digester with steel concrete digester and a gas holding system (egg shaped digesters) and monolithic construction. Therefore, the correspond default values is been considered.
Purpose of Data	Calculation of Project Emission
Comments	T CH_4 leaked / t CH_4 produced

Data / Parameter	$NCV_{Diesel,y}$
Data unit	TJ/Gg
Description	Net calorific value of diesel
Source of data	Page No. 18 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	43
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value has been considered for the calculations.
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter	$EF_{CO2,\ diesel,\ y}$
Data unit	tCO_2/TJ
Description	Weighted average Carbon dioxide emission factor of diesel
Source of data	India's Initial National Communication to UNFCCC IPCC 2006 default values http://www.ipcc-nggip.iges.or.jp/EFDB/find_ef.php
Value applied:	74.10
Justification of choice of data or description of measurement methods and procedures applied	India's Initial National Communication to UNFCCC IPCC 2006 default value has been considered for the calculations.
Purpose of Data	Calculation of Project Emission
Comments	-

4.2 Data and Parameters Monitored

Data / Parameter	W_x
Data unit	T/yr
Description	Total amount of organic waste prevented from disposal in year 'x
Source of data	Plant records, weighbridge
Description of measurement methods and procedures applied	Quantity of waste composted is measured using electronic weighbridge regularly and records are kept on paper and electronically.
Frequency of monitoring/recording	Continuous with annual aggregation
Value applied:	21,607
Monitoring equipment	Weighbridge

QA/QC procedures applied	Regular weighing of waste by project proponent will be carried out in a weighbridge according to Monitoring plan. The weigh bridge would be Wx Wx calibrated annually[9].
Purpose of data	Calculation of Baseline Emission
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	$RATE_{compliance,t,y}$
Data unit	Fraction
Description	State level compliance rate of the MSW Management Rules in that year y
Source of data	Preferably from secondary sources and alternatively from the Central Pollution Control Boards (CPCBs).
Description of measurement methods and procedures applied	Ratio of Quantity of Solid waste generated (TPD) to quantity of Solid waste treated (TPD) in India during the year y.
Frequency of monitoring/recording	Annually
Value applied:	36.67%
Monitoring equipment	NA
QA/QC procedures applied	If due to any reasons the unavailability of official data available about the status of compliance to MSW Rules in the country, the most recent available data would be used for calculation.
Purpose of data	Calculation of Baseline Emission
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	Applicable to calculate baseline emission and confirming applicability of the methodology

[9] Meters Details has been provided in Appendix 1

Data / Parameter	$EC_{PJ,j,y}$
Data unit	MWh
Description	Amount of electricity consumed from the grid as a result of the project activity
Source of data	Electricity meter reading from electricity meter bill by the State Electricity Board or any Private Supplier.
Description of measurement methods and procedures applied	Data is measured and recorded continuously through meters and meter readings are archived electronically. The data will be calculated by monitoring the difference between the reading in meter at the end of the month and beginning of the month. This parameter will be updated ex-post each year over the crediting period.
Frequency of monitoring/recording	Monthly
Value applied:	678.015
Monitoring equipment	Electricity meter (Electricity Board Energy Meter)
QA/QC procedures applied	As the meters will be maintained by third party agency the accuracy of data is ensured. The meters are entirely under the control of State Electricity Board/DISCOM. The metering system will be calibrated according to CEA regulations which specifies Electricity meters to be calibrated once in 5 years. Calibration frequency: One in five years[10]
Purpose of data	Calculation of Project Emission
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	Q_y
Data unit	T/yr

[10] http://www.aegcl.co.in/Metering_Regulations_Of_CEA_17_03_2006.pdf

Description	Quantity of waste composted in year y (wet basis)
Source of data	Plant Records/logbook
Description of measurement methods and procedures applied	Quantity of waste composted is measured using electronic weighbridge regularly and records are kept on paper and electronically
Frequency of monitoring/recording	Continuous with annual aggregation
Value applied:	3,796
Monitoring equipment	Weighbridge/logbooks
QA/QC procedures applied	As the weighbridge meter will be maintained by third party agency the accuracy of data is ensured. The weighbridge calibration frequency is under the control of third party and PP does not have control on it.
Purpose of data	Calculation of Project Emission
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	$Q_{biogas,y}$
Data unit	Nm^3 biogas
Description	Amount of biogas collected at the digester outlet in year y
Source of data	Plant records/logbooks
Description of measurement methods and procedures applied	The values will be obtained from Log book data maintained by the plant personnels.
Frequency of monitoring/recording	Data to be aggregated monthly and yearly.

