WASTE TO ENERGY PROJECTS BY MAHINDRA WASTE TO ENERGY SOLUTIONS LIMITED

Document Prepared by (Infinite Solutions)

Project Title	Waste to Energy Projects by Mahindra Waste to Energy Solutions Limited
Version	03
Date of Issue	28/04/2021
Prepared By	Infinite Solutions
Contact	Address: 214-215 Milinda Manor, Opp. Next Treasure Island, 2 RNT Marg, Indore - 452001, India

CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Project

Mahindra (hereafter referred as "project proponent") is installing Bio-gas Plants (hereafter referred as "proposed project activity") at various locations across India as a grouped project activity. Mahindra is looking forward to earn carbon credits under VCS mechanism for these Bio-gas projects.

The objective of the grouped project activity is to develop a platform for reducing VCS Registration timelines and process costs for registration of individual projects under VCS by Mahindra.

All the project instances i.e., Biogas plants to be included in this grouped project will be from within India only. Hence the location and geographical boundary of the grouped project can be defined as India.

All the project activity instances being included in the proposed grouped project may be owned by different project proponent/SPV but will be located in the India only.

Project Scenario for the Project Instances:
Mahindra with their engineering prowess has proved the benefits and unexplored potentials of biogas utilisation by installing biogas plant with purification system to produce bio-CNG gas which is equal to CNG gas in terms of quality and calorific value.

Biogas technology provides an alternate source of energy in India, and is hailed as an archetypal appropriate technology that meets the basic need for cooking fuel in rural and urban areas. Using local resources, viz. food waste, cattle waste, vegetable and other organic wastes, energy and manure are derived. Realization of this potential and the fact that India supports the largest cattle wealth led to the promotion of National Biogas Programme in a major way in the late 1970s as an answer to the growing fuel crisis. As an extension of technology, Mahindra in the process of developing alternate fuel technologies for rural and urban India for quite long time.

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

Sl No.	Project Instances No.	Plant Location	Technology	Capacity (TPD)	Usage	Commissioning Date
1	Mahindra Waste to Energy Solutions Ltd.	Aurangabad – Maharashtra	Bio Methanation	30	CNG sale	01/05/2019
2		Tirupati – AP	Bio Methanation	40	CNG sale	01/09/2019
3		Piduguralla – AP	Bio Methanation	20	CNG sale	01/06/2019
4		Adoni – AP	Bio Methanation	20	CNG sale	01/03/2020

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

Anaerobic Digestion (AD) is a biological process that happens naturally when bacteria breaks down organic matter in environments with little or no oxygen. It is effectively a controlled and enclosed version of the anaerobic breakdown of organic waste in landfill which release methane.

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

In the absence of the Bio-methanation project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline is to methane emissions avoidance through anaerobic decomposition of MSW in a landfill site in a windrow composting process, which is the same as the baseline scenario.

Hence, pre-project scenario and baseline scenario are the same.

Estimated Average GHG emission reductions from the project activity will be 47,359 tonnes of CO2e per year and total GHG emission reductions for the chosen 7-year crediting period will be 331,510 tonnes of CO2e.

Total emission reductions achieved in this monitoring period:
During the Current Monitoring Period from 01/05/2019 to 31/12/2020 (First and last date included) the project activity has contributed 12,833 tCO_2e GHG reductions.

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

1.2 Sectoral Scope and Project Type

The project activity falls under the following Sectoral scope and Project Type:

Methodology for Energy Use

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

Project Type : I - Renewable Energy Projects

Methodology : AMS I.D, Grid connected renewable electricity generation and ACM0002, Grid-connected electricity generation from renewable sources --- Version 20.0

Methodology for Waste Management

Sectoral scopes: 01 and 13

Methodology : ACM0022, Alternative waste treatment processes Version Number: 02.0

The project is a grouped project activity developed by Mahindra Group.

1.3 Project Eligibility

In line with the VCS standard 4.1 section 2.1.1, The project is a biogas plant with purification system to produce bio-CNG gas which is equal to CNG gas in terms of quality and calorific value, which consists mainly of methane (CH_4), which is eligible under the scope of the VCS Program.

Thus, leads to reduction in Greenhouse Gas (GHG) emission i.e., one of the Six Kyoto Protocol greenhouse gases. Also, the grouped project activity is supported by the methodologies approved under a VCS approved GHG program.

Thus, this grouped project activity is eligible under VCS program.

1.4 Project Design

This is a grouped project activity.

Eligibility Criteria

This is a grouped project, the eligibility criteria for inclusion of new instances of each project activity has been defined below:

S. no.	Eligibility Criteria	Project Activity instances eligibility
1	Applicability Conditions: The project activity instances shall meet applicability conditions for applicable methodology as defined in section 2.2	The current instances described are in line with the methodology
2	Geographical Area: The project activity instances to be included in the grouped project activity will be activities involving waste to Energy projects in India	All the instances are located within the boundary of the country, India.
3	Baseline scenario: All Project Activity Instances shall meet the baseline definition as defined in respective valid methodology and as explained in section 2.4	The baseline for each instance is inline with the methodology requirements.
4	Start Date: The start date of each project activity instance under the grouped project should not be prior to the start date of the grouped project. The start date of each project activity instance will be determined through documentary evidence.	The data of the first commissioning is 01/05/2019. All other instances shall be subsequent to this date. The commissioning certificate shall act as the evidence to determine the same
5	Conditions that avoid double counting of emission reductions like unique identifications of project and claiming emission	The initial project activity instances – has not applied in any other mechanism.

	reduction only under one GHG program for any given monitoring period.	Declaration needs to be provided that for any given monitoring period, the carbon credits would be issued in only one mechanism.
6	The Grouped Project specific requirements stipulated by the Entity responsible for coordinating and managing grouped project for conducting local stakeholder consultations.	Local stakeholder consultation has been conducted at the project site for initial project activity instances. Details are mentioned in subsequent section of this document. Hence, this condition is fulfilled.

1.5 Project Proponent

Organization name	MAHINDRA WASTE TO ENERGY SOLUTIONS LTD.
Contact person	Mr. B. Gowdhaman
Title	Plant In charge
Address	Mahindra Towers, Dr. GM Bhosale Marg, Worli, Mumbai – 400 018
Telephone	-
Email	info@mahindra.com

1.6 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

1.7 Ownership

The respective commissioning certificate for project activity are the supporting documents to demonstrate the project ownership. This demonstrates the right of use according to clause 3.6.1 (3) of VCS Standard (v4.1) – "a project ownership arising by virtue of a statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions and/or removals". Also, other legal compliances may be considered;

- Consent to Operate
- Commissioning certificate
- Consent to Establish

Further, individual compliance aspects will be provided for each of the project activity instance to be included in the grouped project activity based on the clearances/approval/certificates received for implementation of project instance.

1.8 Project Start Date

Project Start Date: 01/05/2019;

The project activity at Aurangabad site was commissioned and started operation on 01/05/2019. Hence the project start date is defined as the earliest commissioning date within all the units.

1.9 Project Crediting Period

Project crediting period: Renewal crediting period

Start date of Crediting period: 01/05/2019

End date of crediting period: 30/04/2026

Total number of years: 7

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

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

As per the section 3.9.1 of VCS standard version 4.1, the projects are classified as follows:

1) Projects: Less than or equal to 300,000 tonnes of CO2e per year

2) **Large Projects: Greater than 300,000 tonnes of CO2e per year**

The grouped project activity instances being included currently have less than 300,000 tCO2e Emission reductions, hence these project activity instances are classified as "Projects"
Similarly, the estimated GHG Emission Reductions will depend upon the Quantity of Bio-CNG and Manure Production by individual project activity instances. The tentative Emission Reduction for the project activity instances being included in the grouped project activity are as follows:

Current Project activity instances	Estimated annual Emission Reductions over a year period (tCO_2e)
Aurangabad – MH	13,141
Tirupati – AP	17,169
Piduguralla – AP	8,727
Adoni – AP	8,322
Total	47,359

Project Scale	
Project	✓
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
Year 1	14,741
Year 2	36,017
Year 3	46,254
Year 4	53,116
Year 5	57,716
Year 6	60,800
Year 7	62,867
Total estimated ERs	331,510
Total number of crediting years	7
Average annual ERs	47,359

However, emission reductions achieved as part of grouped project activity will increase as per addition of new project activity instances in the future.

1.11 Description of the Project Activity

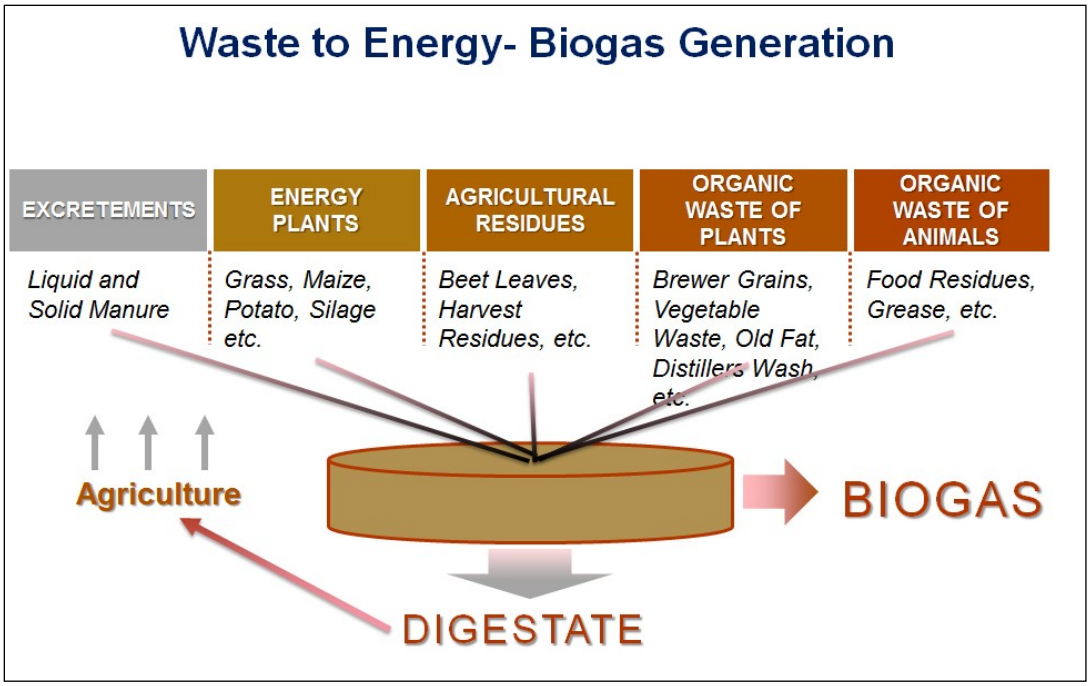
The project activity is a grouped project activity in which several project instances would be added from time to time.

