



WASTE TO ENERGY PROJECTS BY MAHINDRA WASTE TO ENERGY SOLUTIONS LIMITED



Project title	Waste to Energy Projects by Mahindra Waste to Energy Solutions Limited
Project ID	2093
Monitoring period	01-January-2022 to 30-November-2023
Original date of issue	19-July-2024
Most recent date of issue	18-August-2025
Version	12.1
VCS Standard Version	VCS Standard, v4.6
Prepared by	Infinite Environmental Solutions Limited

CONTENTS

PROJECT DETAILS	4
1.1 Summary Description of the Implementation Status of the Project	4
1.2 Audit History.....	5
1.3 Sectoral Scope and Project Type	5
1.4 Project Proponent	5
1.5 Other Entities Involved in the Project	6
1.6 Project Start Date	6
1.7 Project Crediting Period	6
1.8 Project Location	6
1.9 Title and Reference of Methodology	8
1.10 Double Counting and Participation under Other GHG Programs	8
1.11 Double Claiming, Other Forms of Credit, and Scope 3 Emissions.....	9
1.12 Sustainable Development Contributions	9
1.13 Commercially Sensitive Information.....	12
2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT	12
2.1 Stakeholder Engagement and Consultation.....	12
2.2 Risks to Stakeholders and the Environment.....	15
2.3 Respect for Human Rights and Equity	17
2.4 Ecosystem Health	18
3 IMPLEMENTATION STATUS.....	19
3.1 Implementation Status of the Project Activity	19
3.2 Deviations.....	24
3.3 Grouped Projects	34
3.4 Baseline Reassessment.....	34
4 DATA AND PARAMETERS.....	34
4.1 Data and Parameters Available at Validation	34
4.2 Data and Parameters Monitored.....	42
4.3 Monitoring Plan.....	53
5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS	54
5.1 Baseline Emissions	54

5.2	Project Emissions	60
5.3	Leakage Emissions	66
5.4	GHG Emission Reductions and Carbon Dioxide Removals	68
APPENDIX 1: COMMERCIALY SENSITIVE INFORMATION.....		74

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. Municipal Solid Waste (MSW) like food waste, cattle waste, vegetable and other organic wastes, energy and organic 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 and Composting is the natural process of recycling organic matter into a fertilizer that can enrich soil and plants.

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:

Table 1: Project capacity and location details

Sl. No.	Project Instance	Plant location	Technology	Capacity (TPD)	Usage	Commissioning Date
1	Mahindra Waste to Energy Solutions Limited	Aurangabad - Maharashtra	Bio Methanation and composting	30	CNG and organic manure Sale	01-May-2019
2		Tirupati - AP		40		01-September-2019
3		Piduguralla - AP		20		01-June-2019
4		Adoni - AP		20		01-March-2020

During the Current Monitoring Period from 01-January-2022 to 30-November-2023 (First and last date included) the project activity has contributed 23,089¹ tCO₂e GHG reductions.

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
<i>Validation + Verification</i>	01-May-2019 to 31-December-2020	Verified Carbon Standard	LGAI Technological Center, S.A. (Applus+)	1 Year, 08 Years
<i>Verification</i>	01-January-2021 to 31-December-2021	Verified Carbon Standard	TUV SUD South Asia Pvt. Ltd.	1 Year
<i>Verification</i>	01-January-2022 to 30-November-2023	Verified Carbon Standard	TUV SUD South Asia Pvt. Ltd.	1 Year, 11 Months
<i>Total</i>	03	Verified Carbon Standard	-	04 Years, 07 Months

1.3 Sectoral Scope and Project Type

Sectoral scope²	01
Project activity type	I - Renewable Energy Projects
Sectoral scope	13
Project activity type	Waste handling and disposal

1.4 Project Proponent

Organization name	Mahindra Waste to Energy Solutions Limited
Contact person	Mr. B. Gowdhaman
Title	Plant in charge
Address	Mahindra Towers, Dr. GM Bhosale Marg, Worli, Mumbai – 400018

¹ There was an error in selection of $F_{EC, default}$, calculation of project emission and Leakage emissions so this error impacts the previous two verifications and emission reduction calculations hence, the error part is now adjusted in 1st vintage i.e., 2022 so claimed emission reductions are 13,624 please refer section 5.4 for calculations.

² *Projects, activities, or methodologies may be developed under any of the 16 VCS sectoral scopes: <https://verra.org/programs/verified-carbon-standard/vcs-program-details/#sectoral-scopes>*

Telephone	-
Email	info@mahindra.com

1.5 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

1.6 Project Start Date

Project start date	01-May-2019
Justification	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.

1.7 Project Crediting Period

Crediting period	<input checked="" type="checkbox"/> Seven years, twice renewable <input type="checkbox"/> Ten years, fixed <input type="checkbox"/> Other (state the selected crediting period and justify how it conforms with the VCS Program requirements)
Start and end date of first or fixed crediting period	01-May-2019 to 30-April-2026

1.8 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.

Table 2: Project capacity and location and geocoordinates:

Project Instance No.	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

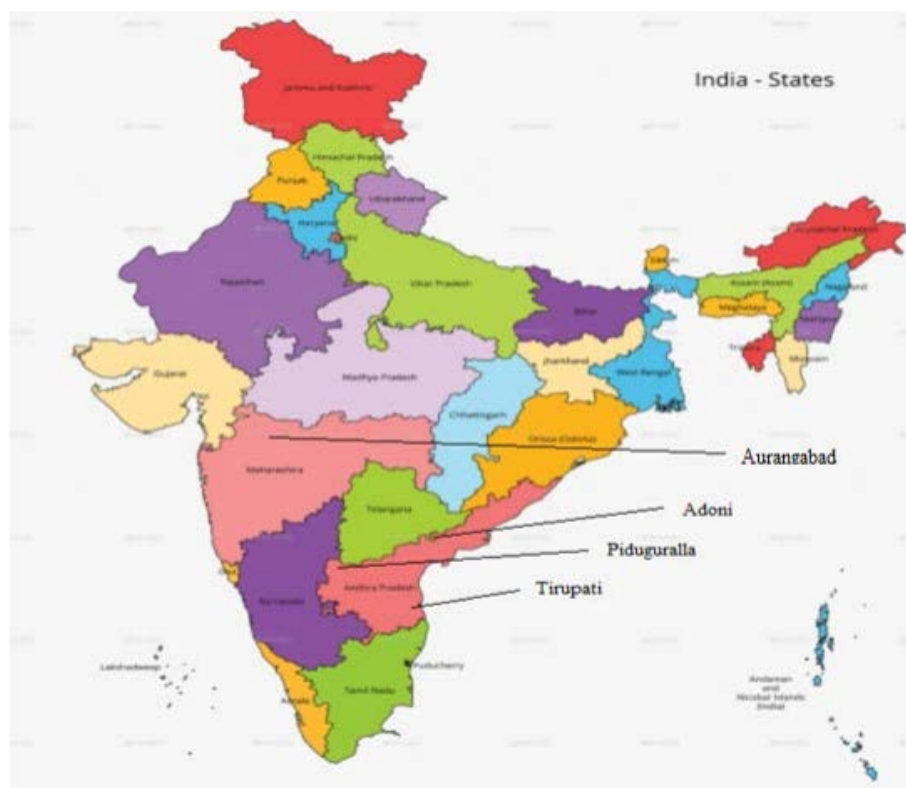


Figure 1: Project Location across the country

1.9 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	ACM0022	Alternative waste treatment processes	02.0 ³
Tool	Tool-03	Tool to calculate project or leakage CO2 emissions from fossil fuel combustion	03.0 ⁴
Tool	Tool-04	Emissions from solid waste disposal sites	08.0 ⁵
Tool	Tool-05	Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation	03.0 ⁶
Tool	Tool-14	Project and leakage emissions from anaerobic digesters	2.0 ⁷
Tool	Tool-13	Project and leakage emissions from composting	2.0 ⁸

1.10 Double Counting and Participation under Other GHG Programs

1.10.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

Yes No

1.10.2 Registration in Other GHG Programs

Is the project registered or seeking registration under any other GHG programs?

Yes No

³ CDM: Alternative waste treatment processes --- Version 2.0 (unfccc.int)

⁴ [am-tool-03-v3.pdf \(unfccc.int\)](#)

⁵ [am-tool-04-v8.0.pdf \(unfccc.int\)](#)

⁶ [am-tool-03-v3.pdf \(unfccc.int\)](#)

⁷ <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-14-v2.pdf>

⁸ <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-13-v2.pdf>

1.11 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.11.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

Yes No

1.11.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

Yes No

1.11.3 Supply Chain (Scope 3) Emissions

Do the project activities affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

Yes No

1.12 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 is provided 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, 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 is also contributing 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 Contributions⁹

Row number	SDG target	SDG indicator	Net impact on SDG indicator	Current project contributions	Contributions over project lifetime
1)	7.2.1	Renewable energy share in the total final energy consumption	Implemented activities to increase.	The project activity successfully produced 546.31 tons of Bio CNG ¹⁰ during the current monitoring period. Which is approximately 0.0237% ¹¹ of India's total Bio-CNG production ¹² .	The project activity produced 955.11 ¹³ tons of Bio CNG since commissioning.
2)	11.6.1	Proportion of solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities	Implemented activities to increase	The total quantity of raw waste treated in the project activity is 41,140.48 tons during the current monitoring period.	The total quantity of raw waste treated in the project activity is 78,879.48 ¹⁴ tons since commissioning.
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	The project has avoided emission of 13,624 tCO ₂ e in the atmosphere.	Since commissioning the project has avoided emissions of 48,118 ¹⁵ tCO ₂ e in the atmosphere.

⁹ SDG 7 and SDG 11 have been introduced in the current monitoring period, while SDG 13 was previously claimed in past verifications.

¹⁰ Bio-CNG, derived from organic waste via a process called anaerobic digestion, is a renewable energy.

¹¹ India's current Bio-CNG output is approximately 3.2 billion cubic meters per year (BCM/yr) (please refer footnote 11) to convert this volume to mass, considering that 1 cubic meter of Bio-CNG is roughly equivalent to 0.72 kilograms, the annual production translates to about 2.3 million tons Substituting the values: 546.31/2,300,000 ×100=0.0237%.

¹² https://www.worldbiogasassociation.org/wp-content/uploads/2023/12/FINAL_COUNTRY_REPORT.with-authors.pdf

¹³ 546.31 (For Current MP) +266.34 (For MP2) + 142.46 (For MP1) =955.11 tons of Bio CNG.

¹⁴ 41,140.48 (For Current MP) + 21,607 (For MP2) + 16,132 (For MP1) = 78,879.48 tons.

¹⁵ 12,833 (For MP1) +15,900 (For MP2) + 13,624 (For current MP) = 42,357 tCO₂e.

1.13 Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Stakeholder Identification	<p>Following stakeholders have been identified for this project activity</p> <ol style="list-style-type: none"> 1. Local community members 2. Local village administration 3. Technology suppliers 4. Employees
Legal or customary tenure/access rights	<p>There is no legal or customary tenure/access rights to territories and resources, including collective and conflicting rights, held by stakeholders, indigenous people (IPs), local communities (LCs), and customary rights holders. Not Applicable</p>
Stakeholder diversity and changes over time	<p>Based on the continuous interactions and ongoing communication with the stakeholders it is identified that the social, economic, and cultural diversity within stakeholder groups remained stable over time and there are no significant changes during the monitoring period.</p>
Expected changes in well-being	<p>Expected changes</p> <ol style="list-style-type: none"> 1. Economic well-being – The project activity is likely to provide employments to the locality thus economic well beings are expected.

	<p>2. Environmental well-being – Bio CNG generation is one of the cleanest renewable energies and does not involve any fossil fuel. There are no GHG emissions. The impact on land, water and air also, Bio-fertilizer is enhancing soil health and maintain natural fertility so it's a positive impact. Thus, the project activity contributes to environmental well-being without causing any negative impact on the surrounding environment.</p>
<p>Location of stakeholders</p>	<p>For Aurangabad site: Aurangabad Industrial Area, Maharashtra, India.</p> <p>For Tirupati site: Temple city, Tirupati Andhra Pradesh, India.</p> <p>For Piduguralla site: Piduguralla town, Guntur District Andhra Pradesh, India.</p> <p>For Adoni site: Adoni town, Kurnool District Andhra Pradesh, India.</p>
<p>Location of resources</p>	<p>All the resources and the territories associated with the project did not result in rehabilitation and resettlement. There is no settlement on the land acquired. Therefore, no territories and resources of stakeholders directly intersect with the project area.</p>

2.1.2 Stakeholder Consultation and Ongoing Communication

<p>Ongoing consultation</p>	<p>Stakeholders' consultation is a continuous process and hence a grievance register is kept at the site office of all the 4 sites where any stakeholder can come and share his/her feedback. The feedback irrespective of the type is taken care by PP with utmost priority.</p>
<p>Date(s) of stakeholder consultation</p>	<ol style="list-style-type: none"> 1. Aurangabad – 25-October-2018. 2. Tirupati – 14–November-2018. 3. Piduguralla – 19–December-2018. 4. Adoni – 08–July-2019.