Value applied:	662,537 Nm^3
Monitoring equipment	Plant Records
QA/QC procedures applied	-
Purpose of data	Calculation of Project Emission
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	$FC_{diesel,Bio\text{-}mathanation,y}$
Data unit	volume (m^3 /yr)
Description	Quantity of diesel combusted in Bio-methanation process during the year y
Source of data	Onsite Logbook
Description of measurement methods and procedures applied	Onsite Measurement The total number of operating hours of DG set and the corresponding quantity of diesel consumed for the purpose is recorded in the log book maintained at the DG set room. The operating hours and the quantity of diesel consumption is recorded.
Frequency of monitoring/recording	Continuous monitoring and monthly compilation
Value applied:	0 m^3
Monitoring equipment	NA
QA/QC procedures applied	he consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities (invoices).
Purpose of data	Calculation of Project Emission
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.

Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

4.3 Monitoring Plan

The monitoring plan defines the standards and rules according to which the emission reductions of the project activity are monitored and verified in conformance with all relevant requirements of the VCS. The monitoring plan and procedures can be updated and adjusted to meet the operational requirements. The monitoring plan is given below:

Use of the Monitoring Plan (MP) by the Site Operator:

This Monitoring Plan identifies key performance indicators of the project and sets out the procedures for metering, monitoring, calculating and verifying the ERs generated by the compost plant, annually. Adherence to the instructions in the Monitoring Plan will be issued to the operator to measure and track the impact of the project on the environment. The MP is thus the basis for the production of ERs and accreditation of the ERs within the VCS mechanism. The operation of the composting facilities will be documented in a quality control program, monitoring the conditions and procedures that ensure the aerobic condition of the waste during the composting process.

AGENT	DELIVERABLE
	Overall responsible for completeness of data, reliability of data (calibration of meters, weighing machines measuring samples) and monthly report generation. Following shall be measured and recorded: 1.1 Electricity consumption for equipment used on site. Data can be collected from electricity meter installed by state electricity board (a kWh-instrument). 2.1 Fuel consumption for equipment used on site. Data can be based upon the received invoices for fuel. Operator shall keep/file receipt of invoices. ✓ Produced compost that is trucked off of site. ✓ Quantity of waste supplied to the compost plant will be measured by weighing on a weighbridge as described in the Monitoring plan. This information is required for calculation of the ER's ✓ Measurement of the composition of the incoming waste in accordance with the procedure as indicated in the sampling plan. ✓ Number and detail of vehicles that bring in the waste and the vehicles that transport compost to the end user.

Training and maintenance procedures:

Training of the staff on good practices of composting would also take place as and when found necessary. A document control system will be implemented by the plant manager in order to ensure proper storage of the monitored data and other relevant documents.

Emergency Procedures for monitoring system:

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

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

As per ACM0022 equation 35, para 107, the emission reduction is calculated as;

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y = Emission Reduction in year y (tCO_2e)

BE_y = Baseline Emission in year y (tCO_2e)

PE_y = Project Emission in the year y (tCO_2e)

LE_y = Leakage Emission in Year y (tCO_2e)

Also,

$BE_y = BE_{Bio\text{-}methanation,\ y}$

$PE_y = PE_{Bio\text{-}methanation,\ y}$

$LE_y = LE_{Bio\text{-}methanation,\ y}$

$BE_{Bio\text{-}Methanation,\ y}$ = Baseline Emissions in year y (tCO_2e) from Bio-methanation.