Project activity Instances being included in this grouped project activity:

Project Instance No.	Project Owner	Plant Location	Technology	Capacity (TPD)
1	Mahindra Waste to Energy Solutions Ltd.	Aurangabad – MH	Bio Methanation	30
2		Tirupati – AP	Bio Methanation	40
3		Piduguralla – AP	Bio Methanation	20
4		Adoni – AP	Bio Methanation	20

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. The interdependence of the bacteria is a key factor in the anaerobic digestion process. Instability during both the start-up and operation of the anaerobic degradation process can be problematic due to the low specific growth rate of the methanogenic microorganisms involved. The amount of one type of organic waste generated at a particular site at a certain time may not be sufficient to make anaerobic digestion cost-effective all year round. Co-digestion then becomes an interesting alternative as it is a well-established concept. Raw Material for biogas production:

- Agricultural residue
- Energy crops
- diary manure and biomass
- Food, fruit and vegetable waste
- Animal waste
- Municipal waste



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

1. Organic/ Bio manure
2. Biogas

Biogas plant slurry is an organic matter and it has rich nutrition content. Thus, the slurry can be de-watered or it can be mixed with garden 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 improvise 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 can be 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.

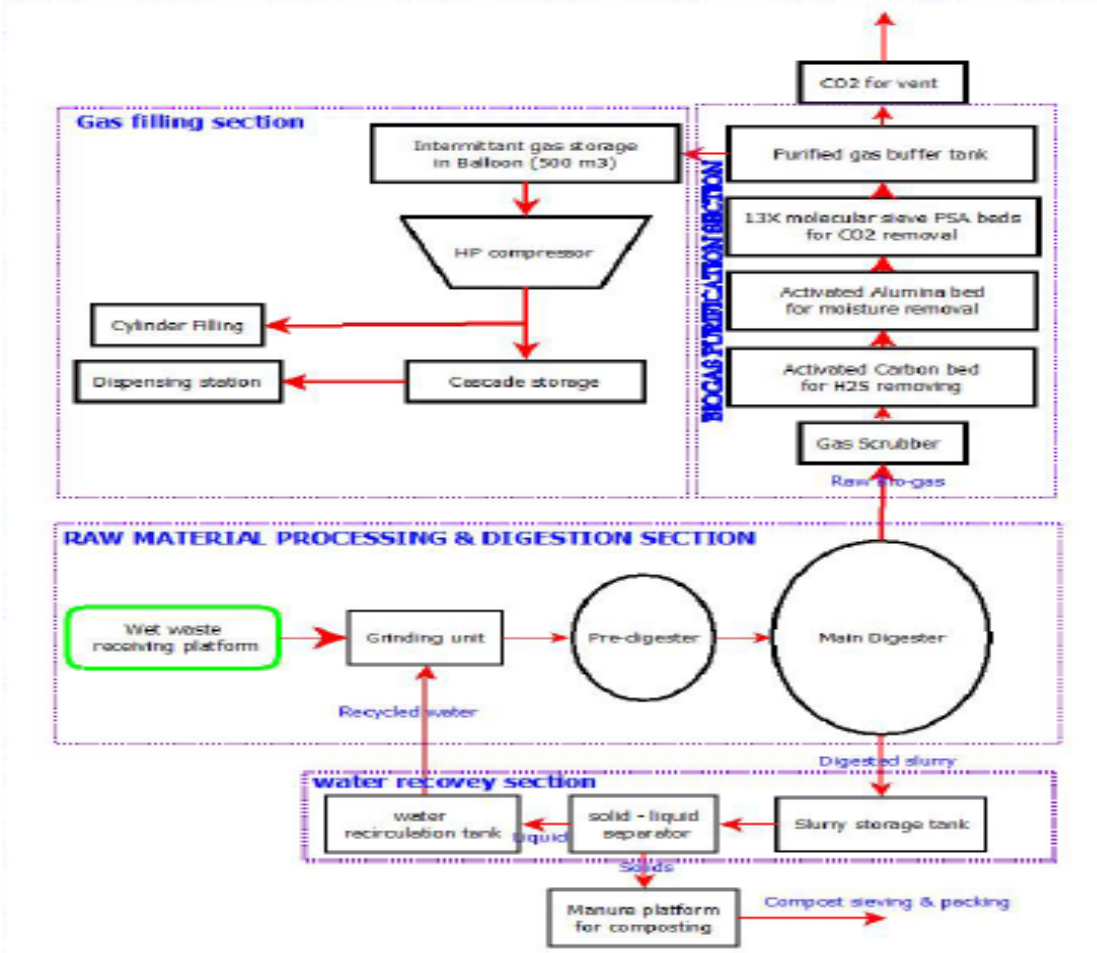


Figure. Manufacturing process flow chart

List of main equipment installed at Bio-Methanation Plant at all sites is tabulated below:

List of equipment for Bio – methanation plant		
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 Nos
5	Aerobic Feeding tank with agitators RCC	1 Nos
6	Raw material feeding pump/ inlet system	1 Nos
7	Anaerobic digester of RCC , with agitators and water sealing technology and FRP dome/balloon.	1 No
8	Water recirculation tank of RCC	1 Nos
9	Slurry collection tank of RCC	1 Nos
10	Slurry de watering system	1 No

11	Biogas balloon	1 Nos
12	Biogas Purification system	1 Unit
13	Biogas Recovery system	1 Unit
14	Earth Mover	1 Nos
15	Shredder machine	1 Nos, 1 ton/hr
16	Compost Sieving machine	1 Nos, 2 tons/hr
17	Biogas flow meter	1 Nos
18	Online monitoring system – digester PH, Tempera- ture, gas CH_4, CO_2, H_2S, Moisture	1 No each
19	Genset for back up	1 Nos, 125 kva
20	Office room with toilet	1 Nos
21	Control room	1 Nos
22	Platform and Shed for purification system	1 Nos
23	Manure storage yard	1 No
24	Compost platform	2 Nos
25	Diesel -Genet (Optional) 200KVA	1 No
Additional equipment required for Bottling Plant along with equipments specified in Table 2.		
26	HP Compressor	1 No,
27	Cascade cylinders	2100 kg storage capacity
28	Area for bottling plant	1 No

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

1.12 Project Location

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

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

Project Instance No.	Location	Technology	Capacity	Plant Location	Latitude and Longitude
1	Aurangabad	Bio Methanation	30	Aurangabad Industrial Area	19° 54' 3.7"N 75° 21' 8.9" E
2	Tirupati	Bio Methanation	40	Temple city, Tirupati	13°37'23" N 79°29'14" E

3	Piduguralla	Bio Methanation	20	Piduguralla town, Guntur District	16° 29′ 50″ N 79° 53′ 21″ E
4	Adoni	Bio Methanation	20	Adoni town, Kurnool District	15° 37′ 18″ N 77°16′ 51″ E

The new instances as added would be updated during the Verification period.

Project Location across the country

1.13 Conditions Prior to Project Initiation

In the absence of the bio-methanation project activity, the waste material would have been dumped unscientifically and ordinary landfills thereby allowing them to undergo anaerobic decomposition resulting emission of methane gas. The baseline identified in section 2.4 is same as the pre-project scenario.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The Project has received necessary approvals for development and commissioning in the name of each individual project owners and is in compliance to the local laws and regulations.

The relevant national laws and regulations pertaining to generation of energy in India are:

- Electricity Act 2003
- National Electricity Policy 2005
- Tariff Policy 2006
- Solid waste management Rules,2016

The Project activity conforms to all the applicable laws and regulations in India:

1. Generation of Bio CNG from waste is not a legal requirement or a mandatory option.
2. There are state and sectoral policies, framed primarily to encourage waste to Energy projects. These policies have also been drafted realizing the extent of risks involved in the projects and to attract private investments.
3. The Indian Electricity Act, 2003 (May 2007 Amendment) does not influence the choice of fuel used for power generation.
4. There is no legal requirement on the choice of a particular technology for power generation

1.15 Participation under Other GHG Programs

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

The Project has not participated in any other GHG programs.

1.15.2 Projects Rejected by Other GHG Programs

The Project is not rejected by other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

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

The details for each proposed grouped project activity instances added shall be described later.

1.16.2 Other Forms of Environmental Credit

The Project has no intent to generate any other form of GHG-related environmental credit for GHG emission reductions or removals claimed under the VCS Program.

The initial project activity instances are neither has nor intends to generate any other form of GHG related environmental credit for GHG emission reductions or removals claimed under the VCS Program.

The details for each proposed grouped project activity instances added shall be described later.

1.17 Additional Information Relevant to the Project

Leakage Management

Leakage emissions are considered as per the applicable tool.