<p>Communication of monitored results</p>	<p>The PP has communicated the monitoring data, information and results of the current monitoring period to the stockholders via mail on 15-January 2024, for all sites.</p>
<p>Consultation records</p>	<p>Process used to document the outcomes of a local stakeholder consultation, follow these four steps:</p> <ul style="list-style-type: none"> • Collect and Record Feedback: The meeting is conducted to gather stakeholder input, and ensure thorough documentation of comments, questions, and participant attendance. • Summarize Key Issues: Consolidate feedback to highlight main concerns, suggestions, and recurring themes, organizing these for clear interpretation. • Document Project Responses: Record the project team’s responses to feedback, including any adjustments made or justifications for unchanged aspects, along with actions taken to address concerns. • Compile and Share the Report: Create a report that details feedback, responses, and actions, making it accessible to stakeholders and archiving it for transparency and future reference.
<p>Stakeholder input</p>	<p>Stakeholders’ consultation is a continuous process and hence a grievance register is kept at the project site office where any stakeholder can come and share his/her feedback. The feedback irrespective of the type is taken care by PP with utmost priority.</p> <p>No grievance for the project activity has been identified during the current monitoring period.</p>

2.1.3 Free, Prior, and Informed Consent

<p>Consent</p>	<p>No property rights are impacted by the Project because the facility is leased and in line with state rules and regulations. There is no ongoing or unresolved conflict or dispute.</p>
<p>Outcome of FPIC</p>	<p>The Plant land lease documents with complete agreement between both the parties is in place.</p>

2.1.4 Grievance Redress Procedure

Grievances received	Resolution and outcome
Development process	Feedback register is kept at project site office where any stakeholder can come and register his/her feedback
Grievance redress procedure	<p>A grievance redress procedure is a formalized process through which individuals or employees can address complaints, concerns, or grievances they may have within an organization. Here's a typical mitigation mechanism:</p> <ul style="list-style-type: none"> • Submission of Grievance: The first step involves the individual formally submitting their grievance in the grievance register which is placed at entrance gate of the project. • Acknowledgment and Analysis: Upon receiving the grievance, the organization acknowledges receipt of the complaint and do the analyze that the grievance is genuine or not. • Resolution of Grievance: Based on the findings of the investigation, the organization works towards resolving the grievance. This could involve taking corrective actions, implementing changes in policies or procedures, providing compensation or restitution. • Documentation: Throughout the entire process, detailed documentation is maintained. This includes records of the grievance, investigation findings, actions taken. <p>Stakeholders' feedback is monitored daily and any grievance if found, resolved immediately</p>

2.1.5 Public Comments

Summary of comments received	Actions taken
No comments received	No comments received

2.2 Risks to Stakeholders and the Environment

	Risk identified	Mitigation or preventative measure taken
Risks to stakeholder participation	No risk identified	There is a transparent grievance mechanism is followed at all the site where any stockholder can put the grievance/ feedback.
Working conditions	Health and safety	Mahindra Waste to Energy Solutions Limited has initiated a customized training program for their engineers and plant operators. The above Program is started as part of the health and safety measures. Also, the PP is providing the good working conditions to work at site.
Safety of women and girls	No risk identified	Prevention of sexual harassment is ensured in the plant. Safety while commute is given importance for the female employees.
Safety of minority and marginalized groups, including children	No risk identified	The project activity is following Child Labour (Prohibition & Regulation) Act, 1986 prohibits employment of children.
Pollutants (air, noise, discharges to water, generation of waste, release of hazardous materials)	Noise & Fire	The Aspect Impact study for all environment issues were carried out. Significant impacts identified are noise and fire. The noise pollution during the construction of the project, is temporary and not significant. The noise from the compressor is less than 90 decibels and it is not running continuously. PPE is present and monitoring of abnormal noises is in place. Fire extinguishers and gas leak detectors are in place. Emergency preparedness plan is available and the personnel have been trained for the same. The project activity is waste to energy project so project is utilizing waste instead of generation of waste. The project activity is waste to energy project so there are no hazardous materials generation at site.

2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

Discrimination and sexual harassment	The project activity has No Discrimination Policy and following it strictly so no discrimination or sexual harassment has occurred.
Management experience	No new entity is involved in project design or implementation. The initially engaged management is experienced enough to handle the implementation of the project activity.
Gender equity in labor and work	PP provides equal opportunities in the context of gender equity and pay for labor and work and following No Discrimination Policy. Also, Women receive equal pay to men for similar roles at the project site.
Human trafficking, forced labor, and child labor	Project activity does not use victims of human trafficking, forced labor, and child labor and following Child Labour (Prohibition & Regulation) Act, 1986 prohibits employment of children.

2.3.2 Human Rights

The project activity is following anti-discrimination practices and follow the Human rights moral principles and PP prepared Anti-discrimination Policy before implementation of the project activity. Facility employees are hired and contracted without discrimination based on gender, race, caste, national origin, religion, age, disability, marital status, sexual orientation, cooperative membership, or political affiliation.

2.3.3 Indigenous Peoples and Cultural Heritage

PP is committed to protect regional as well as national cultural heritage and the project activity is not affecting the any regional or national cultural heritage.

2.3.4 Property Rights

Disputes over rights to territories and resources	<p>No property rights are impacted by the Project because the facility is leased and in line with Maharashtra and Andra Pradesh rules and regulations.</p> <p>The Maharashtra Agricultural Land Leasing Act, 2017¹⁶.</p>
--	---

¹⁶ https://prsindia.org/files/bills_acts/acts_states/maharashtra/2023/Act28of2023MH.pdf

	Andhra Pradesh Capital Region Development Authority Act, 2014 ¹⁷ . Mahindra and Mahindra are parent company and Mahindra Waste to Energy Solutions Limited is SPV hence, PP has the carbon rights.
Respect for property rights	Not Applicable

2.3.5 Benefit Sharing

Summary of the benefit sharing plan	Mahindra Waste to Energy Solutions Limited is legal owner of the project activity and PP has signed a contract with local body and there is no provision for benefit sharing hence, there is no benefit sharing hence the section is Not Applicable.
Benefit sharing during the monitoring period	Not Applicable.

2.4 Ecosystem Health

	Risk identified	Mitigation or preventative measure taken during the monitoring period
Impacts on biodiversity and ecosystems	No risk identified	The project has no impact on biodiversity and ecosystems because Waste recycling protects biodiversity by reducing pollution, habitat destruction, and resource extraction, fostering healthier, more resilient ecosystems.
Soil degradation and soil erosion	No risk identified	By avoiding solid waste in landfills, soil quality is improved in and around the state. This also degrading solid waste from leaching chemicals into soil. And the project activity is generation organic fertilizers and further it is used for soil and agriculture applications so they

¹⁷ https://www.indiacode.nic.in/bitstream/123456789/10534/1/crda_act%2C_2014.pdf

		are improving the soil structure by increased permeability, cation exchange capacity and aggregate stability, and a decreased bulk density.
Water consumption and stress	No risk identified	The outflow from the digestion is further reused. The wastewater is mixed with the organic waste in a mixing tank and sent again to the biodigester; thus, the water is not released to any natural water receiving body and no fresh water consumption at site.
Usage of fertilizers	No risk identified	The project activity is generation organic fertilizers and further it is used for soil and agriculture applications so there is no use of fertilizers at project activity.

2.4.1 Rare, Threatened, and Endangered species

Species or habitat	The project has not adversely impacted habitats for rare, threatened, or endangered species hence not applicable.
---------------------------	---

2.4.2 Introduction of species

The project activity is waste to energy project hence the section is not applicable.

Species introduced	Classification	Justification for use	Adverse effects and mitigation
Not applicable	Not applicable	Not applicable	Not applicable

2.4.3 Ecosystem conversion

The project activity is waste to energy project hence the section is not applicable.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project activity has been successfully commissioned by Mahindra Waste to Energy Solutions Limited 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.

Table 3: Project capacity and technology:

Sl. No.	Project Instance	Plant location	Technology	Commissioning dates	Installed Capacity (TPD)
1	Mahindra Waste to Energy Solutions Limited	Aurangabad - Maharashtra	Combination of Bio Methanation and Windrow composting	01-May-2019	30
2		Tirupati - AP		01- September-2019	40
3		Piduguralla - AP		01-June-2019	20
4		Adoni - AP		01-March-2020	20

The project activity involves the establishment of biogas generation using anaerobic digestion in various cities, municipal corporations to generate energy out of waste, thereby solving two major issues for the country. Anaerobic digestion is a complex, natural, multi-stage process of degradation of organic compounds through a variety of intermediates into methane and carbon dioxide, by the action of a consortium of microorganisms. Municipal Solid Waste (MSW) like food, fruit, vegetable waste and garden waste etc. are the raw Materials used for biogas production. The primary focus of the project is Bio-CNG generation; however, composting is also carried out using windrow composting technology whenever Bio-CNG demand is low. The steps involved in the windrow composting process are as follows:

Windrow Formation: Arrange the organic materials into long, narrow piles (windrows) of 3–5 feet in height and 12–16 feet in width. Maintain a balanced mix of carbon-rich and nitrogen-rich materials for efficient decomposition.

Moisture and Aeration Management: Keep the moisture content between 50–60% to support microbial activity. Turn the windrows regularly using machinery to introduce oxygen, prevent anaerobic conditions, and accelerate decomposition.

Temperature Monitoring and Pathogen Reduction: Monitor internal temperatures to ensure they reach 55–65 °C for at least 3–5 days. This helps kill pathogens and weed seeds, making the compost safe for agricultural use.

Maturation and Curing: Allow the compost to mature for 1–3 months, reducing turning frequency. This phase helps in stabilizing the compost and breaking down complex organic materials.

Screening and Quality Control: Pass the compost through screens to remove large, undecomposed particles. Test for pH, nutrient content, and contamination to ensure the final product meets quality standards.