$PE_{Bio\text{-}Methanation,\ y}$ = Project Emissions in the year y (tCO_2e) from Bio-Methanation.

$LE_{Bio\text{-}Methanation,\ y}$ = Leakage Emissions in year y (tCO_2e) from Bio-Methanation

The amount of methane generated from the disposal of waste at the SWDS is calculated based on a first order decay (FOD) model. The model differentiates between the different types of waste j with respective constant decay rates (k_j) and fractions of degradable organic carbon (DOC_j). The model calculates the methane generation occurring in year y disposed in the SWDS over a

specific time period y. There is no SWDS methane captured, flared and combusted or used in another manner that prevents emission of methane to the atmosphere at the project site.

According to ACM0022, Version-2.0, equation (1) para 41, the baseline emissions would be calculated as:

$$BE_{Bio-methanation,y} = \sum (BE_{CH4,t,y} + BE_{WW,y} + BE_{EN,t,y} + BE_{NG,t,y}) \times DF_{RATE,t,y}$$

With:

$$DF_{RATE,t,y} = \begin{cases} 1 - RATE_{compliance,t,y}, & if\ RATE_{compliance,t,y} < 0.5 \\ 0, & if\ RATE_{compliance,t,y} \geq 0.5 \end{cases}$$

Where,

$BE_{Bio-methanation,y}$	=	Baseline Emissions in year y (tCO_2e) from Bio-Methanation project activity
$BE_{CH4,t,y}$	=	Baseline emissions of methane from the SWDS in year y (t CO_2e)
$BE_{WW,y}$	=	Baseline methane emissions from anaerobic treatment of the wastewater in open anaerobic lagoons or of sludge in sludge pits in the absence of the project activity in year y (t CO_2e)
$BE_{EN,t,y}$	=	Baseline emissions associated with energy generation in year y (tCO_2e)
$BE_{NG,t,y}$	=	Baseline emissions associated with natural gas use in year y (t CO_2e)
$DF_{RATE,t,y}$	=	Discount factor to account for $RATE_{Compliance,t,y}$
$RATE_{Compliance,t,y}$	=	Rate of compliance of a requirement that mandates the use of alternative waste treatment option t in year y
t	=	Type of alternative waste treatment option

Since the project does not involve any anaerobic treatment of the wastewater, energy generation, natural gas use, the $BE_{WW,y}$, $BE_{EN,t,y}$, $BE_{NG,t,y}$ are considered as zero.

Baseline emissions of methane from the SWDS ($BE_{CH4,t,y}$) is determined using the methodological tool "Emissions from solid waste disposal sites". Therefore, following the tool V8, para 17 Equation (1), the emission is calculated as

$$BE_{CH4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^{y} \sum_{j} (W_{j,i} \times DOC_j \times e^{(-k_j \times (y-x))} \times (1 - e^{-k_j}))$$

Where,

$BE_{CH4, SWDS, y}$	=	Baseline methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (t CO_2e/yr)
x	=	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y)
y	=	Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)
$DOC_{f,y}$	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)
$W_{j,x}$	=	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t)
φ_y	=	Model correction factor to account for model uncertainties for year y
f_y	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
GWP_{CH4}	=	Global warming potential of methane
OX	=	Oxidation factor (reflecting the amount of methane from SWDS
F	=	Fraction of methane in the SWDS gas (volume fraction)
MCF_y	=	Methane correction factor for year y
$DOCj$	=	Fraction of Degradable organic carbon in the waste type j (weight fraction)
K	=	Decay rate for the waste type j (1/year)
j	=	Type of residual waste or types of waste in the MSW

The Table(s) below depicts the baseline emission calculations:

Table-1: The fixed data values used in the calculation of baseline emissions

Parameter	Value	Unit
φ_y	0.85	-
f_y	0	tCO_2/ tCH_4
(1-f_y)	1	-
GWP_{CH4}	28	tCO_2/ tCH_4
OX	0.1	-
(1-OX)	0.9	-
F	0.5	-
$DOC_{f,y}$	0.5	Weight Fraction
MCF_y	1.0	-
DOC_j	0.15	Weight Fraction
k_j	0.40	1/yr