Commercially Sensitive Information

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

Sustainable Development

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

Social well being

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

Environmental well being

Bio CNG generation is one of the cleanest renewable energy powers and does not involve any fossil fuel. There are no GHG emissions. The impact on land, water, air and soil is negligible. Thus, the project activity contributes to environmental well-being without causing any negative impact on the surrounding environment.

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

Economic well being

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

Technological well being

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

Further Information

There are no information or incidents that will have bearing on the eligibility of the project, the net GHG emission reductions or removals, or the quantification of the project's net GHG emission reductions or removals.

2 SAFEGUARDS

2.1 No Net Harm

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

2.2 Local Stakeholder Consultation

The Local Stakeholder Meetings were organized at the project sites.

Project Instance No	Project proponent	Plant	Invitation Notice Dates	LSHM Meetings Dates
1.	Mahindra Waste to Energy Solutions Ltd.	Bio-Methanation – 30 TPD(Aurangabad)	02/10/2018	25/10/2018
2.		Bio-Methanation – 40 TPD(Tirupati)	26/10/2018	14/11/2018
3.		Bio-Methanation – 20 TPD (Piduguralla)	29/11/2018	19/12/2018
4.		Bio-Methanation – 20 TPD (Adoni)	14/06/2019	08/07/2019

The following are the stakeholders for the project activity:

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

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

Project representatives explained the project benefits and how project would help to fight Against climate change and no any negative comments received during the local stakeholder round. The Minutes of meeting with commenting sheet from LSH, invitation letter receipt copy is submitted to the DOE for further check. Few queries raised during local stakeholder consultation are addressed satisfactorily. The PP also placed a grievance register onsite in where the stakeholder can put down his/her complain and the same if found genuine will be addressed immediately. Also, regular stakeholder engagement is one the key focus at the site.

2.3 Environmental Impact

The proposed project activity is Waste to energy generation which is free from any kind of anthropogenic emission. Project activity is not having any negative environmental impacts. These projects rather help having a positive impact on the environment as it leads to efficient management waste.

2.4 Public Comments

The project shall be listed at the VCS website and no any relevant comments were received during the one month commenting period.

The local stakeholders' consultations were well attended with a number of participants coming from the Urban Local Bodies, local residents from each plant's location, farmers around the project area. The stakeholders raised their concern on environmental and social impact of the project, its financial viability and marketability of compost. These concerns were appropriately addressed by the project proponent, and following table briefs the concerns raised by stakeholders and their corresponding response.

PARTICPANT'S QUESTIONS/CONCERN	RESPONSE
How the waste would be collected door to door throughout the city?	Door to door vehicles would be procured and across all schemes at proper informed time, the waste would be collected on daily basis.
Local People would be employed at the project site?	Local people employment would be preferred at the site.
What would be the minimum labour wages for the workers?	The minimum labour wages provided would be as per the rules and regulations of the Labour Law in States.
What kind of safety equipment are to be installed in the plant?	Fire safety equipment, cautionary signage and other safety accessories would be provided to the workers in the plant.

2.5 AFOLU-Specific Safeguards

Not Applicable to the project activity.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Methodology:

Methodology : ACM0022 Project Type

Sectoral scopes: 01 and 13

Title : Alternative waste treatment processes [1],

Version Number: 02.0

The methodology refers to following CDM tools:

- Tool to calculate project or leakage CO2 emissions from fossil fuel combustion[2], Version 3.0, EB 96, Annex 4
- Emissions from solid waste disposal sites, Version 08.0, EB 94, Annex 7
- Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation[3], Version 03.0, EB 96, Annex 5
- Project and leakage emissions from composting , Version 2.0, EB 96, Annex 6

3.2 Applicability of Methodology

As per Methodology Approved consolidated methodology ACM0022 – "Alternative waste treatment processes":

"This methodology applies to project activities where fresh waste, originally intended for disposal in a solid waste disposal site (SWDS), is treated using any (combination) of the waste treatment options listed in Table 2 below. The project activity therefore avoids emissions of methane associated with disposing organic waste in a SWDS with or without a partial landfill gas (LFG) capture system. In addition, the project activity may also potentially claim emission reductions for:

(a) Avoiding methane emissions from degradation of wastewater in an anaerobic lagoon or sludge pit by treating the wastewater in combination with fresh waste by either co-composting or anaerobic digestion;

The project doesn't involve treatment of waste water through co-composting or anaerobic digestion. Hence, this condition is not applicable to the project activity.

(b) Displacing natural gas in a natural gas distribution system with upgraded biogas;

The project does not involve any displacement of the natural gas distribution system.

Hence this condition is not applicable to the project activity.

(c) Displacing electricity in a grid or electricity generation by a fossil fuel fired captive power-only or cogeneration plant; and

The project activity does not include electricity generation by fossil fuel fired captive power plant or any cogeneration plant. Therefore, this scope & applicability is not applicable to the proposed project activity.

(d) Displacing heat generation by a fossil fuel fired cogeneration plant, boiler or air heater.

The proposed project activity does not involve in any thermal treatment process by fossil fuel fired captive power plant or any cogeneration plant. Therefore, this scope & applicability is not applicable to the proposed project activity.

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

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

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

As per methodology, Table 2 (of the methodology, given below) 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.

Applicability Criterion	Project Case
The following general applicability conditions apply to all project activities using this methodology: a) The project activity involves the construction of a new plant to implement one or several of the alternative waste treatment options provided in Methodology Table; 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; 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; d) Any run-off wastewater is treated within the project boundary; e) The project does not reduce the amount of waste that would be recycled in the absence of the project activity.	a) This project activity is anaerobic digestion of the organic fraction of municipal solid waste and biomass waste collected from door-to-door waste collecting vehicles. b) Not applicable as the project activity involves anaerobic digestion. c) Neither the organic fresh waste nor the product and by-product from the waste treatment plant are stored on-site under anaerobic conditions. d) No run-off wastewater is treated within project activity. e) The project does not reduce the amount of waste that would be recycled in the absence of the project activity. Hence the project activity meets the given applicability criterion.
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: 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; 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); c) In the case that the project activity generates electricity: the electricity is generated in	a) The disposal of fresh waste in a SWDS is without a LFG capture system. Also, project activity is constructed in conjunction with the local municipality which have land for construction of SWDS. b) This is not a co-composting project activity. c) These project activity does not generates electricity. d) These project activity does not generate electricity.

an existing/new captive fossil fuel fired power-only plant, captive cogeneration plant and/or in the grid (P2, P4 or P6); 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).	
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.	The emission reduction is claimed only for the baseline scenarios, the project activity doesn't claim emission reductions from the use of product or by-products.
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").	Not applicable for the project activity.
Note that in the case that applicable laws or regulations require the use of the waste treatment option(s) implemented under the 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.	The Union Ministry of Environment, Forests and Climate Change (MoEF&CC) notified the new Solid Waste Management Rules (SWM), 2016 which only advised the processing of bio-degradable waste. The various technological construction are solely initiatives by Municipal Corporation.

Mahindra Waste to Energy Solutions Ltd. identifies the following realistic and credible alternatives to the project activity which could be implemented in order to handle the municipal solid waste and the food waste available to them from various parts of towns. These plausible alternatives were further analyzed with reference to the implications of implementing the alternatives.

Applicability conditions for different waste treatment options

Waste treatment option under the project activity	Applicable types of wastes that may be treated	Applicable products and their use	Applicable waste by-products	Specific applicability conditions for the treatment option
Composting or co-composing	1. Types of waste specified in the scope and applicability section of the methodological	Compost: any use applicable	1. Glass, aluminum, ferrous metals and plastics from waste sorting	Any applicability conditions specified in the methodological tool "Project and

	tool "Project and leakage emissions from composting"; 2. Run-off wastewater 3. Excluding hospital and industrial waste		stages; 2. Run-off wastewater	leakage emissions from composting"
The methodological tool "Project and leakage emissions from composting", requires processing of fresh waste in the composting facility. In line with the tool, the project activity involves processing of fresh MSW in a compost plant. The project activity involves processing of fresh MSW in a compost plant and Bio-methanation plant. The project activity shall not process any hospital and industrial waste. All the procedures and applicability conditions of the said tool shall be followed. Hence above-mentioned applicability conditions are applicable to the project activity.				
Anaerobic digestion	1. Wastewater; 2. Fresh waste, excluding hospital and industrial waste	Biogas which may be flared, used to generate electricity or heat, and/or is upgraded and distributed in a natural gas distribution grid	1. Glass, aluminium, ferrous metals and plastics from waste sorting stages; 2. Run-off wastewater; 3. Digestate	Any applicability conditions specified in the methodological tool "Project and leakage emissions from anaerobic digesters"
The project activity shall not process any hospital and industrial waste. There is no discharge of waste water. The MSW is segregated in to bio degradable, Non-biodegradable and recyclables The MSW is segregated in to bio degradable, Non-biodegradable. All the procedures and applicability conditions of the methodological tool "Project and leakage emissions from anaerobic digesters" tool shall be followed. Hence above-mentioned applicability conditions are applicable to the project activity.				
Thermal treatment	Fresh waste, excluding hospital and industrial waste	RDF/SB: any use is applicable	1. Glass, aluminium and ferrous metals from waste sorting stages	-
The project activity does not involve any thermal treatment of waste. So, this applicable condition not satisfies the applicability criterion in case of this project activity.				
Mechanical treatment	Fresh waste, excluding hospital and industrial waste	RDF/SB: any use is applicable	1. Run-off wastewater; 2. Glass, aluminium and ferrous metals from waste	-

			sorting stages	
The project activity does not involve any mechanical treatment of waste. So, this applicable condition not satisfies the applicability criterion in case of this project activity.				
Gasification	Fresh waste	1. Syngas which may be used to generate electricity and/or heat	1. Gasification by-products (e.g. inert materials); 2. Run-off wastewater; 3. Glass, aluminium and ferrous metals from waste sorting stages	-
The project activity involves in production of syngas (CH4). So, this applicable condition satisfies the applicability criterion in case of this project activity.				
Incineration	Fresh waste	Electricity and/or heat	1. Incineration by-product (e.g. inert materials); 2. Run-off wastewater; 3. Glass, aluminium and ferrous metals from waste sorting stages	1. Incineration technology is rotary kiln, rotating fluidized bed, circulating fluidized bed, hearth or grate type; 2. The fraction of energy generated by auxiliary fossil fuels is not more than 50% of the total energy generated in the incinerator
The project activity does not involve any Incineration technology. So, this applicable condition not satisfies the applicability criterion in case of this project activity.				