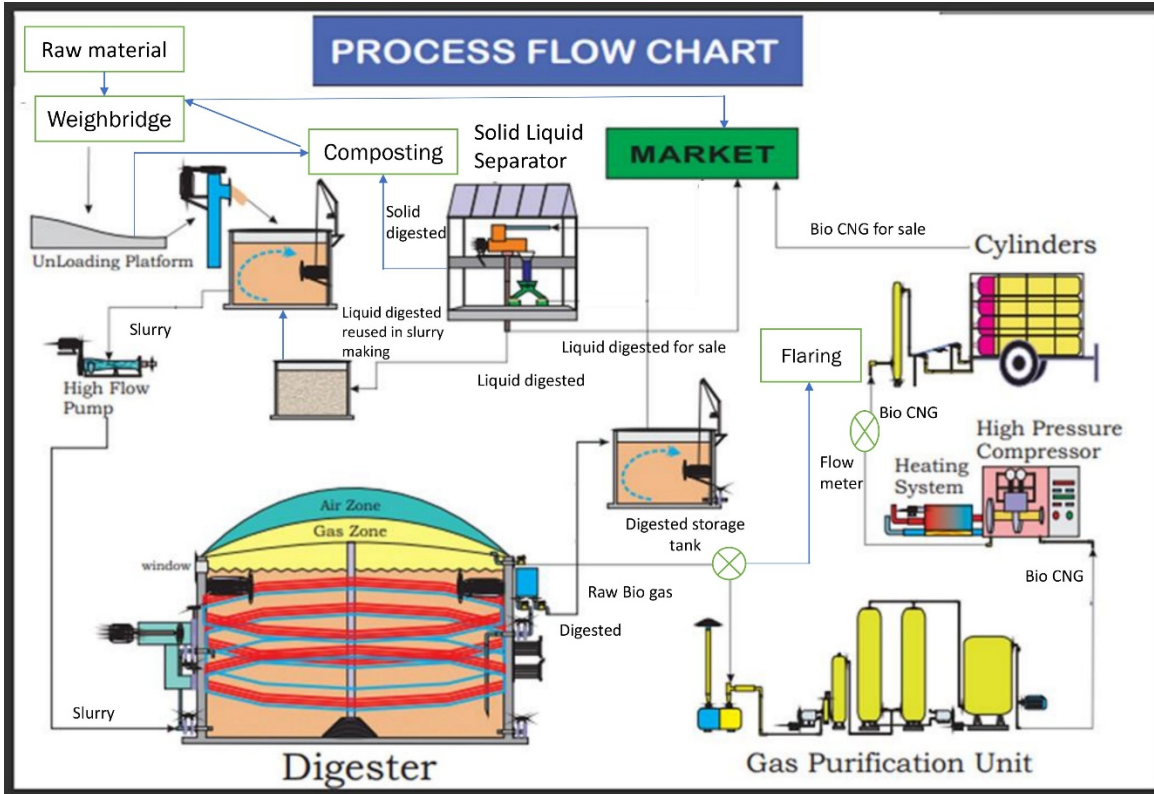


Figure 2: Process Flow chart of Bio methanation and composting plant

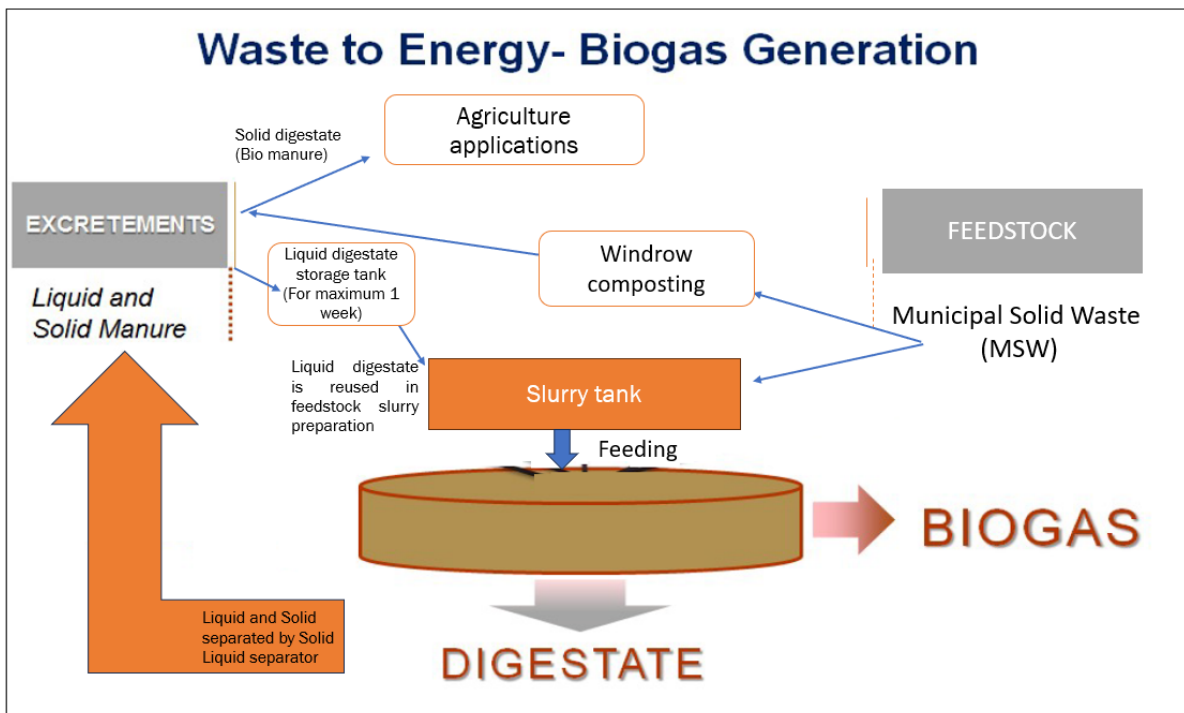


Figure 3: Line diagram of Bio methanation and composting plant

There are mainly two products produced from the plant. They are

1. Biogas
2. Organic/ Bio manure

Biogas plant slurry is an organic matter, and it has rich nutrition content. Thus, the slurry is de-watered, or it is mixed with waste to produce Organic manure/fertilizer for cultivation/horticulture. Manure is an excellent fertilizer containing nitrogen, phosphorus, potassium and other nutrients. It also adds organic matter to the soil which may improve soil structure, aeration, soil moisture-holding capacity, and water infiltration. Ever since agriculture has evolved, animal waste has been treated as a fertilizing element for the soil. The first step towards civilization was plantation and as time progressed, human beings developed new techniques of plantations and looked forward to improvising on the previous ones. It was a simple observation that the primitive man made, that led him to treat animal waste as manure.

Biogas generated is converted into bio methane with the help of two steps; a cleaning process to remove the trace components and an upgrading process to adjust the calorific value. Upgrading is generally performed in order to meet the standards for use as vehicle fuel or for injection in the natural gas grid. A number of techniques are available for the up gradation of biogas. These techniques include chemical absorption method, high pressure water scrubbing, pressure swing adsorption, cryogenic separation, and membrane separation method but the project is using chemical absorption method for biogas purification. The main equipment installed at Bio-Methanation Plant at all sites are:

Table 4: List of equipment for project:

List of equipment for project plant ¹⁸		
Sl. No.	Description	Qty/size
1	Feeding platform with shed for raw material feeding system	1 No.
2	Screw/ Feed conveyor for material handling.	2 Nos. each 3 ton/hr
3	Raw material grinder for grinding 20 tons/day	3 Nos, each 3 tons/hr
4	Water storage tank RCC	1 No.
5	Aerobic Feeding tank with agitators RCC	1 No.
6	Raw material feeding pump/ inlet system	1 No.
7	Anaerobic digester of RCC, with agitators and water sealing technology and FRP dome/balloon.	1 No.
8	Water recirculation tank of RCC	1 No.
9	Slurry collection tank of RCC	1 No.
10	Slurry de watering system	1 No.

¹⁸ The project activity has 4 sites and this list of equipment is same for all 4 sites.

11	Biogas balloon	1 No.
12	Biogas Purification system	1 Unit
13	Biogas Recovery system	1 Unit
14	Earth Mover	1 No.
15	Shredder machine	1 Nos, 1 ton/hr
16	Compost Sieving machine	1 Nos, 2 tons/hr
17	Biogas flow meter (Model - Burak/BA-800)	1 No.
18	Online monitoring system – digester PH, Temperature, gas CH ₄ , CO ₂ , H ₂ S, Moisture	1 No. each
19	Genset for back up	1 No., 125 kva
20	Control room	1 No.
21	Platform and Shed for purification system	1 No.
22	Manure storage yard	1 No.
23	Compost platform	2 No.
24	Diesel -Genet (Optional) 200KVA	1 No.
Additional equipment required for Bottling Plant along with equipment specified in Table 2		
26	HP Compressor	1 No.
27	Cascade cylinders	2100 kg storage capacity
28	Area for bottling plant	1 No.
Technical specification of flaring system (Model BF0500)		
29	Capacity	500 Nm ³ /hr
30	Height	6 m
31	Working Pressure	50 - 250 Bar
32	Voltage	220 VAC
33	Efficiency	90%

The project activity has been in operation continuously since its commissioning. During the present monitoring period i.e. 01-January-2022 to 30-November-2023 (Both days included), the project is in normal operation status; there have been no emergencies happened to the monitoring system. There are no events or situation that occurred during the monitoring period which may impact the applicability of the methodology.

Lifetime of the project activity

The operational life of the combination of Bio-methanation and composting project activity is 20 years based upon the standard operational and maintenance practices followed at site.

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

There are some project description deviations applied during the 2nd periodic verification (i.e., 01-January-2021 to 31-December-2021) of the project activity which are transparently described under this section of MR.

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 "tCH₄/t", the correct data unit is "tCO₂/t"¹⁹.

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 PDMR section 4.2, 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_{CH_4} '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 3.14 of VCS standard_V-4.1.

This is the 2nd periodic verification of the project and during this verification (i.e., 01-January-2021 to 31-December-2021), referring paragraph 3.14.4 of VCS standard (V-4.1), "For GHG emission reductions occurring on or after 1 January 2021, all ex-ante estimates and ex-post calculations shall be converted to CO₂e using GWP values from the IPCC Fifth Assessment Report (AR5). For GHG emission reductions occurring on or before 31 December 2020, all ex-ante

¹⁹ <https://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-13-v2.pdf>

estimates and ex-post calculations may be converted to CO₂e 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 28²⁰ 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.

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 (2nd) 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 (tCO ₂ e/year)
Estimated value as per Approved PD	$DOC_{f,y}$	0.9	47,359
As per deviation requested	$DOC_{f,y}$	0.5	25,440

Since this error was identified during the 2nd verification, the VCU_s issued in the 1st verification were overestimated. However, this overestimation has been identified in the current (3rd) verification, and the necessary adjustment has been incorporated in the current monitoring. The details are provided in Point 4 of Section 5.4 of the monitoring report.

5) Deviation 5:

In registered PD_{MR}, the accuracy class of Energy meters for Aurangabad Plant having meter Sr.No. - X1082365 and Tirupati Plant having meter Sr.No. - X0774356 is mentioned as 0.5s whereas as per calibration certificates it is 0.2s. It has been identified during the verification

²⁰ GWP_{CH4} = 27.2, GWP_{CH4} = 273 are used for calculation as per IPCC Sixth Assessment Report (AR6).

process and now it has been corrected. This deviation has neither an impact on additionality nor on the design of the project.

6) Deviation 6:

In registered PDMR, the values of Default factor for the electricity consumption associated with the anaerobic digester per ton of methane generated is considered 0 from Data / Parameter table 5 of tool 14 version 02.0 for Covered anaerobic lagoons (gravity fed) / conventional digesters instead of Conventional digesters with continuously stirred tank reactor type for wastewater so the value of $F_{EC, default}$ is 1.02 MWh/tCH₄ produced. It has been identified during the verification process and now it has been corrected. This error also impacts the previous verifications and emission reduction calculations and the hence, the error part is adjusted in current monitoring.

7) Deviation 7:

In Section 4.2 of the Joint PD-MR and in other parameters do not include provisions for composting. However, during the current and previous verification periods, there are times when the project is conducting composting instead of bio methanation. The provision of composting impact server aspects which are as follows:

Suitability of methodology:

As per Table 1. Methodology key elements of methodology ACM0022 version 2.0 “Composting process in aerobic conditions” is eligible to apply methodology ACM0022 so PP is using same methodology for composting as well as for Anaerobic digestion. Hence, Now the project is combination of the “Composting process in aerobic conditions” and “Anaerobic digestion with biogas collection and flaring and/or its use”.

Based on above justification we can conclude that the applied methodology is suitable.