Table-2: The monitoring data values used in the calculation of baseline emissions of Aurangabad

S. No.	Month	Monthly Qty of Municipal Solid waste treated (In Ton)	Amount of Bio Gas collected (Nm^3)	Monthly Qty of Bio CNG (In T)	Monthly Qty of Compost (In Ton)	Monthly Electricity Consumption	Monthly Diesel Consumption (In Ltr.)
1	Jan-21	536	23,905	10	25	27,998	0
2	Feb-21	348	23,905	10	39	23,643	0
3	Mar-21	471	19,652	8	30	26,527	0
4	Apr-21	306	14,080	6	30	23,538	0
5	May-21	239	10,647	4	20	18,550	0
6	Jun-21	362	13,383	5	0	14,053	0
7	Jul-21	369	12,438	5	14	20,610	0
8	Aug-21	387	28,706	12	17	32,915	0
9	Sep-21	444	23,881	10	21	30,270	0
10	Oct-21	403	22,388	9	0	23,260	0
11	Nov-21	408	19,950	8	25	22,755	0
12	Dec-21	455	24,876	10	20	30,323	0
Total		**4,728**	**237,811**	**96**	**241**	**294,442**	**0**

Table-3: The monitoring data values used in the calculation of baseline emissions of Adoni

S. No.	Month	Monthly Qty of Municipal Solid waste treated (In Ton)	Amount of Bio Gas collected (Nm^3)	Monthly Qty of Bio CNG (In T)	Monthly Qty of Compost (In Ton)	Monthly Electricity Consumption	Monthly Diesel Consumption (In Ltr.)
1	Jan-21	557	622	0.25	123	4,185	0
2	Feb-21	357	1,741	0.70	121	3,568	0
3	Mar-21	389	1,244	0.50	120	4,412	0
4	Apr-21	377	1,741	0.70	127	3,488	0
5	May-21	379	1,493	0.60	129	4,153	0
6	Jun-21	373	1,741	0.70	135	4,089	0
7	Jul-21	364	1,990	0.80	113	3,416	0
8	Aug-21	367	1,741	0.70	120	4,277	0
9	Sep-21	311	1,119	0.45	125	4,258	0
10	Oct-21	398	1,368	0.550	95	3,879	0
11	Nov-21	386	1,468	0.590	120	4,917	0
12	Dec-21	370	1,493	0.600	110	3,782	0
Total		**4,628**	**17,761**	**7**	**1,438**	**48,424**	**0**

Table-4: The monitoring data values used in the calculation of baseline emissions of Tirupati

S. No.	Month	Monthly Qty of Municipal Solid waste treated (In Ton)	Amount of Bio Gas collected (Nm^3)	Monthly Qty of Bio CNG (In T)	Monthly Qty of Compost (In Ton)	Monthly Electricity Consumption	Monthly Diesel Consumption (In Ltr.)
1	Jan-21	909	28,607	12	77	20,154	0
2	Feb-21	543	30,410	12	100	19,516	0
3	Mar-21	796	33,085	13	90	23,556	0
4	Apr-21	679	31,604	13	40	18,574	0
5	May-21	523	21,953	9	70	19,254	0
6	Jun-21	387	24,876	10	65	16,424	0
7	Jul-21	707	33,582	14	35	27,578	0
8	Aug-21	421	22,388	9	20	17,828	0
9	Sep-21	507	22,388	9	40	18,712	0
10	Oct-21	403	27,114	11	20	27,906	0
11	Nov-21	741	29,851	12	20	18,746	0
12	Dec-21	680	28,109	11	10	24,228	0
Total		**7,296**	**333,968**	**134**	**587**	**252,476**	**0**

Table-5: The monitoring data values used in the calculation of baseline emissions of Piduguralla