3.3 Project Boundary

The boundary for the project is as follows;

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from heat generation	CO_2	Yes	Major emission source if heat generation is included in the project activity and displaces more carbon intensive heat generation in the baseline
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from decomposition of waste at the SWDS	CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH4 emissions from landfills. Exclusion of this gas is conservative
		CO_2	No	CO_2 emissions from the decomposition of fresh waste are not accounted for
	Emissions from anaerobic lagoons or sludge pits	CO_2	No	CO_2 emissions from biomass source are considered GHG neutral
		CH_4	Yes	Methane emission from anaerobic process
		N_2O	No	Not significant. Excluded for simplification and conservativeness
Project	Emissions from use of natural gas	CO_2	No	Excluded for simplification. This is conservative
		CH_4	No	Major emission source if supply of upgraded biogas through a natural gas distribution network is included in the project activity
		N_2O	No	Excluded for simplification. This is conservative

Source		Gas	Included?	Justification/Explanation
	Emissions from on-site fossil fuel consumption due to the project activity other than for electricity generation	CO_2	Yes	May be an important emission source. Includes heat generation for mechanical/thermal treatment process, start up of the gasifier, auxiliary fossil fuels needed to be added into incinerator, etc. It does not include transport
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from on-site electricity use	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	Yes	N_2O may be emitted from composting, incineration, syngas produced and RDF/SB combustion
	Emissions from wastewater treatment	N_2O	Yes	N_2O may be emitted from composting, incineration, syngas produced and RDF/SB combustion
		CO_2	Yes	CO_2 emissions from incineration, gasification or combustion of fossil-based waste shall be included. CO_2 emissions from the decomposition or combustion of fresh waste are not accounted
		CH_4	Yes	CH_4 leakage from the anaerobic digester and incomplete combustion in the flaring process are potential sources of project emissions. CH_4 may be emitted from incineration, gasification, composting and RDF/SB combustion
		CO_2	No	CO_2 emissions from the decomposition of fresh waste are not accounted

Source		Gas	Included?	Justification/Explanation
	Emissions from wastewater treatment	CH_4	Yes	CH_4 emissions from anaerobic treatment of wastewater are accounted for. Aerobic treatment of wastewater shall not result in CH_4 emissions
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Greenfield Solar Power Project Activity.	CO_2	No	No CO_2 emissions are emitted from the project
		CH_4	No	Project activity does not emit CH_4
		N_2O	No	Project activity does not emit N_2O
		Other	No	Project activity does not emit other forms of GHG emissions

3.4 Baseline Scenario

Bio-methanation Plant:

According to ACM0022 Version 2.0, the baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere.

The baseline is to methane emissions avoidance through anaerobic decomposition and anaerobic digestion of MSW in a landfill site. No landfill gas capture system is installed in the Landfill site and there is no legal or regulatory mandate on the project proponent to recover the landfill gas.

As per the consolidated methodology ACM0022 Version 2.0, two approaches are available to the project participants to select the most plausible baseline scenarios and to demonstrate additionality.

Approach 1 is used to the "Combined tool to identify the baseline scenario and demonstrate additionality".

Approach 2 broadly refers to the project located in the LDC country and auto additionality of the project, which is not the case of the proposed project activity.

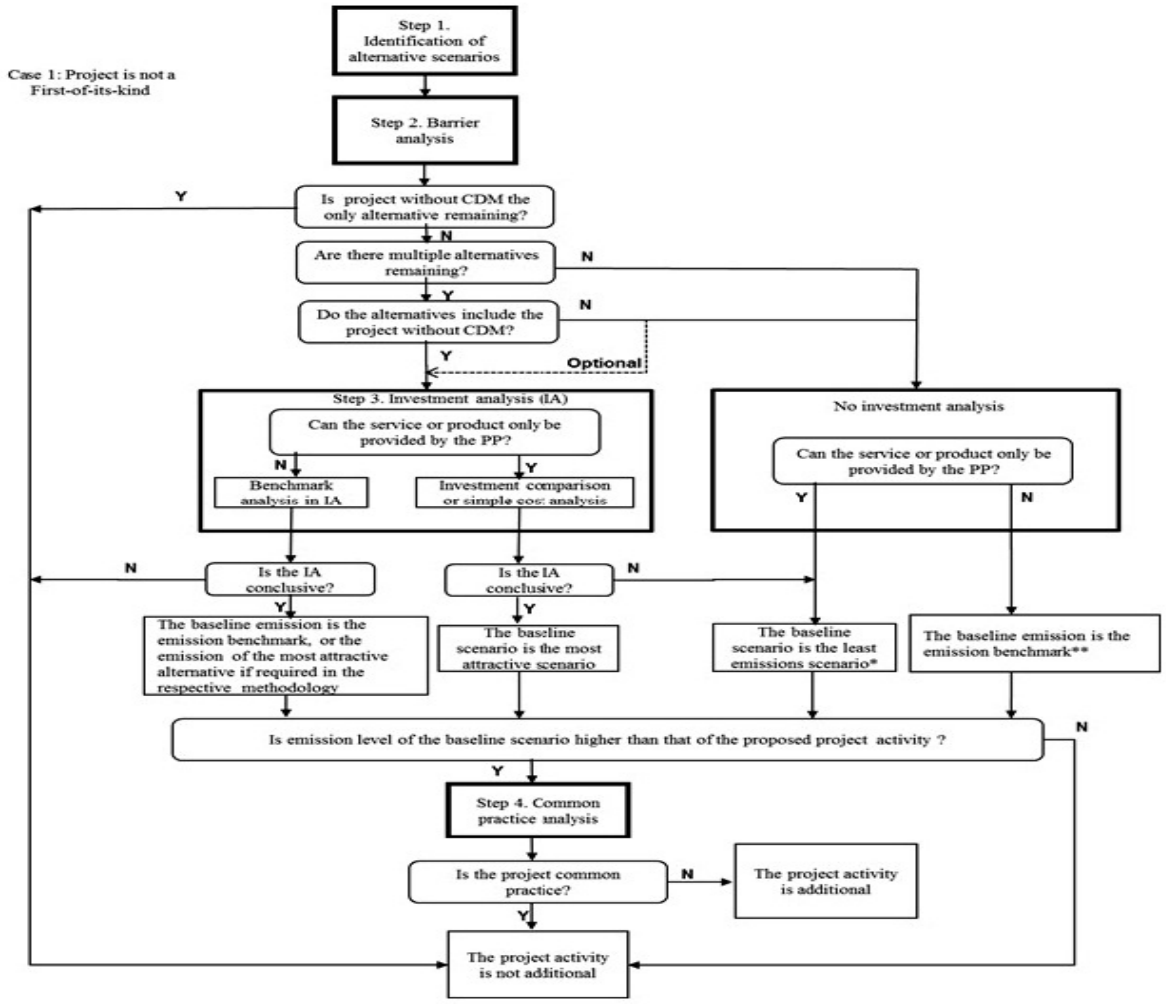
Therefore approach 1 is selected for the procedures.

The "Combined tool to identify the baseline scenario and demonstrate additionality" version 07.0.0, has been used for baseline identification and demonstration of additionality.

Step 0: *Demonstration whether the proposed project activity is the first-of-its-kind*

The proposed project activity is not the first-of-its-kind.

Figure 1. Flowchart of the step-wise approach (Case 1: Project is not a first-of-its-kind)



* In case of only one alternative remaining, the baseline scenario is the remaining alternative;
** If not required otherwise in the respective methodology

Step 1: *Identification of alternatives Scenario*

Sub-step 1a: *Define alternatives scenarios to the proposed CDM project activity*

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

As per the consolidated methodology ACM0022 V2.0, "In identifying baseline alternatives for the treatment of fresh waste the following alternatives or combination of these alternatives shall, inter alia, be considered:"

Representation	Parameters	Plausible Scenarios	Reason with Justification
M1	The project activity without being registered as a CDM	Yes	This alternative involves processing of waste in a Bio-methanation plant. This option is in compliance

	project activity (i.e., any (combination) of the waste treatment options listed in Table 2 of the methodology);		with all the mandatory laws and regulations. This option has been considered as a baseline alternative.
M2	Disposal of the fresh waste in a SWDS with a partial capture of the LFG and flaring of the captured LFG;	No	The common practice in towns was to dump the MSW generated in the designated open landfill[4] which does not have a provision for landfill gas capture. Hence, this option has not been considered as a baseline alternative.
M3	Disposal of the fresh waste in a SWDS without a LFG capture system;	Yes	This is the 'Business As Usual' Scenario. All waste is collected and transported to the designated landfill sites. This alternative does not have any landfill gas capture and flaring system, since it does not require any capital investment or operation and maintenance cost or any other associated cost. Therefore, this alternative is a real and plausible baseline alternative.
M4	Part of the fresh fraction of the solid waste is recycled and not disposed in the SWDS;	No	The common practice in towns was to dump the MSW generated in the designated open landfill. No part of waste is recycled therefore not considered as a baseline alternative.
M5	Part of the fresh fraction of the solid waste is treated aerobically and not disposed in the SWDS;	No	M5 cannot be considered a baseline alternative to the project activity since it aims only at introducing a waste treatment system and there is no possibility to generate biogas when treating the solid waste aerobically. Thus, M5 is discarded for further consideration
M6	Part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS;	No	Incineration of solid wastes (in part or full) was not recommended by CPCB[5]. Hence this alternative has not been considered as an alternative to the project activity.
M7	Part of the organic fraction of the solid waste is gasified and not disposed in the	No	Gasification of solid wastes (in part or full) was not recommended by CPCB[6].. Hence this alternative has not been considered as an

[4] Every state in India has open dumping as current practice.

https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2018-19.pdf, pg 13-14

[5] https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2018-19.pdf ; refer page 13-14

[6] https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2018-19.pdf ; refer page 13-14

	SWDS;		alternative to the project activity.
M8	Part of the organic fraction of the solid waste is treated in an anaerobic digester and not disposed in the SWDS;	No	The project activity involves aerobic treatment through Bio-methanation for treatment of MSW. Thus, M8 is a part of the project activity under consideration and therefore not considered as a baseline alternative.
M9	Part of the organic fraction of the solid waste is mechanically or thermally treated to produce RDF/SB and not disposed in the SWDS.	No	The project alternative does not include mechanical treatment of solid waste (RDF manufacturing) for treatment of MSW in the project activity. Hence, this option is not considered as a baseline alternative.