Applicability conditions:

Since in JPD&MR the applicability is just justified based on Anaerobic digestion and now the project is a combination of Anaerobic digestion and Composting so the applicability conditions are as follows:

Applicability Criterion	Project Case
<p>Table 2 provides the applicability conditions that apply for each specific treatment option. In addition, the following general applicability conditions apply to all project activities using this methodology:</p> <p>(a) The project activity involves the construction of a new plant to implement one</p>	<p>The project case are as follows:</p> <p>a) This project activity is combination of anaerobic digestion and composting of the</p>

<p>or several of the alternative waste treatment options provided in Table 2 below;</p> <p>(b) In the project plant, except for the case of composting, co-composting and anaerobic digestion, only wastes for which emission reductions are claimed (fresh waste or wastewater) are processed. In the case of anaerobic digestion, only run-off wastewater may be processed in addition to fresh waste and wastewater;</p> <p>(c) Neither organic fresh waste nor products and by-products from the waste treatment plant established under the project activity are stored on-site under anaerobic conditions. For example, no organic materials are stored in a stockpile that is considered a SWDS;</p> <p>(d) Any run-off wastewater is treated within the project boundary;</p> <p>(e) The project does not reduce the amount of waste that would be recycled in the absence of the project activity. Detailed justifications shall be provided and documented in the clean development mechanism project design document (CDM-PDD) for demonstrating that the project activity does not reduce the amount of waste that would be recycled in the absence of the project activity.</p>	<p>organic fraction of municipal solid waste and biomass waste collected from door-to-door waste collecting vehicles.</p> <p>b) The project is combination of anaerobic digestion and composting but for composting there is no separate new construction has been done.</p> <p>c) Neither the organic fresh waste nor the product and by-product from the waste treatment plant are stored on-site under anaerobic conditions.</p> <p>d) No run-off wastewater is treated within project activity.</p> <p>e) The project does not reduce the amount of waste that would be recycled in the absence of the project activity.</p> <p>Hence, the project activity meets the given applicability criterion.</p>
<p>Finally, the methodology is only applicable if the procedure for the selection of the most plausible baseline scenario, as outlined below, results in that the baseline scenario is:</p> <p>(a) The disposal of the fresh waste in a SWDS with or without a partial LFG capture system (M2 or M3); and in this case, it shall be demonstrated that land is available to construct a new SWDS with a comparable annual waste acceptance rate and operating lifetime as the project activity;</p>	<p>The project case are as follows:</p> <p>a) The disposal of fresh waste in a SWDS is without an LFG capture system. Also, project activity is constructed in conjunction with the local municipality which have land for construction of SWDS.</p>

<p>(b) In the case of co-composting or the use of wastewater in an anaerobic digester: the treatment of organic wastewater in an existing or new to be built anaerobic lagoon or sludge pit without methane recovery (W1 or W4);</p> <p>(c) In the case that the project activity generates electricity: the electricity is generated in an existing/new captive fossil fuel fired power-only plant, captive cogeneration plant and/or in the grid (P2, P4 or P6);</p> <p>(d) In the case that the project activity generates heat and this displaces heat generation in the baseline: the heat is generated in an existing/new fossil fuel fired cogeneration plant, boiler or air heater (H2 or H4).</p>	<p>b) The project is doing composting of MSW and there is no involvement of co-composting in the project activity.</p> <p>c) These project activity does not generate electricity.</p> <p>d) These project activity does not generate electricity.</p>
<p>Under this methodology, emission reductions can only be claimed for the baseline scenarios indicated above. If project participants wish to claim emission reductions from the use of the products or by-products in other activities than those specified above, then they may request registration for a separate project activity, applying a relevant methodology.</p>	<p>The emission reduction is claimed only for the baseline scenarios that is treatment of MSW, the project activity doesn't claim emission reductions from the use of product or by-products.</p>
<p>In addition, in the particular case where heat is generated from combustion of a product or by-product from the waste treatment options and used in the cement industry, the emission reductions for this use shall not be claimed under this methodology but in a separate project activity, applying the relevant methodology (e.g. "ACM0003: Partial substitution of fossil fuels in cement or quicklime manufacture").</p>	<p>Not applicable for the project activity.</p>
<p>Note that in the case that applicable laws or regulations require the use of the waste treatment option(s) implemented under the</p>	<p>The Union Ministry of Environment, Forests and Climate Change (MoEF&CC) notified the new Solid Waste Management Rules (SWM),</p>

<p>project activity, the compliance rate of such laws and regulations should be below 50 per cent in the period for which issuance of CERs is requested in order to claim emission reductions for that period.</p>	<p>2016 which only advised the processing of bio-degradable waste. The various technological construction are solely initiatives by Municipal Corporation.</p>
--	--

Additionality: In the JPD&MR, additionality is demonstrated through Investment Analysis, specifically via Internal Rate of Return (IRR) calculations. The analysis includes six sensitivity parameters that influence IRR. The implications of incorporating composting into the project and the impact of these sensitivity parameters are as follows:

- **Biogas CNG Production:** This parameter contributes to revenue generation. Since the project involves composting instead of anaerobic digestion or biogas CNG production, there is a revenue loss. As a result, IRR will not increase due to this parameter.
- **Organic Manure Production:** This parameter contributes to revenue generation; the production of organic manure remains approximately the same in both anaerobic digestion and composting. Therefore, this parameter does not impact IRR.
- **O&M:** This parameter represents an expense. Composting has 47.61% lower O&M costs than anaerobic digestion²¹. However, the variation required to reach the benchmark IRR is 96.68% (approximately twice the reduction in costs). Thus, IRR will not reach the benchmark due to this parameter.
- **Project Cost:** Since the project is already commissioned and operational, and composting is conducted using the existing setup, there is no change in project costs. Therefore, this parameter does not affect IRR.
- **Selling Price of CNG:** This parameter influences revenue generation. As the project is based on composting rather than anaerobic digestion or CNG production, this results in revenue loss. Consequently, IRR will not increase due to this parameter.
- **Selling Price of Organic Manure:** Similar to the Organic Manure Production parameter, the selling price of organic manure remains comparable in both anaerobic digestion and composting. As a result, this parameter does not impact IRR.

In summary, the sensitivity analysis confirms that transitioning to composting does not enhance IRR beyond the benchmark.

Emissions reductions:

For Baseline emissions of methane from the SWDS the applied methodology ACM0022 version 2.0 references Tool 04: Emissions from Solid Waste Disposal Sites. As per Tool 04, baseline emissions are based on the methane emissions that would occur from the SWDS in the absence of the project activity. Therefore, the baseline emissions for both composting and bio

²¹ <https://pubmed.ncbi.nlm.nih.gov/30803595/>

methanation are same but the project emissions associated with composting is not considered in joint PD&MR so in current monitoring period the project emissions are considered as per section 5.4.1. Project emissions from composting or co-composting ($PE_{COMP,y}$). As per section 5.4.1. Project emissions associated with composting or co-composting ($PE_{COMP,y}$) are calculated according to the methodological tool 13 “Project and leakage emissions from composting”.

As per para 13 of tool 13 The project emissions from composting are determined as follows:

$$PE_{COMP,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{N_2O,y} + PE_{RO,y}$$

Where:

- $PE_{COMP,y}$ = Project emissions associated with composting in year y (t CO₂e/yr)
- $PE_{EC,y}$ = Project emissions from electricity consumption associated with composting in year y (t CO₂/yr)
- $PE_{FC,y}$ = Project emissions from fossil fuel consumption associated with composting in year y (t CO₂/yr)
- $PE_{CH_4,y}$ = Project emissions of methane from the composting process in year y (t CO₂e/yr)
- $PE_{N_2O,y}$ = Project emissions of nitrous oxide from the composting process in year y (t CO₂e/yr)
- $PE_{RO,y}$ = Project emissions of methane from run-off wastewater associated with co-composting in year y (t CO₂e/y)

As per para 14 of tool 13 version 02.0 “The quantity of waste composted is a parameter required in the determination of emissions associated with each source of project emissions. There are two options to determine the quantity of waste composted in year y (Q_y). In case of co-composting, wastewater is not accounted for in the estimation of Q_y .”

So, there are two options that are:

- Option 1:** Procedure using a weighing device.
- Option 2:** Procedure without using a weighing device.

So, Option 1: Procedure using a weighing device is opted which states that “Monitor the weight of waste delivered to the composting installation using an on-site weighbridge.

As per section 6.1.2. Determination of project emissions from electricity consumption ($PE_{EC,y}$), Since, separate monitored data for electricity consumption for composting is not available, then electricity consumption from composting ($EC_{PJ,comp,y}$) may be determined based on a default value for the specific quantity of electricity consumed per tonne of waste composted ($SEC_{comp,default}$) is considered and the formula for the same is as follows:

$$EC_{PJ,comp,y} = Q_y \times SEC_{comp,default}$$

Where:

- $EC_{PJ,comp,y}$ = Quantity of electricity consumed for composting in year y (MWh/yr)
 Q_y = Quantity of waste composted in year y (t/yr)
 $SEC_{comp,default}$ = Default value for the specific quantity of electricity consumed per tonne of waste composted (MWh/t)

As per para 18 of tool 13 version 02.0 “Note that the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” hence, $PE_{EC,y}$ shall be calculated using the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation.

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$$

Where:

- $PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO₂ / yr)
 $EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
 $EF_{EF,j,y}$ = Emission factor for electricity generation for source j in year y (t CO₂/MWh)
 $TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

As per 6.1.3. Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$): Where the composting activity involves fossil fuel consumption, project participants may choose between the following two options to calculate $PE_{FC,y}$:

Option 1: Procedure using monitored data

Option 2: Procedure using a default value.

Since, separate monitored data for consumption of fossil fuel for composting is not available hence, Option 2: Procedure using a default value is opted.

As per para 21 of the tool 13 Project emissions from fossil fuel consumption associated with composting are calculated as follows:

$$PE_{FC,y} = Q_y \times EF_{FC,default}$$

Where:

- $PE_{FC,y}$ = Project emissions from fossil fuel consumption associated with composting in year y (t CO₂ / yr)
- Q_y = Quantity of waste composted in year y (t/yr)
- $EF_{FC,default}$ = Default emission factor for fossil fuels consumed by the composting activity per tonne of waste (t CO₂/t)

As per para 22 of the tool 13 Project emissions of methane from composting are determined as follows:

$$PE_{CH_4,y} = Q_y \times EF_{CH_4,y} \times GWP_{CH_4}$$

Where:

- $PE_{CH_4,y}$ = Project emissions of methane from the composting process in year y (t CO_{2e} / yr)
- Q_y = Quantity of waste composted in year y (t/yr)
- $EF_{CH_4,y}$ = Emission factor of methane per tonne of waste composted valid for year y (t CH₄ / t)
- GWP_{CH_4} = Global Warming Potential of CH₄ (t CO_{2e} / t CH₄)

As per para 23 of the tool 13 There are two options which project participants may choose for determining $EF_{CH_4,y}$:

Option 1: Procedure using monitored data

Option 2: Procedure using default values.

So, the PP has opted Option 2: Procedure using default values.

As per para 25 of the tool 13, A default value is used: $EF_{CH_4,y} = EF_{CH_4,default}$. The default value is provided in the “Data and parameters not monitored” section of this tool (tool 13).

As per para 26 of the tool 13 Project emissions of nitrous oxide from composting are determined as follows:

$$PE_{N_2O,y} = Q_y \times EF_{N_2O,y} \times GWP_{N_2O}$$

Where:

- $PE_{N_2O,y}$ = Project emissions of nitrous oxide from composting in year y (t CO_{2e}/yr)
- Q_y = Quantity of waste composted in year y (t/yr)
- $EF_{N_2O,y}$ = Emission factor of nitrous oxide per tonne of waste composted valid for year y (t N₂O/t)
- GWP_{N_2O} = Global Warming Potential of N₂O (t CO_{2e}/t N₂O)

As per para 27 of the tool 13 There are two options which project participants may choose for determining $EF_{N2O,y}$:

Option 1: Procedure using monitored data

Option 2: Procedure using default values.

So, the PP has opted Option 2: Procedure using default values. As per para 29 of the tool 13, A default value is used: $EF_{N2O,y} = EF_{N2O,default}$. The default value is provided in the “Data and parameters not monitored” section of this tool (tool 13).

As per section 6.1.6. Determination of project emissions from run-off wastewater ($PE_{RO,y}$) of tool 13 Project emissions of methane from run-off wastewater ($PE_{RO,y}$) are calculated only for the case of co-composting. Since the project is not doing any co-composting hence, $PE_{RO,y}$ is not applicable. Hence,

$$PE_{RO,y} = 0$$

This deviation does not affect the applicability of the methodology, the project's additionality, or the emission reductions achieved.

Previous verifications:

Since composting activities were also included in the previous verifications, the project emissions associated with composting from that period have been calculated and adjusted accordingly in the current monitoring. Please refer to Section 5.4 of this report for detailed calculations.

Subsequent verifications:

In subsequent verifications, the project will account for emissions associated with composting using the methodology and calculations outlined in this deviation.

8) Deviation 8:

In Section 5.3 of the Joint PD-MR it is states that the storage lagoon is not un-aerated, leakage emissions are considered to be zero. However, there is no lagoon at the project site. The liquid digestate is stored in an open tank and reused for feedstock slurry preparation on daily basis the maximum duration of storage of liquid digestate is one week. So now, the leakage emissions associated with its storage are calculated in accordance with Section 6.2.1 of Methodological Tool 14: Project and Leakage Emissions from Anaerobic Digesters.

The value of $F_{ww,CH_4,default}$ is considered form Methodological Tool 14, based on type of the digester as per para 11 (b) of tool 14, the project digester is “Conventional digesters” type hence, the value of $F_{ww,CH_4,default}$ is 0.20 is considered for calculations.