S. No.	Month	Monthly Qty of Municipal Solid waste treated (In Ton)	Amount of Bio Gas collected (Nm^3)	Monthly Qty of Bio CNG (In T)	Monthly Qty of Compost (In Ton)	Monthly Electricity Consumption	Monthly Diesel Consumption (In Ltr.)
1	Jan-21	445	4,975	2	120	7,230	0
2	Feb-21	410	5,597	2	121	7,171	0
3	Mar-21	473	7,201	3	125	9,829	0
4	Apr-21	495	9,950	4	127	7,165	0
5	May-21	328	6,219	3	175	5,207	0
6	Jun-21	317	6,219	3	128	5,009	0
7	Jul-21	517	3,731	2	130	5,194	0
8	Aug-21	411	6,219	3	131	8,091	0
9	Sep-21	400	4,975	2	135	6,317	0
10	Oct-21	393	4,975	2	91	10,176	0
11	Nov-21	425	7,463	3	132	5,387	0
12	Dec-21	342	5,473	2	115	5,897	0
Total		**4,956**	**72,998**	**29**	**1,531**	**82,673**	**0**

Table-6: The calculation result of BE_y during reporting monitoring period

Project Activity	Using the default and monitored values $BE_{Composting,y}$
$BE_{Aurangabad}$	3,525.52
BE_{Adoni}	3,450.85
$BE_{Tirupati}$	5,440.09
$BE_{Piduguralla}$	3,694.42
Total Baseline Emission BE_y	**16,111 tCO_2e (Round down values)**

5.2 Project Emissions

The project emission calculation as per para 65 of ACM0022 version 02,

For Bio-methanation Project:

As per consolidated methodology ACM0022 para 65, equation 18, the project emissions from Bio-Methanation ($PE_{Bio\text{-}Methanation}$) are determined as follows:

$$PE_{Bio-methanation\,y} = PE_{COMP,y} + PE_{AD,y} + PE_{GAS,y} + PE_{RDF\_SB,y} + PE_{INC,y}$$

Where,

$PE_{Bio\text{-}methanation}$	=	Project emissions in year y (t CO_2e) from Bio-Methanation
$PE_{COMP,\,y}$	=	Project emissions from composting or co-composting in year y (t CO_2e)
$PE_{AD,\,y}$	=	Project emissions from anaerobic digestion and biogas combustion in year y (t CO_2e)
$PE_{GAS,\,y}$	=	Project emissions from gasification in year y (t CO_2e)
$PE_{RDF\_SB,\,y}$	=	Project emissions associated with RDF/SB in year y (t CO_2e)
$PE_{INC,\,y}$	=	Project emissions from incineration in year y (t CO_2e)
$PE_{EC,\,y}$	=	Project emissions from electricity consumption associated with anaerobic digester in year y (t CO_2e /yr)
$PE_{FC,\,y}$	=	= Project emissions from fossil fuel anaerobic digester associated with composting in year y (t CO_2e /yr

The Bio-methanation project doesn't include direct composting, gasification, no association of RDF/SB and incineration at the project site. Therefore, $PE_{COMP,y}$, $PE_{GAS,y}$, $PE_{RDF,SB,y}$ and $PE_{INC,y}$ are considered as zero.

As per tool "Project and leakage emission from anaerobic digesters" para 13, equation (1), $PE_{AD,y}$ are considered as zero.

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y}$$

Where:-

$PE_{AD,y}$ = Project emissions associated with anaerobic digester in year y (t CO_2e)

$PE_{EC,y}$ = Project emissions from electricity consumption associated with anaerobic digester in year y (t CO_2e /yr)

$PE_{FC,y}$ = Project emissions from fossil fuel anaerobic digester associated with composting in year y (t CO_2e /yr)

$PE_{CH4,y}$ = Project emissions of methane from the anaerobic digester process in year y

$PE_{flare,y}$ = Project emissions from flaring of biogas in year y (CO_2e/ yr)

Since the capacity of each bio-methanation plant is small, and the project emission from biogas flaring is negligible (less than 0.5% of the baseline emissions) therefore $PE_{flare,y}$ is considered as zero. Also, as per the methodological tool 06 Project emissions from flaring, project activity flaring is not from the biogenic sources like landfill gas or biogas from wastewater treatment or coal mine methane.