Outcome of step 1a and step 1b:

Following alternatives amongst the ones listed above are in compliance with all the mandatory legal and regulatory requirements:

M1	The project activity without being registered as a CDM project activity (i.e., any (combination) of the waste treatment options listed in Table 2 of the methodology);
M3	Disposal of the fresh waste in a SWDS without an LFG capture system

Step 2: Barrier analysis

Project proponent (PP) is to determine whether the Project activity faces barriers that:

(a) Prevent the implementation of this type of proposed project activity; and

(b) Do not prevent the implementation of at least one of the alternatives; using the following sub-steps:

Step 2a: Identify barriers that would prevent the implementation of alternative scenario

Step 2b: Eliminate alternative scenarios which are prevented by the identified barriers

As per the "Combined tool to identify the baseline scenario and demonstrate additionality", version 07, project participant is required to "establish a complete list of realistic and credible barriers that may prevent alternative scenarios to occur. Such realistic and credible barriers may include:" (a) Investment Barriers, (b) Technological Barriers and (c) Other barrier, preferably specified in the underlying methodology approved consolidated baseline and monitoring methodology ACM0022 – "Alternative waste treatment processes", version 2.0 as examples

Outcome of Step 2(a) and 2(b): The following alternatives faces investment barrier –

M1	The project activity without being registered as a CDM project activity (i.e., any (combination) of the waste treatment options listed in Table 2 of the methodology);	Investment barrier	The project activity without revenue from VER requires investment and from project proponent and generates revenue through sale of CNG. However, the return from the investment is not sustainable. The alternative does not face any barrier other than insufficient financial return which is elaborated in step 3 –

			Investment Analysis in accordance with combined tool.
M3	Disposal of the fresh waste in a SWDS without a LFG capture system.	No Barrier	This alternative does not face any barrier. This alternative neither requires any investment from the project developer nor does it generate any revenue.

As per the above analysis, there are two alternatives i.e. M1 and M3

Scenario M1 is unlikely due to the strong investment barrier for its implementation. This is demonstrated as per the Investment Analysis included in Step 3.

.

Step 3: Investment Analysis

Step 4: Common Practice Analysis

Step 3 and step 4 are being conducted as part of section 3.5 of the VCS Joint PD & MR. Please refer the same.

3.5 Additionality

As per para 29 of "Tool for the demonstration and assessment of additionality" (version 07.0.0), for financial analysis of the project, the following three options are available:

Option I: Simple Cost Analysis

Option II: Investment Comparison Analysis

Option III: Benchmark Analysis

The project will generate revenues from sale of Bio-CNG, therefore Option I is not applicable. Option II also does not apply since there is no comparable investment alternative available to the project participant. In line with the para 32 of the Tool the most appropriate financial analysis method is therefore option III: the benchmark analysis, where the returns on investment in the project activity are compared to benchmark returns that are available to any investors in the country.

Project Participants have considered Post-Tax Equity IRR for investment analysis at the time of decision-making. As Project Participants is only interested in the returns project is generating on the portion of investment costs, which is financed by them in the form of equity.

As per Para 15 of EB105, Annex 06 states that Required/expected returns on equity are appropriate benchmarks for an equity IRR. Therefore, the Expected return on equity is considered appropriate benchmark.

Accordingly, the post-tax Equity IRR has been considered as the relevant financial indicator for Investment Analysis.

Default Value Benchmark:
The Required return on equity (benchmark) was computed in the following manner:

Nominal Benchmark = {(1+Real Benchmark) *(1+Inflation rate)}-1

Where:

(a) Default value for Real Benchmark is the default value of expected return on equity in real terms for Energy Industries (Group 1) in India as provided in the Appendix.
(b) Inflation Rate forecast for India as per IMF website.

Benchmark estimation

Default Value as per latest version of Investment Analysis Tool version 10:
Table under EB 105 annex 06 specifies default value of expected return on equity in real terms for Energy Industries (Group 1) in India = 10.24%

Inflation Forecast for India as per RBI website[7] and corresponding benchmark values:

Project Instance No.	Project Owner	Plant Location	Inflation Forecast (10 Years)	Benchmark
1	Mahindra Waste to Energy Solutions Ltd.	Aurangabad – MH	4.50%	**15.20%**
2		Tirupati – AP	4.50%	**15.20%**
3		Piduguralla – AP	4.50%	**15.20%**
4		Adoni – AP	4.50%	**15.20%**

The equity IRR for (**Bio-Methanation Plant)** has been computed based on the following input assumptions:

Parameters	Project Instance - 1	Project Instance - 2	Project Instance - 3	Project Instance - 4	Basis
Location	Aurangabad, MH	Tirupati, AP	Piduguralla, AP	Adoni, AP	DPR
Capacity of Bio-Methanation Plant	30	40	20	20	DPR
Cost of Project (Rs. million)	128.10	77.76	61.10	64.10	DPR
Financing Pattern – Equity Loan (Rs. Million)	32.03	19.44	15.28	16.03	DPR
Financing Pattern – Term Loan (Rs. Million)	96.08	58.32	45.83	48.08	DPR
Rate of Interest	8%	8%	8%	8%	DPR
Selling Price of CNG (Rs./Kg)	46	46	46	46	DPR
O&M Cost (including Manpower and compliances)	7.4	6.8	6.8	6.8	DPR
Income Tax- MAT	21.55%	21.55%	21.55%	21.55%	Income Tax Act
Income Tax	29.12%	29.12%	29.12%	29.12%	Income Tax Act

Based on above the equity IRR works out to:

[7] https://www.rbi.org.in/Scripts/PublicationsView.aspx?id=18113

Project Instance No.	Project Owner	Plant Location	Equity IRR	Benchmark
1	Mahindra Waste to Energy Solutions Ltd.	Aurangabad – MH	3.56%	15.20%
2		Tirupati – AP	3.98%	15.20%
3		Piduguralla – AP	6.28%	15.20%
4		Adoni – AP	6.29%	15.20%

As evident the IRR is lower than the benchmark rate. The additionality of the project is thus evident.

Sensitivity Analysis

Guidance on investment analysis requires the project developer to subject critical assumptions to reasonable variation to ascertain the robustness of the conclusion drawn, that is, the project is additional. As required a sensitivity analysis has been conducted to measure the impact, of changes in the chosen parameters. The rationale of sensitivity is, "The ultimate objective of the sensitivity analysis is to determine the likelihood of the occurrence of a scenario other than the scenario presented, in order to provide a cross-check on the suitability of the assumptions used in the development of the investment analysis."

The results of the sensitivity analysis are as given below:

Sensitivity Analysis for Aurangabad – MH Plant (30 TPD):

Variation %	-10%	Normal	10%	Variation required to reach benchmark
Biogas CNG Production	0.89%	3.56%	6.09%	51.09%
Organic Manure Production	2.97%	3.56%	4.14%	230.23%
O&M	5.10%	3.56%	1.89%	-96.68%
Project Cost	5.34%	3.56%	2.11%	-42.44%
Selling Price of CNG	0.89%	3.56%	6.09%	51.09%
Selling Price of Organic Manure	2.97%	3.56%	4.14%	230.23%

Sensitivity Analysis for Tirupati – AP Plant (40 TPD):

Variation %	-10%	Normal	10%	Variation required to reach benchmark
Biogas CNG Production	Undetermined	3.98%	13.31%	12.56%
Organic Manure Production	1.63%	3.98%	5.85%	79.22%
O&M	11.75%	3.98%	Undetermined	-16.26%
Project Cost	7.84%	3.98%	0.74%	-24.55%
Selling Price of CNG	Undetermined	3.98%	13.31%	12.56%
Selling Price of Organic Manure	1.63%	3.98%	5.85%	79.22%

Sensitivity Analysis for Piduguralla – AP Plant (20 TPD):

Variation %	-10%	Normal	10%	Variation required to reach benchmark
Biogas CNG Production	1.76%	6.28%	10.13%	24.85%
Organic Manure Production	4.84%	6.28%	7.62%	74.65%
O&M	9.31%	6.28%	2.48%	-34.21%
Project Cost	8.69%	6.28%	4.28%	-28.92%
Selling Price of CNG	1.76%	6.28%	10.13%	24.85%
Selling Price of Organic Manure	4.84%	6.28%	7.62%	74.65%

Sensitivity Analysis for Adoni – AP Plant (20 TPD):

Variation %	-10%	Normal	10%	Variation required to reach benchmark
Biogas CNG Production	1.76%	6.29%	10.38%	23.10%
Organic Manure Production	4.86%	6.29%	7.71%	69.40%
O&M	9.46%	6.29%	2.54%	-32.17%
Project Cost	8.91%	6.29%	4.26%	-27.32%
Selling Price of CNG	1.76%	6.29%	10.38%	23.10%
Selling Price of Organic Manure	4.86%	6.29%	7.71%	69.40%

The sensitivity analysis reveals that even with significant changes in various parameters, the Equity IRR does not cross benchmark rate. Therefore, the project is additional and is not a business – as – usual scenario.