For this calculation, the relevant parameter $F_{ww,CH_4,default}$ is incorporated in section 4.2 of the MR. Since this correction affects previous verifications and emission reduction calculations, the error has been adjusted in the current monitoring.

3.3 Grouped Projects

The project is a grouped project activity by Mahindra Waste to Energy Solutions Limited and no new project activity instances is added during this monitoring period the details of Project capacity and location details for all the project instances are as follows:

Table 5: Project capacity and location details

S. No	Project Instance	Plant location	Technology	Capacity (TPD)	Usage	Commissioning Date
1	Mahindra Waste to Energy Solutions Limited	Aurangabad - Maharashtra	Bio Methanation and composting	30	CNG and Organic manure Sale	01-May-2019
2		Tirupati - AP		40		01-September-2019
3		Piduguralla - AP		20		01-June-2019
4		Adoni - AP		20		01-March-2020

3.4 Baseline Reassessment

Did the project undergo baseline reassessment during the monitoring period?

Yes No

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter table 1

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 are 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 table 2

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 table 3

Data / Parameter	DOC _j
Data unit	-
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.15
Justification of choice of data or description of measurement methods and procedures applied	The value is considered from tool 04, Data / Parameter table 6 for Food, food waste, beverages and tobacco (other than sludge). IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
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 table 4

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 table 5

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 table 6

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 table 7

Data / Parameter	k _i
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 table 8

Data / Parameter	GWP _{CH4}
Data unit	t CO ₂ e/t CH ₄
Description	Global Warming Potential of methane
Source of data	IPCC Fifth Assessment Report
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 table 9

Data / Parameter	f _y
Data unit	tCO ₂ e/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	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

measurement methods and procedures applied	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	-

Data / Parameter table 10

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 table 11

Data / Parameter	$EF_{FC, default}$
Data unit	t CO ₂ / t
Description	Default emission factor for fossil fuel consumed by the Bio-methanation 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 table 12

Data / Parameter	$f_{CH_4, default}$
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 table 13

Data / Parameter	ρ_{CH_4}
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 table 14

Data / Parameter	$EF_{CH_4, default}$
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 table 15

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 table 16

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	-

Data / Parameter table 17

Data / Parameter	$F_{EC, default}$
Data unit	MWh/ tCH ₄ produced
Description	Default factor for the electricity consumption associated with the anaerobic digester per ton of CH ₄ generated
Source of data	The values were derived based on a review of registered CDM projects, other projects using digesters and reference books (Metcalf & Eddy, 2003; and for solid waste Sri Bala et al., 2009) 1.02 - Conventional digesters with continuously stirred tank reactor type for wastewater;
Value applied:	1.02
Justification of choice of data or description of measurement methods and procedures applied	As per tool 14 version 02.0 default value for Covered anaerobic lagoons (gravity fed) / conventional digesters instead of Conventional digesters with continuously stirred tank reactor type for wastewater so the value of $F_{EC, default}$ is 1.02 MWh/tCH ₄ is considered.
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter table 18

Data / Parameter	$EF_{FC, default}$
Data unit	tCO ₂ / t
Description	Default emission factor for fossil fuel consumed by the composting activity per tonne of waste composted
Source of data	Tool 13, Project and leakage emission from composting, Version 2.0, EB 96, Annex 6 (Data / Parameter table 5)
Value applied:	0.0207
Justification of choice of data or description of measurement methods and procedures applied	Option 2 is opted to Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$)

Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter table 19

Data / Parameter	EF _{CH4,default}
Data unit	t CH ₄ / t
Description	Default emission factor of methane per tonne of waste composted
Source of data	<p>The emission factor was selected based on studying published results of emission measurements from composting facilities, literature reviews on the subject and published emission factors. Data from recent, high-quality sources was analyzed and a value conservatively selected from the higher end of the range in results.</p> <p>Tool 13, Project and leakage emission from composting, Version 2.0, EB 96, Annex 6 (Data / Parameter table 2)</p>
Value applied:	0.002
Justification of choice of data or description of measurement methods and procedures applied	Option 2 is opted to Determination of methane and nitrous oxide emissions from the composting process.
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter table 20

Data / Parameter	EF _{N2O,default}
Data unit	t N ₂ O / t
Description	Default emission factor of nitrous oxide per tonne of waste composted
Source of data	<p>The emission factor was selected based on studying published results of emission measurements from composting facilities, literature reviews on the subject and published emission factors. Data from recent, high-quality</p>

	sources was analyzed and a value conservatively selected from the higher end of the range in results. Tool 13, Project and leakage emission from composting, Version 2.0, EB 96, Annex 6 (Data / Parameter table 3)
Value applied:	0.0002
Justification of choice of data or description of measurement methods and procedures applied	Option 2 is opted to Determination of methane and nitrous oxide emissions from the composting process.
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter table 21

Data / Parameter	SEC _{comp,default}
Data unit	MWh / t
Description	Default value for the specific quantity of electricity consumed per tonne of waste composted
Source of data	Based on a review of information from relevant validation reports of CDM projects. Tool 13, Project and leakage emission from composting, Version 2.0, EB 96, Annex 6 (Data / Parameter table 4)
Value applied:	0.01
Justification of choice of data or description of measurement methods and procedures applied	Applicable to Determination of project emissions from electricity consumption.
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter table 22

Data / Parameter	TDL _{j,y}
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data	Tool 05 Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Data / Parameter table 3).
Value applied:	20%
Justification of choice of data or description of measurement methods and procedures applied	Use as default values of 20% for project or leakage electricity consumption sources.
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter table 23

Data / Parameter	GWP _{N20}
Data unit	t CO ₂ e / tN ₂ O
Description	Global Warming Potential of N ₂ O
Source of data	IPCC Fifth Assessment Report
Value applied:	265
Justification of choice of data or description of measurement methods and procedures applied	Standard for application of the global warming potentials to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto protocol
Purpose of Data	Calculation of Project Emission
Comments	-

Data / Parameter table 24

Data / Parameter	$F_{ww,CH4,default}$
Data unit	Fraction
Description	Default factor representing the remaining CH4 production capacity of liquid digestate
Source of data	Methodological tool 14: Project and leakage emissions from anaerobic digesters, Data / Parameter table 8.
Value applied:	0.20
Justification of choice of data or description of measurement methods and procedures applied	As per para 11 (b) of tool 14 definition and types of Anaerobic digester the type of the project digester is Conventional digesters type. Hence the value is considered from Data / Parameter table 8 of Tool 14, 0.20: Conventional digesters;
Purpose of Data	Calculation of Leakage Emission
Comments	Conventional digesters is type of the digester as per para 11 (b) of tool 14.

4.2 Data and Parameters Monitored

Data / Parameter table 25

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 treated is measured using electronic weighbridge regularly and records are kept on paper and electronically.
Frequency of monitoring/recording	monitored continuously and consolidated monthly

Value applied:	<table border="1"> <thead> <tr> <th>Plant location</th> <th>Total amount of organic waste prevented (in T)</th> </tr> </thead> <tbody> <tr> <td>Aurangabad - MH</td> <td>11,241.39</td> </tr> <tr> <td>Tirupati – AP</td> <td>11,492.94</td> </tr> <tr> <td>Piduguralla – AP</td> <td>9,606.27</td> </tr> <tr> <td>Adoni - AP</td> <td>8,799.88</td> </tr> <tr> <td>Total</td> <td>41,140.48</td> </tr> </tbody> </table>	Plant location	Total amount of organic waste prevented (in T)	Aurangabad - MH	11,241.39	Tirupati – AP	11,492.94	Piduguralla – AP	9,606.27	Adoni - AP	8,799.88	Total	41,140.48
	Plant location	Total amount of organic waste prevented (in T)											
	Aurangabad - MH	11,241.39											
	Tirupati – AP	11,492.94											
	Piduguralla – AP	9,606.27											
	Adoni - AP	8,799.88											
Total	41,140.48												
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 calibrated annually ²² .												
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	<p>The data would be archived electronically and maintained for the entire crediting period plus two years.</p> <p>There are 4 sites in the project activity. Out of the 4 sites, Aurangabad site is collecting organic fraction as well as other types of municipal solid waste. Another 3 sites are only collecting and treating organic fraction.</p> <p>The weight of all type of waste is measured using the same weighbridge available at individual site, please refer appendix 2 for more information of weighbridge.</p>												

Data / Parameter table 26

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) ²³ .

²² The Details has been provided in Appendix 2.

²³ https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf

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:	49.96%
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

Data / Parameter table 27

Data / Parameter	EC _{P,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.
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:	1,793.74

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 ²⁴
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 table 28

Data / Parameter	Q _y													
Data unit	T/yr													
Description	Quantity of waste composted in year y (wet basis)													
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	monitored continuously and consolidated monthly													
Value applied:	<table border="1"> <thead> <tr> <th>Plant location</th> <th>Quantity of waste (in T)</th> </tr> </thead> <tbody> <tr> <td>Aurangabad - MH</td> <td>3,852.22</td> </tr> <tr> <td>Tirupati - AP</td> <td>0.00</td> </tr> <tr> <td>Piduguralla - AP</td> <td>7,770.36</td> </tr> <tr> <td>Adoni - AP</td> <td>8,630.91</td> </tr> <tr> <td>Total</td> <td>20,253.49</td> </tr> </tbody> </table>	Plant location	Quantity of waste (in T)	Aurangabad - MH	3,852.22	Tirupati - AP	0.00	Piduguralla - AP	7,770.36	Adoni - AP	8,630.91	Total	20,253.49	
Plant location	Quantity of waste (in T)													
Aurangabad - MH	3,852.22													
Tirupati - AP	0.00													
Piduguralla - AP	7,770.36													
Adoni - AP	8,630.91													
Total	20,253.49													
Monitoring equipment	Weighbridge													

²⁴ http://www.aegcl.co.in/Metering_Regulations_Of_CEA_17_03_2006.pdf

QA/QC procedures applied	Regular weighing of Quantity of waste composted by project proponent will be carried out in a weighbridge according to Monitoring plan. The weigh bridge would be calibrated annually ²⁵ .
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. The weight of waste and Quantity of compost are measured using the same weighbridge available at individual site, please refer appendix 2 for more information of weighbridge.

Data / Parameter table 29

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:	<table border="1"> <thead> <tr> <th>Plant location</th> <th>Amount of biogas (in Nm³)</th> </tr> </thead> <tbody> <tr> <td>Aurangabad - MH</td> <td>548,585.00</td> </tr> <tr> <td>Tirupati - AP</td> <td>661,740.00</td> </tr> <tr> <td>Piduguralla - AP</td> <td>139,459.00</td> </tr> <tr> <td>Adoni - AP</td> <td>12,614.00</td> </tr> <tr> <td>Total</td> <td>1,362,398 Nm³</td> </tr> </tbody> </table>	Plant location	Amount of biogas (in Nm ³)	Aurangabad - MH	548,585.00	Tirupati - AP	661,740.00	Piduguralla - AP	139,459.00	Adoni - AP	12,614.00	Total	1,362,398 Nm³	
Plant location	Amount of biogas (in Nm ³)													
Aurangabad - MH	548,585.00													
Tirupati - AP	661,740.00													
Piduguralla - AP	139,459.00													
Adoni - AP	12,614.00													
Total	1,362,398 Nm³													
Monitoring equipment	Flow meter													

²⁵ The Details has been provided in Appendix 2.

QA/QC procedures applied	The flow meter is calibrated ones in the year and the calibration details are provided in the appendix 2 of this report.
Purpose of data	Calculation of Project Emission
Calculation method	The parameter is measured parameter hence calculation method is not applicable.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter table 30

Data / Parameter	FC _{diesel,Bio-mathanation,y}
Data unit	volume (m ³ /yr)
Description	Quantity of diesel combusted in Bio-methanation and composting process during the year y
Source of data	Onsite Logbook and invoices of purchase
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
Monitoring equipment	NA
QA/QC procedures applied	The 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. There is no use of diesel hence the invoices are not available.

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 is 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 is 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 is 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
	<p>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:</p> <ul style="list-style-type: none"> 1.1 Electricity consumption for equipment used on site. Data is collected from electricity meter installed by state electricity board (a kWh-instrument). 2.1 Fuel consumption for equipment used on site. Data is 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 is 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 is 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 (tCO₂e)

BE_y = Baseline Emission in year y (tCO₂e)

PE_y = Project Emission in the year y (tCO₂e)

LE_y = Leakage Emission in Year y (tCO₂e)

Also,

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

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

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

$BE_{\text{Bio-Methanation, y}}$ = Baseline Emissions in year y (tCO₂e) from Bio-methanation.