$$PE_{EC,y} = Q_{CH4,y} \times F_{EC,default} \times EF_{EL,}$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption associated with anaerobic digester in year y (t CO_2e)

$Q_{CH4,y}$ = Quantity of methane produced in the anaerobic digester in year y (tCH_4)

$F_{EC,default}$ = Default factor for the electricity consumption associated with the anaerobic digester per ton of methane generated (MWh/tCH_4)

EF_{EL} = Default emission factor for the electricity consumed in year y (t CO_2/ MWh)

$$Q_{CH4,y} = Q_{biogas,y} \times f_{CH4,default} \times \varphi_{CH4}$$

Where:

$Q_{CH4,y}$ = Quantity of methane produced in the digester in year y (tCH_4)

$Q_{biogas,y}$ = Amount of biogas collected at the digester outlet in year y (Nm^3 biogas)

$f_{CH4,default}$ = Default emission factor for the fraction of methane in the biogas

φ_{CH4} = Density of methane at normal conditions (t CH_4/ Nm^3 CH_4)

As per the methodological tool 03, Version 03.0, Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, the $PE_{FC,y}$ for diesel consumption at site is calculated as follows:

$$PE_{FC,diesel,y} = \sum_{i} FC_{diesel,Bio-methnation,y} \times COEF_{diesel,y}$$

Where:

$PE_{FC,diesel,y}$	=	CO_2 emissions from fossil fuel combustion in Bio-methanation during the year y (tCO_2/ yr)
$FC_{diesel,Bio-methanation,y}$	=	The quantity of diesel combusted in Bio-methanation process during the year y (mass or volume unit/yr)
$COEF_{diesel,y}$	=	The CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)

The $COEF_{diesel,y}$ is calculated as follows:

$$COEF_{diesel,y} = NCV_{diesel,y} \times EF_{CO2,i,y}$$

Where:

$COEF_{diesel,y}$	=	The CO_2 emission coefficient of diesel in year y (tCO_2/mass or volume unit)
$NCV_{diesel,y}$	=	The weighted average net calorific value of the diesel in year y (GJ/mass or volume unit)
$EF_{CO2,diesel,y}$	=	The weighted average CO_2 emission factor of diesel in year y (tCO_2/GJ)

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4}$$

Where:

$PE_{CH4,y}$	=	Project emissions of methane from the anaerobic digester in year y (t CO_2)
$Q_{CH4,y}$	=	Quantity of methane produced in the anaerobic digester in year y(tCH_4/yr)
$EF_{CH4,default}$	=	Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester (fraction)
GWP_{CH4}	=	Global Warming Potential of CH_4 (t CO_2e / t CH_4)

The Table(s) below depicts the project emission calculations:

Table-7: The fixed data values used in the calculation of project emissions

Parameter	Value	Unit
$EF_{EF, j, y}$	0.83	tCO_2/MWh
$EF_{FC, default}$	0.0207	tCO_2/t
$f_{CH4,default}$	0.6	m^3 CH_4 / m^3

φ_{CH4}	0.00067	t CH_4 / m^3 CH_4
$EF_{CH4, default}$	0.028	T CH_4 leaked / t CH_4 produced
$NCV_{Diesel,y}$	43	TJ/Gg
$EF_{CO2, diesel, y}$	74.10	tCO_2/TJ

Using above formulas, parameters and values mentioned in Table-2 to Table-5, the project emissions are:

Table-8: The calculation result of PE_y during reporting monitoring period

Project Activity	Using the default and monitored values $BE_{Composting,y}$
$PE_{Aurangabad}$	75
PE_{Adoni}	6
$PE_{Tirupati}$	106
$PE_{Piduguralla}$	24
Total Project Emission PE_y	**211 tCO_2e**

5.3 Leakage

As per Methodological tool 14 Version 2.0," Project and leakage emissions from anaerobic digesters", The leakage emissions associated with the anaerobic digester *(LE_{AD})* is