Barrier analysis

Barrier analysis has not been used.

Common practice analysis

For the concerned project, the Common Practice Analysis has been carried out. Stepwise approach for common practice analysis has been carried out as per Methodological tool "Common Practice", version 03.1 EB84, Annex 7:

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

	Aurangabad – MH	Tirupati – AP	Piduguralla – AP	Adoni – AP	
Range	Capacity				UNIT
+50%	45	60	30	30	TPD
Capacity of the proposed project activity	30	40	20	20	TPD

-50%	15	20	10	10	TPD

Bio-methanation facilities with capacity +/- 50% of the capacity of the project activity has been considered i.e., bio-methanation plants within project boundary of capacity in the range mentioned in the above table has only been considered further analysis.

Based upon the annual report on implementation of Solid waste management rules 2018-19[8] Bio-methanation project are identified.

Step (2): Identify similar projects (CDM/VCS/GS projects and non CDM/VCS/GS projects) which fulfil all of the following conditions:

a. The projects are located in the applicable geographical area;

b. The projects apply the same measure as the proposed project activity;

c. The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;

d. The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;

e. The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;

f. The projects started commercial operation before the project design document (CDMPDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.

Identification of the similar projects (CDM/VCS/GS projects and non CDM/VCS/GS projects) is carried out as per sub-steps of Step (2) as follows:

a. As the projects is located in Project Instance 1 in Maharashtra and Project Instances 2, 3, 4 in Andhra Pradesh therefore the projects located in the geographical area of Maharashtra for Project Instance 1 and Andhra Pradesh for Project Instance 2,3,4 have been chosen for analysis. The project activity involves treatment of municipal solid waste. The project activity is located in the Maharashtra state and Andhra Pradesh state of India and the policy applicable for the handling Municipal Solid waste handling is regulated by respective state and zonal Municipal Corporation. The policies/regulation for each state is regulated by respective state and zonal Municipal Corporations and they differ for respective states.

b. The project uses municipal generated solid waste for the processing, therefore projects using municipal solid waste for treatment is considered for analysis.

c. The project produces CNG gas (generated from the municipal waste), therefore those projects producing CNG gas is considered for the analysis.

[8] https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2017-18.pdf

d. The capacity range of the projects is within the applicable capacity range from the table mentioned in step (1).

e. The start date of the large-scale project activity is the board decision date. Therefore, projects before state date have been considered for analysis.

The Numbers of Similar projects identified, which fulfil above-mentioned condition are

Particulars	Aurangabad – MH	Tirupati – AP	Piduguralla – AP	Adoni – AP
Bio-methantion	0	0	0	0

Step (3): Within the projects identified in Step 2, identify those that are neither registered as CDM/VCS and GS project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number Nall.

CDM project activities, which have got registered or are under validation, have been excluded in this step.

Particulars	Aurangabad – MH	Tirupati – AP	Piduguralla – AP	Adoni – AP
Nall	0	0	0	0

Step (4): Within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number Ndiff.

As per the tool on Common Practice, the project activities have been separated from the different technologies on the basis two criteria:

3. Size of Installation – Since project activity is large scale project, small and micro scale projects are considered as different technology project. Based on this criteria, there are no any different technology project out of similar identified projects.

4. Investment climate on the date of the investment decision – For proposed project activity, there are no any different technology project considered out of similar identified projects.

Hence, projects where either of the conditions is satisfied those projects are counted for calculating Ndiff projects.

Particulars	Aurangabad – MH	Tirupati – AP	Piduguralla – AP	Adoni – AP
Ndiff	0	0	0	0

Step (5): Calculate factor F=1-Ndiff/Nall representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the propose project activity.

Calculate F=1-Ndiff/Nall

F = 1-(0/1) = 1

As per methodological tool "common practice" version 03.1, the proposed project activity is a "common practice" within a sector in the applicable geographical area if the factor F is greater than 0.2 and Nall-Ndiff is greater than 3.

Thus if both conditions are fulfilled, then project activity will be a common practice otherwise, the project activity is treated as not a common practice.

Outcome of Common Practice analysis:

Particulars	Aurangabad – MH	Tirupati – AP	Piduguralla – AP	Adoni – AP
F	Undefined	Undefined	Undefined	Undefined
Nall-Ndiff	0	0	0	0

The project instances does not satisfy condition (i) and (ii), the proposed project instance is not a "common practice" within a sector in the applicable geographical area.

Thus, the proposed project instance is not a "common practice" within a sector in the applicable geographical area.

The above discussions show that Bio methanation plant development of such magnitude is not a common practice and the project activity is not financially attractive; hence the project activity is additional.

3.6 Methodology Deviations

There is no methodology deviation.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

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

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y = Emission Reduction in year y (tCO_2e)

BE_y = Baseline Emission in year y(tCO_2e)

PE_y = Project Emission in the year y (tCO_2e)

LE_y = Leakage Emission in Year y (tCO_2e)

Also,

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

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

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

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

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

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

The amount of methane generated from the disposal of waste at the SWDS is calculated based on a first order decay (FOD) model. The model differentiates between the different types of waste j with respective constant decay rates (k_j) and fractions of degradable organic carbon (DOC_j). The model calculates the methane generation occurring in year y disposed in the SWDS over a specific time period y. There is no SWDS methane captured, flared and combusted or used in another manner that prevents emission of methane to the atmosphere at the project site.

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

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

Equation (2)

With:

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

Equation (3)

Where,

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

$BE_{CH4,\ t,\ y}$ = Baseline emissions of methane from the SWDS in year y (t CO_2e)

$BE_{WW,y}$ = Baseline methane emissions from anaerobic treatment of the wastewater in open anaerobic lagoons or of sludge in sludge pits in the absence of the project activity in year y (t CO_2e)

$BE_{EN,t,y}$ = Baseline emissions associated with energy generation in year y (tCO_2e)

$BE_{NG,t,y}$ = Baseline emissions associated with natural gas use in year y ($t\ CO_2e$)

$DF_{RATE,t,y}$ = Discount factor to account for $RATE_{Compliance,t,y}$

$RATE_{Compliance,t,y}$ = Rate of compliance of a requirement that mandates the use of alternative waste treatment option t in year y

t = Type of alternative waste treatment option

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

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

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

Where,

$BE_{CH4,\ SWDS,\ Y}$ = Baseline methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* ($t\ CO_2e/yr$)

x = Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y)

y = Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)

$DOC_{f,y}$ = Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)

$W_{j,x}$ = Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t)

φ_y = Model correction factor to account for model uncertainties for year y

f_y = Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y

GWP_{CH4} = Global Warming Potential of methane

OX = Oxidation factor (reflecting the amount of methane from SWDS that is

oxidized in the soil or other material covering the waste)

F = Fraction of methane in the SWDS gas (volume fraction)

MCF_y = Methane correction factor for year y

DOCj = Fraction of Degradable organic carbon in the waste type j (weight fraction)

K = Decay rate for the waste type j (1/year)

j = Type of residual waste or types of waste in the MSW

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

As per the methodology, Application B: The CDM project activity avoids or involves the disposal of waste at a SWDS best outfits the project case, therefore various default values are used as per the methodological tool which are listed in section 4.1.

4.2 Project Emissions

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

For Bio-methanation Project:

As per consolidated methodology ACM0022 para 65, equation 18, the project emissions from Bio-Methanation ($PE_{Bio-Methanation)}$ 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 CO_2e) 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 composting, gasification, no association of RDF/SB and incineration at the project site. Therefore, $PE_{COMP,y}$,$PE_{GAS,y}$,$PE_{RDF,SB,y}$ and $PE_{INC,y}$ are considered as zero.

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

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

Where:

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

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

$PE_{flare,y}$ = Project emissions from flaring of biogas in year yCO2e/yr)

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

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

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption associated with anaerobic digester in year y (t CO2e)

$Q_{CH4,y}$ = 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 (tCO2/MWh)

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

Where:

$Q_{CH4,y}$ = Quantity of methane produced in the digester in year y (tCH4)

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

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

φ_{CH4} = Density of methane at normal conditions (t CH4 / Nm3CH4)

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:

$PE_{FC,diesel,y}$ = the CO2 emissions from fossil fuel combustion in Bio-methanation during the year y (tCO2/yr)

$FC_{diesel,Bio-methanation,y}$ = Is the quantity of diesel combusted in Bio-methanation process during the year y (mass or volume unit/yr)

$COEF_{diesel,y}$ = Is the CO2 emission coefficient of fuel type i in year y (tCO2/mass or volume unit)

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

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

Where:

$COEF_{diesel,y}$ = Is the CO2 emission coefficient of diesel in year y (tCO_2/mass or volume unit)

$NCV_{diesel,y}$ = Is the weighted average net calorific value of the diesel in year y (GJ/mass or volume unit)

$EF_{CO2,diesel,y}$ = Is the weighted average CO2 emission factor of diesel in year y (tCO2/GJ)

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

Where:

$PE_{CH4,y}$ = Project emissions of methane from the anaerobic digester in year y (tCO2)

$Q_{CH4,y}$ = Quantity of methane produced in the anaerobic digester in year y(tCH4/yr)

$EF_{CH4,default}$ = Default emission factor for the fraction of CH4 produced that leaks from the anaerobic digester (fraction)

GWP_{CH4} = Global Warming Potential of CH4 (t CO2e/tCH4)

4.3 Leakage

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

$LE_{AD,y}$ = Leakage emissions associated with the anaerobic digester in year y (tCO2e)

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y(tCO2e)

$LE_{COMP,y}$ = Leakage emissions associated with composting digestate in year y (tCO2e)

In the Project case $LE_{Storage,y}$ is considered zero as the storage lagoon is not un-aerated. Also, LE_c, is calculated using the methodological tool "Project and leakage emissions from composting". The term $PE_{comp,y} + LE_{comp,y}$ in the methodological tool "Project and leakage emissions from composting"

provides the value for $LE_{comp,y}$ of this tool. Therefore, following equation (6) of this document is used to calculate the $LE_{comp,y}$.