$PE_{\text{Bio-Methanation, y}}$ = Project Emissions in the year y (tCO₂e) from Bio-Methanation.

$LE_{\text{Bio-Methanation, y}}$ = Leakage Emissions in year y (tCO₂e) 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:

$$BE_{Bio-methanation,y} = \sum (BE_{CH_4,t,y} + BE_{WW,y} + BE_{EN,t,y} + BE_{NG,t,y}) \times DF_{RATE,t,y}$$

With:

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

Where,

- $BE_{Bio-methanation,y}$** = Baseline Emissions in year y (tCO₂e) from Bio-Methanation project activity
- $BE_{CH_4,t,y}$** = Baseline emissions of methane from the SWDS in year y (t CO₂e)
- $BE_{WW,y}$** = 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 CO₂e)
- $BE_{EN,t,y}$** = Baseline emissions associated with energy generation in year y (tCO₂e)
- $BE_{NG,t,y}$** = Baseline emissions associated with natural gas use in year y (t CO₂e)
- $DF_{RATE,t,y}$** = 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 ($BE_{CH_4,t,y}$) 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

$$BE_{CH_4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH_4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^y \sum_j (W_{j,i} \times DOC_j \times e^{(-k_j \times (y-x))} \times (1 - e^{-k_j}))$$

Where,

- $BE_{CH_4, SWDS, y}$** = Baseline methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (t CO₂e/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
- DOC_j = 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-6: 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-7: The monitoring data values used in the calculation of baseline emissions of Aurangabad

S. No.	Month	Monthly Qty of Municipal Solid waste treated	Amount of Bio Gas collected (Nm ³)	Monthly Qty of Bio CNG (In Ton)	Monthly Qty of Compost (In Ton)	Monthly Diesel Consumption (In Ltr.)

		(In Ton)				
1	Jan-22	478.689	24,876.00	10.00	5.00	0.00
2	Feb-22	434.23	24,876.00	10.00	10.00	0.00
3	Mar-22	512.79	24,876.00	10.00	10.00	0.00
4	Apr-22	442.56	20,398.00	8.00	15.00	0.00
5	May-22	581.86	21,072.00	8.00	10.00	0.00
6	Jun-22	524.74	24,876.00	10.00	15.00	0.00
7	Jul-22	560.35	24,900.00	10.00	10.00	0.00
8	Aug-22	702.39	26,134.00	11.00	13.00	0.00
9	Sep-22	388.68	24,876.00	10.00	13.00	0.00
10	Oct-22	584.54	19,900.00	8.00	13.00	0.00
11	Nov-22	599.29	24,915.00	10.00	13.00	0.00
12	Dec-22	689.35	25,331.00	10.00	13.00	0.00
13	Jan-23	560.80	25,122.00	10.10	13.00	0.00
14	Feb-23	612.88	27,453.00	11.04	13.00	0.00
15	Mar-23	566.60	24,878.00	10.00	49.00	0.00
16	Apr-23	500.69	27,363.00	11.00	13.00	0.00
17	May-23	372.03	24,878.00	10.00	55.00	0.00
18	Jun-23	369.94	23,241.00	9.34	95.50	0.00
19	Jul-23	350.74	24,898.00	10.01	42.85	0.00
20	Aug-23	375.87	22,388.00	9.00	91.00	0.00
21	Sep-23	333.99	22,388.00	9.00	30.05	0.00
22	Oct-23	369.10	20,289.00	8.16	92.00	0.00
23	Nov-23	329.28	18,657.00	7.50	35.00	0.00
Total		11,241.39	548,585.00	220.15	669.40	0.00

Table-8: 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 ²⁶ (Nm ³)	Monthly Qty of Bio CNG (In T)	Monthly Qty of Compost (In Ton)	Monthly Diesel Consumption (In Ltr.)
1	Jan-22	352.41	2,488.00	1.00	70.00	0.00
2	Feb-22	313.00	2,488.00	1.00	70.00	0.00
3	Mar-22	342.51	2,488.00	1.00	70.00	0.00
4	Apr-22	357.22	1,741.00	0.70	70.00	0.00

²⁶ In some of the months Amount of Bio Gas is zero due to the less demands of the CBG the PP is doing composting and treating the waste. As the project baseline is treatment of fresh waste which is same.

5	May-22	322.32	2,488.00	1.00	75.00	0.00
6	Jun-22	347.04	498.00	0.20	75.00	0.00
7	Jul-22	352.56	398.00	0.16	81.00	0.00
8	Aug-22	342.06	25.00	0.01	80.00	0.00
9	Sep-22	341.15	0.00	0.00	120.00	0.00
10	Oct-22	421.20	0.00	0.00	121.00	0.00
11	Nov-22	424.25	0.00	0.00	120.00	0.00
12	Dec-22	449.56	0.00	0.00	120.00	0.00
13	Jan-23	402.20	0.00	0.00	135.15	0.00
14	Feb-23	344.09	0.00	0.00	125.22	0.00
15	Mar-23	368.72	0.00	0.00	144.12	0.00
16	Apr-23	371.69	0.00	0.00	123.51	0.00
17	May-23	349.47	0.00	0.00	120.10	0.00
18	Jun-23	392.32	0.00	0.00	125.58	0.00
19	Jul-23	465.93	0.00	0.00	125.30	0.00
20	Aug-23	435.85	0.00	0.00	120.21	0.00
21	Sep-23	418.07	0.00	0.00	125.99	0.00
22	Oct-23	452.11	0.00	0.00	120.24	0.00
23	Nov-23	434.15	0.00	0.00	125.11	0.00
Total		8,799.88	12,614.00	5.07	2,462.53	0.00

Table-9: 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 Diesel Consumption (In Ltr.)
1	Jan-22	385.39	20,381.00	8.19	0.00	0.00
2	Feb-22	324.53	15,423.00	6.20	10.00	0.00
3	Mar-22	335.99	17,413.00	7.00	25.00	0.00
4	Apr-22	511.70	24,876.00	10.00	0.00	0.00
5	May-22	877.75	24,876.00	10.00	0.00	0.00
6	Jun-22	1,104.90	31,095.00	12.50	18.00	0.00
7	Jul-22	962.28	34,826.00	14.00	16.00	0.00
8	Aug-22	625.10	27,363.00	11.00	21.00	0.00
9	Sep-22	634.90	27,363.00	11.00	0.00	0.00
10	Oct-22	457.01	37,313.00	15.00	41.00	0.00
11	Nov-22	455.40	34,826.00	14.00	0.00	0.00
12	Dec-22	162.45	36,070.00	14.50	20.00	0.00
13	Jan-23	128.12	39,801.00	16.00	0.00	0.00
14	Feb-23	249.75	29,851.00	12.00	108.00	0.00
15	Mar-23	549.05	29,851.00	12.00	63.00	0.00

16	Apr-23	459.67	24,876.00	10.00	29.00	0.00
17	May-23	363.40	31,095.00	12.50	0.00	0.00
18	Jun-23	652.65	34,826.00	14.00	5.00	0.00
19	Jul-23	618.29	37,313.00	15.00	0.00	0.00
20	Aug-23	452.16	29,851.00	12.00	0.00	0.00
21	Sep-23	496.83	24,876.00	10.00	25.00	0.00
22	Oct-23	378.35	22,699.00	9.13	12.00	0.00
23	Nov-23	307.30	24,876.00	10.00	0.00	0.00
Total		11,492.94	661,740.00	266.02	393.00	0.00

Table-10: 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 Diesel Consumption (In Ltr.)
1	Jan-22	368.23	4,229.00	1.70	100.00	0.00
2	Feb-22	387.55	5,597.00	2.25	100.00	0.00
3	Mar-22	324.11	6,219.00	2.50	125.00	0.00
4	Apr-22	389.02	4,353.00	1.75	101.00	0.00
5	May-22	397.22	5,597.00	2.25	101.00	0.00
6	Jun-22	373.50	6,219.00	2.50	100.00	0.00
7	Jul-22	421.83	5,373.00	2.16	105.00	0.00
8	Aug-22	338.93	5,721.00	2.30	110.00	0.00
9	Sep-22	450.53	6,219.00	2.50	110.00	0.00
10	Oct-22	408.41	7,463.00	3.00	110.00	0.00
11	Nov-22	462.69	6,343.00	2.55	111.00	0.00
12	Dec-22	475.04	6,468.00	2.60	111.00	0.00
13	Jan-23	440.13	6,244.00	2.51	130.01	0.00
14	Feb-23	388.00	6,617.00	2.66	115.00	0.00
15	Mar-23	441.78	6,269.00	2.52	130.00	0.00
16	Apr-23	450.18	4,975.00	2.00	125.00	0.00
17	May-23	462.81	5,124.00	2.06	132.00	0.00
18	Jun-23	466.56	7,512.00	3.02	128.00	0.00
19	Jul-23	477.74	8,706.00	3.50	124.00	0.00
20	Aug-23	458.54	6,716.00	2.70	130.00	0.00
21	Sep-23	380.31	4,975.00	2.00	130.30	0.00
22	Oct-23	397.28	4,353.00	1.75	125.15	0.00
23	Nov-23	445.88	8,167.00	2.30	128.30	0.00
Total		9,606.27	139,459.00	55.08	2,681.76	0.00

Table-11: The calculation results of BE_y during reporting monitoring period

Project Activity	Using the default and monitored values BE _y
BE _{Aurangabad}	8,744
BE _{Adoni}	6,761
BE _{Tirupati}	9,492
BE _{Piduguralla}	7,651
Total Baseline Emission BE_y	32,648 tCO₂e

5.2 Project Emissions

Table-12: 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
SEC _{comp, default}	0.01	MWh/t
TDL _{j, y}	20%	-
EF _{FC, default}	0.0207	tCO ₂ /t
EF _{CH4, default}	0.002	tCH ₄ /t
EF _{N2O, default}	0.0002	tN ₂ O/t
GWP _{N2O}	265	tCO ₂ e/tN ₂ O
F _{ww, CH4, default, y}	0.2	Fraction

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 ($PE_{Bio-Methanation}$) 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,

- $PE_{Bio-methanation}$ = Project emissions in year y (t CO₂e) from Bio-Methanation
- $PE_{COMP, y}$ = Project emissions from composting or co-composting in year y (t CO₂e)
- $PE_{AD, y}$ = Project emissions from anaerobic digestion and biogas combustion in year y (t CO₂e)
- $PE_{GAS, y}$ = Project emissions from gasification in year y (t CO₂e)
- $PE_{RDF_SB, y}$ = Project emissions associated with RDF/SB in year y (t CO₂e)

- $PE_{INC,y}$ = Project emissions from incineration in year y (t CO₂e)
- $PE_{EC,y}$ = Project emissions from electricity consumption associated with anaerobic digester in year y (t CO₂e /yr)
- $PE_{FC,y}$ = Project emissions from fossil fuel anaerobic digester associated with composting in year y (t CO₂e /yr)

The Bio-methanation project doesn't include direct, gasification, no association of RDF/SB and incineration at the project site. Therefore, $PE_{GAS,y}$, $PE_{RDF,SB,y}$ and $PE_{INC,y}$ are considered as zero but some time the project is doing composting hence the emissions associated with the composting is considered as per tool 13 below.