$LE_{AD, y}$ = Leakage emissions associated with the anaerobic digester in year y (t CO_2e)

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (t CO_2e)

$LE_{COMP,y}$ = Leakage emissions associated with composting digestate in year y (t CO_2e)

In the Project case $LE_{Storage,y}$ is considered zero as the storage lagoon is not un-aerated. Also, LE_c, is calculated using the methodological tool "Project and leakage emissions from composting". The term $PE_{comp,y}$ + $LE_{comp,y}$ in the methodological tool "Project and leakage emissions from composting" provides the value for $LE_{comp,y}$ of this tool. Therefore, following equation (6) of this document is used to calculate the $LE_{comp,y}$.

5.4 Net GHG Emission Reductions and Removals

The total emission reduction achieved in current monitoring period is

$$ER_y = BE_y - PE_y - LE_y$$

Where:

BE_y = $BE_{Bio\text{-}methanation, y}$

PE_y = $PE_{Bio\text{-}methanation, y}$

LE_y = $LE_{Bio\text{-}methanation,y}$

Hence, total emission reductions for the project activity in current monitoring period are:

ER_y = **15,900 tCO_2e (Rounded down)**

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)
2021 (01-January-2021 – 31-December-2021)	16,111	211	0	15,900
Total	16,111	211	0	**15,900**

It is to be noted here that as per the estimated emission reduction from the project activity for the current monitoring period is 25,440 tCO_2e, whereas actual emission reductions achieved are 15,900 tCO_2e, which is 37.50% lower than the estimated emission reductions.

Ex-ante emissions reductions /removals	Achieved emissions reductions /removals	Percent difference	Justification for the difference
25,440	15,900	-37.50%	PP has calculated the estimated ERs on the basis of 365 days working of plant. Whereas in the reported monitoring period due to the low availability of waste, the production could not be achieved in the expected quantity, which results in less production than expected. Which results in lower of emission reductions quantity than what was originally estimated.

APPENDIX 1: <CALIBRATION DETAILS>

Bio-Methanation Plant :-

1) Aurangabad Plant (30 TPD)

- **Weighbridge Details: -**

S. No.	1/1		
MAX Capacity	40000 Kg		
Make	Prime & Automation		
Model	Class III		
Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	26/08/2020	Validity	25/08/2021
Calibration Date	24/08/2021	Validity	23/08/2022

- **Electricity Meter Details: -**

S. No.	X1082365		
Class	0.5 Sec		
Calibration Date	22/02/2019	Validity	21/02/2024

2) Tirupati Plant (40 TPD)

- **Weighbridge Details: -**

S. No.	WB1321		
MAX Capacity	50000 Kg		
Make	Prime & Automation		
Model	Class III		
Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	08/06/2020	Validity	07/06/2021
Calibration Date	06/06/2021	Validity	05/06/2022

- **Electricity Meter Details: -**

S. No.	X0774356		
Class	0.5 Sec		
Calibration Date	26/06/2019	Validity	25/06/2024

3) Piduguralla Plant (20 TPD): -

- Weighbridge Details: -

S. No.	130408		
MAX Capacity	60000 Kg		
Make	LOTUS		
Model	Class III		
Minimum Capacity	200 Kg		
Minimum Value	5 Kg		
Calibration Date	23/05/2020	Validity	22/05/2021
Calibration Date	21/05/2021	Validity	20/05/2022

- Electricity Meter Details: -

S. No.	18259357		
Class	0.2 Sec		
Calibration Date	04/09/2017	Validity	03/09/2022

4) Adoni Plant (20 TPD): -

- Weighbridge Details: -

S. No.	041		
MAX Capacity	40000 Kg		
Make	WEITRANS		
Model	Class III		
Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	06/02/2020	Validity	05/02/2021
Calibration Date	04/02/2021	Validity	04/02/2022

- Electricity Meter Details:

S. No.	X0773812		
Class	0.2 Sec		
Calibration Date	09/09/2019	Validity	08/09/2024