4.4 Estimated Net GHG Emission Reductions and Removals

The net emission reduction are calculated as

$$ER_y = BE_y - PE_y - LE_y$$

Where:

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

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

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

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
Year 1	16,212	1,472	0	14,741
Year 2	38,056	2,039	0	36,017
Year 3	48,293	2,039	0	46,254
Year 4	55,155	2,039	0	53,116
Year 5	59,755	2,039	0	57,716
Year 6	62,839	2,039	0	60,800
Year 7	64,906	2,039	0	62,867
Total	**345,217**	**13,707**	**0**	**331,510**
Average	**49,317**	**1,958**		**47,359**

5 MONITORING

5.1 Data and Parameters Available at Validation

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

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	For the calculation of the Baseline Emission

Comments	When methane passes through the top-layer, part of it is oxidized by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidized to CO_2 This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

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

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	For the calculation of the Baseline Emission
Comments	-

Data / Parameter	k_j
Data unit	1/yr
Description	Decay rate for the waste type j
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	For the calculation of the Baseline Emission
Comments	-

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/t CH4
Description	Global Warming Potential of methane
Source of data	IPCC
Value applied:	25
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	For the calculation of the Baseline and Project Emission
Comments	-

Data / Parameter	f_y
Data unit	t CO_2e/t CH4
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
Source of data	CDM Methodological Tool 04, Version 08.0
Value applied:	0%
Justification of choice of data or description of measurement methods and procedures applied	Value shall be assigned taking into account the amount of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y comply with relevant regulations and contractual requirements of the host country. Since there exists no regulations or contractual requirement to capture and destroy the methane generated from the landfills in India, hence it has been fixed ex ante and assigned a value of 0%
Purpose of Data	For the calculation of the Baseline Emission
Comments	-

Data / Parameter	$EF_{EF,j,y}$
Data unit	tCO2/MWh
Description	Weighted average emission factor, CO_2 Baseline Database for the Indian Power Sector, Version 15.0
Source of data	Calculated from CEA database, Version 15, December 2019
Value applied:	0.83
Justification of choice of data or description of measurement methods and procedures applied	The data are obtained from “CO2 Baseline Database for Indian Power Sector” version 15, published by the Central Electricity Authority, Ministry of Power, Government of India.

Purpose of Data	For the calculation of the Project Emission
Comments	This parameter is fixed ex-ante for the entire crediting period.

Data / Parameter	$EF_{FC, default}$
Data unit	t CH_4 / t
Description	Default emission factor for fossil fuel consumed by the Bio-methantion activity per tonne of waste composted (wet basis)
Source of data	Data taken from the 2006 IPCC Guidelines
Value applied:	0.0207
Justification of choice of data or description of measurement methods and procedures applied	As per CDM Methodological tool 13, version 02.0: Based on a review of fossil fuel consumption per tonne of waste composed in relevant validation reports of CDM projects and using a conservative default emission factor for diesel.
Purpose of Data	For the calculation of the Project Emission
Comments	-

Data / Parameter	$f_{CH4,default}$
Data unit	m^3CH_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	The default value was derived based on reported values from registered projects and research papers (Davidsson, 2007)

procedures applied	
Purpose of Data	For the calculation of the Project Emission
Comments	-

Data / Parameter	φ_{CH4}
Data unit	m^3CH4 / m^3CH4
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	For the calculation of the Project Emission
Comments	-

Data / Parameter	$EF_{CH4,default}$
Data unit	T CH4 leaked / t CH4 produced
Description	Default emission factor for the fraction of CH4 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	The digester with steel concrete digester and a gas holding system (egg shaped digesters) and monolithic construction.

measurement methods and procedures applied	Therefore, the correspond default values is been considered.
Purpose of Data	For the calculation of the Project Emission
Comments	T CH4leaked / t CH4 produced

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

Data / Parameter	$EF_{CO2, diesel, y}$
Data unit	tCO2/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	For the calculation of the Project Emission
Comments	-

5.2 Data and Parameters Monitored

Data / Parameter	W_x
Data unit	T/yr
Description	Total amount of organic waste prevented from disposal in year 'x
Source of data	Plant records, weighbridge
Description of measurement methods and procedures applied	Quantity of waste composted is measured using electronic weighbridge regularly and records are kept on paper and electronically.
Frequency of monitoring/recording	Continuous with annual aggregation
Value applied:	38,494
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[9].
Purpose of data	Calculation of baseline emissions

[9] Meters Details has been provided in Appendix 1

Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	$RATE_{compliance,t,y}$
Data unit	Fraction
Description	State level compliance rate of the MSW Management Rules in that year y
Source of data	Preferably from secondary sources and alternatively from the Central Pollution Control Boards (CPCBs).
Description of measurement methods and procedures applied	Ratio of Quantity of Solid waste generated (TPD) to quantity of Solid waste treated (TPD) in India during the year y.
Frequency of monitoring/recording	Annually
Value applied:	0%
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 emissions
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	$EC_{PJ,j,y}$
Data unit	MWh
Description	Amount of electricity consumed from the grid as a result of the project activity

Source of data	Electricity meter reading from electricity meter bill by the State Electricity Board or any Private Supplier.
Description of measurement methods and procedures applied	Data is measured and recorded continuously through meters and meter readings are archived electronically. The data will be calculated by monitoring the difference between the reading in meter at the end of the month and beginning of the month. This parameter will be updated ex-post each year over the crediting period.
Frequency of monitoring/recording	Monthly
Value applied:	672 MWh
Monitoring equipment	Electricity meter (Electricity Board Energy Meter)
QA/QC procedures applied	As the meters will be maintained by third party agency the accuracy of data is ensured. The meters are entirely under the control of State Electricity Board/DISCOM. The metering system will be calibrated according to CEA regulations which specifies Electricity meters to be calibrated once in 5 years. Calibration frequency: One in five years[10]
Purpose of data	Calculation of Project emissions
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	Qy
Data unit	T/yr
Description	Quantity of waste composted in year y (wet basis)
Source of data	Plant Records/logbook
Description of measurement methods and procedures applied	Quantity of waste composted is measured using electronic weighbridge regularly and records are kept on paper and electronically.

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

Frequency of monitoring/recording	Continuous with annual aggregation
Value applied:	6310.4
Monitoring equipment	Weighbridge/logbooks
QA/QC procedures applied	As the weighbridge meter will be maintained by third party agency the accuracy of data is ensured. The weighbridge calibration frequency is under the control of third party and PP does not have control on it.
Purpose of data	Calculation of Project emissions
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	$Q_{biogas,y}$
Data unit	Nm^3 biogas
Description	Amount of biogas collected at the digester outlet in year y
Source of data	Plant records/logbook
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:	1,626,865 Nm^3
Monitoring equipment	Plant Records
QA/QC procedures applied	-

Purpose of data	Calculation of project emissions
Calculation method	The parameter is measured and if any calculation is required, the calculation is based on measured parameters.
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	$FC_{diesel,Bio\text{-}mathanation,y}$
Data unit	volume (m^3 /yr)
Description	Quantity of diesel combusted in Bio-methanation process during the year y
Source of data	Onsite Logbook
Description of measurement methods and procedures applied	Onsite Measurement The total number of operating hours of DG set and the corresponding quantity of diesel consumed for the purpose is recorded in the log book maintained at the DG set room. The operating hours and the quantity of diesel consumption is recorded.
Frequency of monitoring/recording	Continuous monitoring and monthly compilation
Value applied:	0.574 m^3
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 emissions for Bio-methanation project
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	$DOC_{f,y}$

Data unit	Weight fraction
Description	The fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	Declaration from project participant
Value applied:	0.9
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	For the calculation of the Baseline Emission
Comments	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS.

5.3 Monitoring Plan

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

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

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

AGENT	DELIVERABLE
	Overall responsible for completeness of data, reliability of data (calibration of meters, weighing machines measuring samples) and monthly report generation. Following shall be measured and recorded: *1)* Electricity consumption for equipment used on site. Data can be collected from electricity meter installed by state electricity board (a kWh-instrument).

	2) Fuel consumption for equipment used on site. Data can be based upon the received invoices for fuel. Operator shall keep/file receipt of invoices. ✓ Produced compost that is trucked off of site. ✓ Quantity of waste supplied to the compost plant will be measured by weighing on a weighbridge as described in the Monitoring plan. This information is required for calculation of the ER's ✓ Measurement of the composition of the incoming waste in accordance with the procedure as indicated in the sampling plan. ✓ Number and detail of vehicles that bring in the waste and the vehicles that transport compost to the end user.

Training and maintenance procedures:

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

Emergency Procedures for monitoring system:

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

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 Data and Parameters Monitored

Data / Parameter	W_x
Data unit	T/yr
Description	Total amount of organic waste prevented from disposal during monitoring period
Value applied:	**Bio-methanation-**

Project Instance sites	Total amount of organic wasted(T)
Aurangabad (30 TPD)	4,517
Piduguralla (20 TPD)	4,510
Adoni (20 TPD)	2,679

	Tirupati (40 TPD) | 4,426
Comments	The data would be archived electronically and maintained for the entire crediting period plus two years.