As per tool "Project and leakage emission from anaerobic digesters" para 13, equation (1), $PE_{AD,y}$ is calculated as follows:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{flare,y}$$

Where:-

- $PE_{AD,y}$ = Project emissions associated with anaerobic digester in year y (t CO₂e)
- $PE_{EC,y}$ = Project emissions from electricity consumption associated with anaerobic digester in year y (t CO₂e /yr)
- $PE_{FC,y}$ = Project emissions from fossil fuel anaerobic digester associated with composting in year y (t CO₂e /yr)
- $PE_{CH_4,y}$ = Project emissions of methane from the anaerobic digester process in year y
- $PE_{flare,y}$ = Project emissions from flaring of biogas in year y (CO₂e/ 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.

$$PE_{EC,y} = Q_{CH_4,y} \times F_{EC,default} \times EF_{EL}$$

Where:

- $PE_{EC,y}$ = Project emissions from electricity consumption associated with anaerobic digester in year y (t CO₂e)
- $Q_{CH_4,y}$ = Quantity of methane produced in the anaerobic digester in year y (tCH₄)
- $F_{EC,default}$ = Default factor for the electricity consumption associated with the anaerobic digester per ton of methane generated (MWh/tCH₄)
- EF_{EL} = Default emission factor for the electricity consumed in year y (t CO₂/ MWh)

$$Q_{CH_4,y} = Q_{biogas,y} \times f_{CH_4,default} \times \varphi_{CH_4}$$

Where:

- $Q_{CH_4,y}$ = Quantity of methane produced in the digester in year y (tCH₄)
- $Q_{biogas,y}$ = Amount of biogas collected at the digester outlet in year y (Nm³ biogas)
- $f_{CH_4,default}$ = Default emission factor for the fraction of methane in the biogas
- φ_{CH_4} = Density of methane at normal conditions (t CH₄/ Nm³ CH₄)

As per the methodological tool 03, Version 03.0, Tool to calculate project or leakage CO₂ 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:

- $PE_{FC,diesel,y}$ = CO₂ emissions from fossil fuel combustion in Bio-methanation during the year y (tCO₂/ yr)
- $FC_{diesel,Bio-methnation,y}$ = The quantity of diesel combusted in Bio-methanation process during the year y (mass or volume unit/yr)
- $COEF_{diesel,y}$ = The CO₂ emission coefficient of fuel type i in year y (tCO₂/mass or volume unit)

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

$$COEF_{diesel,y} = NCV_{diesel,y} \times EF_{CO_2,i,y}$$

Where:

- $COEF_{diesel,y}$ = The CO₂ emission coefficient of diesel in year y (tCO₂/mass or volume unit)
- $NCV_{diesel,y}$ = The weighted average net calorific value of the diesel in year y (GJ/mass or volume unit)
- $EF_{CO_2,diesel,y}$ = The weighted average CO₂ emission factor of diesel in year y (tCO₂/GJ)

$$PE_{CH_4,y} = Q_{CH_4,y} \times EF_{CH_4,default} \times GWP_{CH_4}$$

Where:

- $PE_{CH_4,y}$ = Project emissions of methane from the anaerobic digester in year y (t CO₂)
- $Q_{CH_4,y}$ = Quantity of methane produced in the anaerobic digester in year y (tCH₄/yr)
- $EF_{CH_4,default}$ = Default emission factor for the fraction of CH₄ produced that leaks from the anaerobic digester (fraction)
- GWP_{CH_4} = Global Warming Potential of CH₄ (t CO₂e / t CH₄)

sometime the project is doing composting hence, the project emissions associated with the composting is considered as per tool 13 and deviation No.7 mentioned in the section 3.2.2 of this monitoring report. As per para 13 of tool 13 (Equation 1) The project emissions from composting are determined as follows:

$$PE_{COMP,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{N_2O,y} + PE_{RO,y}$$

Where:

- $PE_{COMP,y}$ = Project emissions associated with composting in year y (t CO₂e/yr)
- $PE_{EC,y}$ = Project emissions from electricity consumption associated with composting in year y (t CO₂/yr)
- $PE_{FC,y}$ = Project emissions from fossil fuel consumption associated with composting in year y (t CO₂/yr)
- $PE_{CH_4,y}$ = Project emissions of methane from the composting process in year y (t CO₂e/yr)
- $PE_{N_2O,y}$ = Project emissions of nitrous oxide from the composting process in year y (t CO₂e/yr)
- $PE_{RO,y}$ = Project emissions of methane from run-off wastewater associated with co-composting in year y (t CO₂e/y)

As per para 14 of tool 13 version 02.0 “The quantity of waste composted is a parameter required in the determination of emissions associated with each source of project emissions. There are two options to determine the quantity of waste composted in year y (Q_y). In case of co-composting, wastewater is not accounted for in the estimation of Q_y .”

So, there are two options that are:

Option 1: Procedure using a weighing device.

Option 2: Procedure without using a weighing device.

So, Option 1: Procedure using a weighing device is opted which states that “Monitor the weight of waste delivered to the composting installation using an on-site weighbridge.

As per section 6.1.2. Determination of project emissions from electricity consumption ($PE_{EC,y}$), Since, separate monitored data for electricity consumption for composting is not available, then electricity consumption from composting ($EC_{PJ,comp,y}$) may be determined based on a default value for the specific quantity of electricity consumed per tonne of waste composted ($SEC_{comp,default}$) is considered and the formula for the same is as follows:

$$EC_{PJ,comp,y} = Q_y \times SEC_{comp,default}$$

Where:

- $EC_{PJ,comp,y}$ = Quantity of electricity consumed for composting in year y (MWh/yr)
- Q_y = Quantity of waste composted in year y (t/yr)
- $SEC_{comp,default}$ = Default value for the specific quantity of electricity consumed per tonne of waste composted (MWh/t)

As per para 18 of tool 13 version 02.0 “Note that the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” hence, $PE_{EC,y}$ shall be calculated using the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation.

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$$

Where:

- $PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO₂ / yr)
- $EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
- $EF_{EF,j,y}$ = Emission factor for electricity generation for source j in year y (t CO₂/MWh)
- $TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

As per 6.1.3. Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$): Where the composting activity involves fossil fuel consumption, project participants may choose between the following two options to calculate $PE_{FC,y}$:

Option 1: Procedure using monitored data

Option 2: Procedure using a default value.

Since, separate monitored data for consumption of fossil fuel for composting is not available hence, Option 2: Procedure using a default value is opted.

As per para 21 of the tool 13 Project emissions from fossil fuel consumption associated with composting are calculated as follows:

$$PE_{FC,y} = Q_y \times EF_{FC,default}$$

Where:

- $PE_{FC,y}$ = Project emissions from fossil fuel consumption associated with composting in year y (t CO₂ / yr)
- Q_y = Quantity of waste composted in year y (t/yr)
- $EF_{FC,default}$ = Default emission factor for fossil fuels consumed by the composting activity per tonne of waste (t CO₂/t)

As per para 22 of the tool 13 Project emissions of methane from composting are determined as follows:

$$PE_{CH_4,y} = Q_y \times EF_{CH_4,y} \times GWP_{CH_4}$$

Where:

- $PE_{CH_4,y}$ = Project emissions of methane from the composting process in year y (t CO₂e / yr)
- Q_y = Quantity of waste composted in year y (t/yr)
- $EF_{CH_4,y}$ = Emission factor of methane per tonne of waste composted valid for year y (t CH₄ / t)
- GWP_{CH_4} = Global Warming Potential of CH₄ (t CO₂e / t CH₄)

As per para 23 of the tool 13 There are two options which project participants may choose for determining $EF_{CH_4,y}$:

Option 1: Procedure using monitored data

Option 2: Procedure using default values.

So, the PP has opted Option 2: Procedure using default values.

As per para 25 of the tool 13, A default value is used: $EF_{CH_4,y} = EF_{CH_4,default}$. The default value is provided in the “Data and parameters not monitored” section of this tool (tool 13).

As per para 26 of the tool 13 Project emissions of nitrous oxide from composting are determined as follows:

$$PE_{N_2O,y} = Q_y \times EF_{N_2O,y} \times GWP_{N_2O}$$

Where:

- $PE_{N_2O,y}$ = Project emissions of nitrous oxide from composting in year y (t CO₂e/yr)

- Q_y = Quantity of waste composted in year y (t/yr)
- $EF_{N20,y}$ = Emission factor of nitrous oxide per tonne of waste composted valid for year y (t N₂O/t)
- GWP_{N20} = Global Warming Potential of N₂O (t CO₂e/t N₂O)

As per para 27 of the tool 13 There are two options which project participants may choose for determining $EF_{N20,y}$:

Option 1: Procedure using monitored data

Option 2: Procedure using default values.

So, the PP has opted Option 2: Procedure using default values. As per para 29 of the tool 13, A default value is used: $EF_{N20,y} = EF_{N20,default}$. The default value is provided in the “Data and parameters not monitored” section of this tool (tool 13).

As per para 30 of tool 13 Project emissions of methane from run-off wastewater are calculated only for the case of co-composting. Moreover, if run-off wastewater is collected and re-circulated to the composting process, then $PE_{Ro,y}$ is assumed to be zero.

Using above formulas, parameters and values mentioned in Table-1 to Table-7, the project emissions are:

Table-13: The calculation results of PE_y during reporting monitoring period

Project Activity	Using the default and monitored values $PE_{y,27}$
$PE_{Aurangabad}$	2,074
PE_{Adoni}	1,233
$PE_{Tirupati}$	1,390
$PE_{Piduguralla}$	1,379
Total Project Emission PE_y	6,076 tCO₂e

5.3 Leakage Emissions

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

$$LE_y = LE_{comp,y} + LE_{AD,y} + LE_{RDF,S,y}$$

Where:

- LE_y = Leakage emissions in the year y (t CO₂e)
- $LE_{COMP,y}$ = Leakage emissions from composting or co-composting in year y (t CO₂e)
- $LE_{AD,y}$ = Leakage emissions from anaerobic digester in year y (t CO₂e)
- $LE_{RDF,S,y}$ = Leakage emissions associated with RDF/SB in year y (t CO₂e)

²⁷ Vintage wise round up values.

In the Project case $LE_{RDF,S,y}$ is considered zero as there is no involvement of RDF/SB in the project activity. Also, $LE_{comp,y}$ refers the methodological tool “Project and leakage emissions from composting”. As per para 33 of tool “Project and leakage emissions from composting” Leakage emissions from composting ($LE_{COMP,y}$) shall be accounted for if compost is subjected to anaerobic storage or disposed of in a SWDS. So, in the project activity there is no anaerobic storage of compost and the compost is not disposed of in a SWDS therefore, $LE_{comp,y}$ is considered zero.

Hence, $LE_{comp,y} = 0$ and $LE_{RDF,S,y} = 0$.

As per para 27 of tool 14, Storage of digestate under anaerobic conditions can cause CH₄ emissions due to further anaerobic digestion of the residual organic matter. The procedure for determining $LE_{storage,y}$ is distinguished for liquid digestate and solid digestate.

The solid digestate (Fermented Organic Manure) is not stored under anaerobic conditions hence, the leakage emission associated with storage of solid digestate is negligible.

The liquid digestate is stored in an open tank and reused for feedstock slurry preparation on daily basis. Reusing liquid digestate in feedstock slurry making enhances microbial activity, improving biogas yield and process efficiency. It also conserves water, recycles and nutrients, making the operation more sustainable but as a conservative approach PP is considering the leakage emissions associated with liquid digestate storage and are calculated in accordance with Section 6.2.1 of Methodological Tool 14: Project and Leakage Emissions from Anaerobic Digesters, the determination of $LE_{storage,y}$ for liquid digestate follows one of two options:

- Option 1: Procedure using monitored data.
- Option 2: Procedure using a default value.

In this case, Option 2: Procedure using a default value has been selected.

$$LE_{storage,y} = F_{ww,CH4,default} \times Q_{CH4,y} \times GWP_{CH4}$$

Where:

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

$F_{ww,CH4,default}$ = Default factor representing the remaining methane production capacity of liquid digestate (fraction).

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

GWP_{CH4} = Global warming potential of CH₄ (t CO₂ / t CH₄).

Table-14: The calculation results of LE_y during reporting monitoring period

Project Activity	$F_{ww,CH4,default,y}$	$Q_{CH4,y}$	GWP_{CH4}	$LE_{y,28}$
LE _{Aurangabad}	0.2	294.13	28	1,648
LE _{Adoni}	0.2	5.07	28	29
LE _{Tirupati}	0.2	266.02	28	1,491
LE _{Piduguralla}	0.2	56.06	28	315
Total Leakage Emission LE_y				3,483 tCO₂e

²⁸ Vintage wise round up values.

5.4 GHG Emission Reductions and Carbon Dioxide Removals

The total emission reduction achieved in current monitoring period is

$$ER_y = BE_y - PE_y - LE_y$$

Where:

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

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

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

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

$$ER_y = 23,089 \text{ tCO}_2 \text{ (Rounded down)}$$

Vintage period	Baseline emissions (tCO _{2e})	Project emissions (tCO _{2e})	Leakage emissions (tCO _{2e})	Reduction VCUs (tCO _{2e})	Removal VCUs (tCO _{2e})	Total VCUs (tCO _{2e})
01-Jan-2022 to 31-Dec-2022	15,545	2,971	1,582	0	0	10,992
01-Jan-2023 to 30-Nov-2023	17,103	3,105	1,901	0	0	12,097
Total	32,648	6,076	3,483	0	0	23,089

It is to be noted here that as per the estimated emission reduction from the project activity for the current monitoring period is 48,719 tCO_{2e}, whereas actual emission reductions achieved are 23,089 tCO_{2e}, which is 52.61% lower than the estimated emission reductions.

Vintage period	Ex-ante estimated reductions/removals	Achieved reductions/removals	Percent difference	Explanation for the difference
01-Jan-2022 to 31-Dec-2022	25,440	10,992	56.79%	The percentage difference is. due to the low collection of solid waste, the production could not be achieved in the expected quantity, which results in less production than expected.
01-Jan-2023 to 30-Nov-2023	23,279	12,097	48.03%	
Total	48,719	23,089	52.61%	

				Which results in lower of emission reductions quantity than what was originally estimated.
--	--	--	--	--

There are some errors in the registered PD&MR hence, these errors are rectified in the current monitoring period and the error part of the emission reductions are adjusted in the current verification, the details are as follows:

1. Default factor for the electricity consumption:

In registered PDMR, the values of Default factor for the electricity consumption associated with the anaerobic digester per ton of methane generated is considered 0 instead of 1.02 MWh/tCH₄. This error is found out during the current monitoring period therefore the error is rectified and updated but this error also impacts the previous two verifications and emission reduction calculations and the hence, the error part is now adjusted in 1st vintage i.e., 2022 of current monitoring the information of Claimed VCUs are as follows:

- Monitoring period 1: 01-May-2019 to 31- December-2020:

Table-15: Project emissions associated with electricity for MP 1

Vintage	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Total PE _{EC,y} (tCO _{2e})
	For Aurangabad		Adoni		Tirupati		Piduguralla		
2019	39.83	52.81	0	0	0	0	1.23	1.62	54.44
2020	78.61	104.23	0.83	1.09	0	0	20.58	27.29	132.61
Total for MP1 (Round up value)									188.00 tCO _{2e}

- Monitoring period 2: 01-January-2021 to 31- December-2021:

Table-16: Project emissions associated with electricity for MP 2

Vintage	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Q _{CH₄,y} (Tons)	PE _{EC,y} (tCO _{2e})	Total PE _{EC,y} (tCO _{2e})
	For Aurangabad		Adoni		Tirupati		Piduguralla		
2021	96	126.77	7	9.47	134.255	178.02	29.35	38.91	354.00
Total for MP2 (Round up value)									354.00 tCO _{2e}

Error part of associated with PE_{EC,y} = 188+354 = 542 tCO_{2e}.

2. leakage emissions:

In Section 5.3 of the Joint PD-MR, leakage emissions are considered to be zero. However, some times the liquid digestate has been stored, the leakage emissions associated with its storage are calculated in accordance with Section 6.2.1 of Methodological Tool 14: Project and Leakage Emissions from Anaerobic Digesters. For this calculation, the relevant parameter $F_{ww, CH_4, default}$ is incorporated and considered in the calculations. It has been identified during the verification process and now it has been corrected. This error also impacts the previous verifications and emission reduction calculations and the hence, the error part is adjusted in current monitoring.

Table-17: Leakage emissions associated with storage of digestate

Monitoring period	$F_{ww, CH_4, default}$ (fraction)	$Q_{CH_4, y}$ (Tons)	GWP_{CH_4} (tCO ₂ /tCH ₄)	$LE_{storage, y}$ (tCO ₂ e)
MP1 (2019)	0.2	41.05	28	229.90
MP1 (2020)	0.2	100.01	28	560.04
MP2 (2021)	0.2	266.34	28	1,491.50
Total $LE_{storage, y}$				2,282.00 tCO₂e

Error part of associated with leakage emissions = 2,282 tCO₂e.

3. Project emission associated with composting:

Monitoring period	Quantity of waste composted (Ton)
Monitoring period 1 (01-May-2019 to 31- December -2020)	2,499 ²⁹
Monitoring period 2 (01- January -2021 to 31- December -2021)	3,796 ³⁰

As per para 13 of tool 13 (Equation 1) The project emissions from composting are determined as follows:

$$PE_{COMP, y} = PE_{EC, y} + PE_{FC, y} + PE_{CH_4, y} + PE_{N_2O, y} + PE_{RO, y}$$

Project emissions from electricity consumption associated with composting: Some time the project activity may involve in composting so as per para 18 of the tool 13 default value for the specific quantity of electricity consumed per tonne of waste composted ($SEC_{comp, default}$) is considered and the formula for the same is as follows:

²⁹ The value is sourced from approved PD&MR page number 58 (193+1,102+428+776 = 2,499).

³⁰ The value is sourced from approved Monitoring report of 2nd verification page number 25 (3,796).

$$EC_{PJ,comp,y} = Q_y \times SEC_{comp,default}$$

Now, $PE_{EC,y}$ shall be calculated using the methodological tool “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation.

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$$

Monitoring period	$EC_{PJ,comp,y}$ (MWh)	$EF_{EF,j,y}$ (tCO ₂ /MWh)	$PE_{EC,y}$ (tCO _{2e})
Monitoring period 1 (01-May-2019 to 31- December -2020)	24.99	0.83	24.89
Monitoring period 2 (01- January -2021 to 31- December -2021)	37.96	0.83	37.81

As per para 21 of the tool 13 Project emissions from fossil fuel consumption associated with composting are calculated as follows:

$$PE_{FC,y} = Q_y \times EF_{FC,default}$$

Monitoring period	$PE_{FC,y}$ (tCO _{2e})
Monitoring period 1 (01-May-2019 to 31- December -2020)	51.73
Monitoring period 2 (01- January -2021 to 31- December -2021)	78.58

As per para 22 of the tool 13 Project emissions of methane from composting are determined as follows:

$$PE_{CH_4,y} = Q_y \times EF_{CH_4,y} \times GWP_{CH_4}$$

Monitoring period	$PE_{CH_4,y}$ (tCO _{2e})
Monitoring period 1 (01-May-2019 to 31- December -2020)	139.94
Monitoring period 2 (01- January -2021 to 31- December -2021)	212.58

As per para 26 of the tool 13 Project emissions of nitrous oxide from composting are determined as follows:

$$PE_{N20,y} = Q_y \times EF_{N20,y} \times GWP_{N20}$$

Monitoring period	PE _{N20,y} (tCO _{2e})
Monitoring period 1 (01-May-2019 to 31- December -2020)	132.45
Monitoring period 2 (01- January -2021 to 31- December -2021)	201.19

As per para 30 of tool 13 Project emissions of methane from run-off wastewater are calculated only for the case of co-composting. Moreover, if run-off wastewater is collected and re-circulated to the composting process, then PE_{RO,y} is assumed to be zero.

Error part of PE_{comp,y} = 880 tCO_{2e}.

4. Error adjustment of Baseline Emissions of MP1:

During the second verification, the issue highlighted in Deviation 4 was identified and subsequently corrected. However, since this deviation has been applied starting from the second verification, and the first verification had already been approved prior to this correction, the impact of the deviation has not been incorporated in the first verification. As a result, it can be stated that the emission reduction calculations in the first verification contain some errors. These errors have not been adjusted or accounted for in the current (third) verification. The details are as follows:

Deviation 4 states that “The value of the monitoring parameter $DOC_{f,y}$ 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 2nd 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 formula of baseline emissions is as follows:

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

Means the multiplication factor $DOC_{f,y}$ of baseline emissions was taken 0.9 instead of 0.5 means the baseline emissions are calculated 1.8³¹ times higher than actual so appropriate calculation are as follows:

Monitoring period	Baseline Emissions as per MP 1 (BE _y)	Appropriate Baseline Emissions (BE _y)	Error Part
Monitoring period 1 (01-May-2019 to 31- December - 2020)	12,963	12,963/1.8= 7,202	5,761

Apart from baseline emissions calculation there was also some other calculations which was already taken care and adjusted above in Error part 1, 2, and 3.

Total Error part = 542+2,282+880+5,761 = 9,465.00 tCO_{2e} .

Vintage period	Total VCUs (tCO _{2e})	Error part (Which is adjusted in current verification) (tCO _{2e})	Total VCUs Claimed (tCO _{2e})
01-Jan-2022 to 31-Dec-2022	10,992	9,465	1,527
01-Jan-2023 to 30-Nov-2023	12,097	0	12,097
Total	23,089	9,465	13,624

³¹ 0.9/0.5=1.8.

APPENDIX 1: COMMERCIALY SENSITIVE INFORMATION

No commercially sensitive information has been excluded from the public version of the project description. Hence, appendix 1 is not applicable.

APPENDIX 2: CALIBRATION DETAILS

1) Aurangabad Plant (30 TPD)

➤ Weighbridge Details³²: -

S. No.	1/1 (Rs.4000)		
MAX Capacity	40,000 Kg		
Make	Prime & Automation		
Model	Class III		
Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	24-August-2021	Validity	23-August-2022
Calibration Date	20-August-2022	Validity	19-August-2023
Calibration Date	15-August-2023	Validity	14-August-2024

➤ Electricity Meter Details: -

S. No.	X1082365		
Class	0.2 Sec		
Calibration Date	22-February-2019	Validity	21- February -2024

➤ Flow Meter Details: -

Model	BA -800		
S. No.	22-28/742		
Class	2%		
Calibration Date	28-March-2021	Validity	27-March-2022
Calibration Date	19-March-2022	Validity	18-March-2023
Calibration Date	17-March-2023	Validity	16-March-2024

2) Tirupati Plant (40 TPD)

➤ Weighbridge Details³³: -

S. No.	WB1321 (Rs.2500)		
MAX Capacity	50,000 Kg		
Make	Prime & Automation		
Model	Class III		
Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	06-June-2021	Validity	05-June-2022
Calibration Date	06-June-2022	Validity	05-June-2023

³² The same weighbridge is used for measurement of feedstock waste and compost.

³³ The same weighbridge is used for measurement of feedstock waste and compost.

Calibration Date	02-June-2023	Validity	01-June-2024
------------------	--------------	----------	--------------

➤ **Electricity Meter Details: -**

S. No.	X0774356		
Class	0.2 Sec		
Calibration Date	26-June-2019	Validity	25-June-2024

➤ **Flow Meter Details: -**

Model	BA -800		
S. No.	22-28/692		
Class	2%		
Calibration Date	15- February -2021	Validity	14- February -2022
Calibration Date	10- February -2022	Validity	09- February -2023
Calibration Date	07- February -2023	Validity	06- February -2024

3) Piduguralla Plant (20 TPD): -

➤ **Weighbridge Details³⁴: -**

S. No.	130408		
MAX Capacity	60,000 Kg		
Make	LOTUS		
Model	Class III		
Minimum Capacity	200 Kg		
Minimum Value	5 Kg		
Calibration Date	21-May-2021	Validity	20-May-2022
Calibration Date	19-May-2022	Validity	20-May-2023
Calibration Date	18-May-2023	Validity	17-May-2024

➤ **Electricity Meter Details: -**

S. No.	18259357		
Class	0.2 Sec		
Calibration Date	04-September-2017	Validity	03-September 2022
Calibration Date	30-August-2022	Validity	29- August-2027

➤ **Flow Meter Details: -**

Model	BA -800		
S. No.	22-28/732		
Class	2%		
Calibration Date	22-March-2021	Validity	21-March-2021

³⁴ The same weighbridge is used for measurement of feedstock waste and compost.

Calibration Date	20-March-2022	Validity	19-March-2023
Calibration Date	16-March-2023	Validity	15-March-2024

4) Adoni Plant (20 TPD): -

➤ Weighbridge Details³⁵: -

S. No.	041		
MAX Capacity	40,000 Kg		
Make	WEITRANS		
Model	Class III		
Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	04- February-2021	Validity	04- February-2022
Calibration Date	04- February-2022	Validity	04- February-2023
Calibration Date	04- February-2023	Validity	04- February-2024

➤ Electricity Meter Details:

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

➤ Flow Meter Details: -

Model	BA -800		
S. No.	22-28/702		
Class	2%		
Calibration Date	17-March-2021	Validity	16-March-2021
Calibration Date	10-March-2022	Validity	09-March-2023
Calibration Date	08-March-2023	Validity	07-March-2024

³⁵ The same weighbridge is used for measurement of feedstock waste and compost.