Data / Parameter	$RATE_{Compliance,t,y}$
Data unit	Fraction
Description	State level compliance rate of the MSW Management Rules in that year y
Value applied:	

Project Instance sites	2018[11]	2019[12]
Aurangabad (30 TPD)	0%	52.9%
Piduguralla (20 TPD)	0%	8.5%
Adoni (20 TPD)	0%	8.5%
Tirupati (40 TPD)	0%	8.5%

Comments	Ratio of MSW generated (TPD) to the MSW treated (TPD) in the States of India.

Data / Parameter	$EC_{P,j,y}$
Data unit	MWh
Description	Amount of electricity consumed from the grid as a result of the project activity during monitoring period
Value applied:	**Bio-methanation-**

Project Instance sites	Total amount of electricity consumed (MWh)
Aurangabad (30 TPD)	305.344
Piduguralla (20 TPD)	88.04
Adoni (20 TPD)	23.577
Tirupati (40 TPD)	106.668

[11] https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2017-18.pdf

[12] https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2018-19.pdf

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

Data / Parameter	Q_y
Data unit	T/yr
Description	Quantity of waste composted in year y (wet basis)
Value applied:	Bio-methanation-

Project Instance sites	Total amount of waste composted(T)
Aurangabad (30 TPD)	193
Piduguralla (20 TPD)	1102
Adoni (20 TPD)	428
Tirupati (40 TPD)	776

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

Data / Parameter	$Q_{Biogas,y}$
Data unit	Nm^3 biogas
Description	Amount of biogas collected at the digester outlet in year y
Value applied:	Bio-methanation-

Project Instance sites	Total amount of biogas collected at digester (Nm^3)
Aurangabad (30 TPD)	294,609
Piduguralla (20 TPD)	54,236
Adoni (20 TPD)	2,052
Tirupati (40 TPD)	90,311

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

Data / Parameter	$FC_{diesel,Bio\text{-}methanation,\ y}$
Data unit	Volume(m^3/yr)

Description	Quantity of diesel combusted in Bio-methanation process during the year y
Value applied:	**Bio-methanation-**

Project Instance sites	Total amount of diesel combusted(m^3)
Aurangabad (30 TPD)	0.242
Piduguralla (20 TPD)	0.229
Adoni (20 TPD)	0.133
Tirupati (40 TPD)	0.416

Comments	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities (invoices).

6.2 Baseline Emissions

For Bio-Methanation: -

$$BE_{CH4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^{3} \sum (W_{j,i} \times DOC_j \times e^{(-k_j \times (y-x))} \times (1 - e^{-k_j}))$$

Project Instance sites	Using the default and monitored values $BE_{Bio\text{-}methanation,\ y}$
Aurangabad (30 TPD)	4,419
Adoni (20 TPD)	2,530
Piduguralla (20 TPD)	1,898
Tirupati (40 TPD)	4,118
Total	12,963(Rounded Down)

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

6.3 Project Emissions

For Bio-methanation Project

Project emission is calculated using equation (7):

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

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

Therefore, project emission due to anaerobic digestion is calculated as

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

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

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

Project Instance sites	Using the default and monitored values $Q_{CH4,y}$
Aurangabad (30 TPD)	118
Adoni (20 TPD)	1
Piduguralla (20 TPD)	22
Tirupati (40 TPD)	37
Total	178

$PE_{EC,y}$ = 0

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

Project Instance sites	Using the default and monitored values $PE_{FC,diesel,y}$
Aurangabad (30 TPD)	0.61
Adoni (20 TPD)	0.35
Piduguralla (20 TPD)	0.61
Tirupati (40 TPD)	0.38
Total	1.95

Project Instance sites	Using the default and monitored values $PE_{Bio-methanation,\ y}$
Aurangabad (30 TPD)	85
Adoni (20 TPD)	1
Piduguralla (20 TPD)	17
Tirupati (40 TPD)	27
Total	130(Roundup)

6.4 Leakage

For Bio-methanation Project: As per Methodological tool 14 Version 2.0," Project and leakage emissions from anaerobic digesters", The leakage emissions associated with the anaerobic digester $LE_{AD,y}$ is

$$LE_{AD,y} = LE_{Storage,y} + LE_{Comp,y}$$

Where:

$LE_{AD,y}$= Leakage emissions associated with the anaerobic digester in year y (tCO2e)

$LE_{Storage,y}$ = Leakage emissions associated with storage of digestate in year y (tCO_2e)
$LE_{Comp,y}$ = Leakage emissions associated with composting digestate in year y(tCO_2e)

In the Project case $LE_{Storage,y}$ is considered zero as the storage lagoon is not un-aerated.
Also, LE_c, is calculated using the methodological tool "Project and leakage emissions from composting". The term $PE_{comp} + LE_{comp}$, in the methodological tool "Project and leakage emissions from composting" provides the value for LE_{Comp} ,of this tool. Therefore following equation (6) of this document is used to calculate the LE_{comp},. **As per section 3.3 and using Equation (6),** $LE_{comp,\ y}$

$$LE_{Comp,y}\ is\ PE_{COMP,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{N20,y} + PE_{RO,y}$$

The value for LE_{Comp} is Negligible considered as zero.

Project Instance sites	Using the default and monitored values LE_y
Aurangabad (30 TPD)	0
Adoni (20 TPD)	0
Piduguralla (20 TPD)	0
Tirupati (40 TPD)	0
Total	0

6.5 Net GHG Emission Reductions and Removals

The total emission reduction achieved in current monitoring period is

ER_y = $BE_y - PE_y - LE_y$

= 12,833 tCO_2e

Where,

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

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

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

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

= 12,833 tCO_2 (Rounded down)

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

2019(01/05/2019 to 31/12/2019)	1,806	35	-	1,771
2019(01/01/2020 to 31/12/2020)	11,157	95	-	11,062
Total	12,963	130		12,833

The ER estimated during the current monitoring period (611 days) is 79,278. The ER generated during the current monitoring period is 84 % less than the estimated values, which is conservative.

Further breakdown of credit generation from each Project Instance sites:

Bio Methanation (Aurangabad – 30 TPD)				
Monitoring Period	**Baseline Emissions (BE_y)**	**Project Emissions (PE_y)**	**Leakage Emissions (LE_y)**	**Emission Reductions (ER_y)**
	(tCO_2e)	**(tCO_2e)**	**(tCO_2e)**	**(tCO_2e)**
2019(01/05/2019 to 31/12/2019)	908	29	0	879
2020 (01/01/2020 to 31/12/2020)	3511	56	0	3455
Total	**4419**	**85**	**0**	**4,334**

Bio Methanation (Adoni – 20 TPD):				
Monitoring Period	**Baseline Emissions (BE_y)**	**Project Emissions (PE_y)**	**Leakage Emissions (LE_y)**	**Emission Reductions (ER_y)**
	(tCO_2e)	**(tCO_2e)**	**(tCO_2e)**	**(tCO_2e)**
2019(01/05/2019 to 31/12/2019)	0	0	0	0
2020 (01/01/2020 to 31/12/2020)	2530	1	0	2529
Total	**2530**	**1**	**0**	**2,529**

Bio Methanation (Tirupati - 40 TPD):				
Monitoring Period	**Baseline Emissions (BE_y)**	**Project Emissions (PE_y)**	**Leakage Emissions (LE_y)**	**Emission Reductions (ER_y)**
	(tCO_2e)	**(tCO_2e)**	**(tCO_2e)**	**(tCO_2e)**
2019(01/05/2019 to 31/12/2019)	327	4	0	323
2020 (01/01/2020 to 31/12/2020)	3790	23	0	3767
Total	**4118**	**27**	**0**	**4,091**

Bio Methanation (Pidugaralla – 20 TPD):					
Monitoring Period		**Baseline Emissions (BE_y)**	**Project Emissions (PE_y)**	**Leakage Emissions (LE_y)**	**Emission Reductions (ER_y)**
		(tCO_2e)	**(tCO_2e)**	**(tCO_2e)**	**(tCO_2e)**
2019(01/05/2019 to 31/12/2019)		572	2	0	570
2020 (01/01/2020 to 31/12/2020)		1326	15	0	1311
Total		**1898**	**17**	**0**	**1,881**

APPENDIX 1: <CALIBRATION DETAILS >

Bio-Methanation Plant: -

Aurangabad Plant (30 TPD): -

Weighbridge Details: -

S.NO	1/1 (Rs.4000)		
MAX Capacity	40000 Kg		
Make	Prime & Automation		
Model	Class III		
Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	24/04/2019	Validity	23/04/2020
Calibration Date	28/08/2019	Validity	27/08/2020
Calibration Date	26/08/2020	Validity	25/08/2021

Electricity Meter Details: -

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

Tirupati Plant (40 TPD): -

S.NO	WB1321 (Rs.2500)
MAX Capacity	50000 Kg
Make	Prime & Automation
Model	Class III

Minimum Capacity	100 Kg		
Minimum Value	5 Kg		
Calibration Date	20/08/2019	Validity	19/08/2020
Calibration Date	08/06/2020	Validity	07/06/2021

Electricity Meter Details: -

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

Piduguralla Plant (20 TPD): -

S.NO	130408		
MAX Capacity	60000 Kg		
Make	LOTUS		
Model	Class III		
Minimum Capacity	200 Kg		
Minimum Value	5 Kg		
Calibration Date	25/05/2019	Validity	24/05/2020
Calibration Date	23/05/2020	Validity	22/05/2021

Electricity Meter Details: -

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

Adoni Plant (20 TPD): -

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

Electricity Meter Details: -

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