Project design document form
(Version 11.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	IOT Mabagas Limited power plant, Pudhuchatram
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	5.5
Completion date of the PDD	12/09/2019
Project participants	IOT Mabagas Limited (IML) Carbonbay GmbH & Co. KG
Host Party	India
Applied methodologies and standardized baselines	AMS-III.AO. Version 1.0 - Methane recovery through controlled anaerobic digestion AMS-I.D. Version 17 - Grid connected renewable electricity generation
Sectoral scopes	1: Energy industries (renewable - / non-renewable sources) 13: Waste handling and disposal
Estimated amount of annual average GHG emission reductions	22,355 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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Project Participants

IOT Mabagas Limited (IML) is a 50: 50 joint venture (JV) company between M/s IOT Infrastructure & Energy Services Limited and Mabagas International, Germany. IOT is group company of M/s Indian Oil Corporation (State Owned Navarathna Oil Company in India) and Mabagas International is 100% subsidiary of Marquard & Bahls, Germany. IML is formed to invest, build, own and operate renewable energy projects in India with specific focus on waste to energy plants. IML believes that waste management and converting the waste into useful energy is on one hand a great challenge to society and on the other hand a great opportunity for a more sustainable future.

Project activity In the village of Thattayangarpatti, in the Puduchatram block of Namakkal district, the project participant, IML, intends to build and operate an anaerobic digestion plant. The plant will produce biogas with which 2.4 MW of renewable electricity will be generated as part of the proposed greenfield project activity. Through this project activity the amount of greenhouse gases (methane and carbon dioxide) emitted into the atmosphere will be reduced. Pre-Project Scenario In the pre-project scenario, poultry litter is generated at poultry farms in Namakkal district. The bottom of the cages is open, hence litter is allowed to drop down and pile up continuously. After a period of up to six months the litter will be collected and transported to a nearby drying yard or dumping area where it is allowed to further degrade. Such storage conditions and piling up results in anaerobic conditions, leading to methane emissions into the atmosphere due to anaerobic decomposition of the poultry litter. Further feedstock for the project activity are cow dung, and waste streams from the sugar and tapioca processing industries. These wastes are left to decay or not handled properly (stockpiled or treated in uncovered lagoons without proper aeration as further elaborated in table 4.1.c below) and therefore release methane into the atmosphere. This methane release is avoided by treating it in waste-to-energy plants such as the proposed project activity. However, since the Project Participant cannot properly determine the exact baseline for these additional waste streams, their baseline emissions are not included in the emission reduction calculations as stipulated by the used small-scale methodology. International Business Publications states that in this regard the Indian Ministry of New and Renewable Energy (MNRE) is acting upon the notion that rapid industrialization is responsible for huge quantity of wastes, both solid and liquid, in industrial sectors such as sugar (Press mud – is a waste product of the sugar industry), sago (sago water is an effluent from the sago industry where tapioca is transformed to sago) / starch, poultries etc., which are typically dumped on land or discharged into water bodies, without the use of adequate treatment, thereby causing environmental pollution and hazard to health[1]. Similarly, FICCI reports[2] (section 3.3.4) that methane release during the treatment of press mud by sugar mills and distilleries during composting and ill-operated aerobic treatment is not uncommon in India (although the majority of methane release is from anaerobic open lagoons for the treatment of spent wash). FICCI also reports that animal husbandry practices in India cause GHG emissions at the stage of manure management. Besides MNRE and FICCI, the UNDP reports the GHG savings that can be made from switching from open lagoon systems as commonly used for sago waste water treatment to closed anaerobic digesters[3]. Post - Project Scenario In the post-project scenario, the project participant procures the poultry litter from the nearby poultry farms in the district. The other wastes (cow dung and agri wastes.) are also procured from nearby sites. The litter will be collected each 10 to 15 days and will be delivered to a substrate storage area at site and is off-loaded onto a scraper floor (bunker type feeding system) together with the other wastes. All wastes are fed into 4 continuously stirred digesters with a total working volume of 16,000 m3.

[1] International Business Publications paragraph 4.39 page 110 Energy Policy, Laws and Regulations Handbook, Volume 1: http://books.google.nl/books?id=nB2XgE_JvWcC&lpg=PA1&hl=nl&pg=PA20#v=onepage&q&f=false

[2] www.globalmethane.org/Data/292_5_ficci_resource_assess_jan_10.pdf

[3] see IRR Annex 15 page 33ff.

Under controlled conditions biogas is produced through a bio-methanation process, which recovers the methane (biogas) from the litter. The biogas that is generated in the digesters is taken out through a common pipe and is then cooled down to remove moisture before it is fed via blowers into 2 x 1.2 MW biogas engines (2.4 MW total capacity) for the generation of power. The generated electricity (after consuming for internal operation of the plant) is supplied to the state electricity board via a dedicated 22 kV transmission line feeder to the nearby substation. The supplied electricity is sold by the project participant to the distribution licensee as per the modalities of the Energy Biomass Purchase Agreement[4].

The basic technology concept for the project activity is reaching maturity in western countries especially in Germany (where Mabagas has prior experience with a biogas plant in Lünen) and the Netherlands. IML is aiming to adapt the technology know-how existing in Europe to domestic circumstances and environments. However, the amount of poultry litter to be digested in the planned project activity is unusually high and poses technological challenges since no similar plant exists to serve as a role model. PP have a research lab in Mumbai conducting experiments on Continuous Stirred Tank Reactor (CSTR) models of digesters to simulate operating conditions of a prototype of biogas plant, which is envisaged in the proposed project activity. So far around 10 batch tests are successfully conducted. Also the PP have been sending samples of solid and liquid fertilizers to other reputed labs for substantiations of results.

The plant is designed to operate on a mix of approximately 37,000 metric tonnes per annum of poultry litter, 58,000 metric tonnes per annum of agricultural waste streams from the sugar and tapioca processing industries and 1,825 metric tonnes per annum of cow dung. This should result in generation of around 7.9 million cubic meters per annum of biogas, which is expected to generate around 15.4 GWh of gross electricity. Thus, the project activity contributes to the reduction in GHG emissions on account of:
a. Methane Avoidance: The project activity avoids methane release in the atmosphere that would have occurred due to uncontrolled poultry litter disposal / storage practices in the district.
b. Power generation: The project activity generates electricity from the biogas generated from the poultry litter and organic wastes thereby replacing equivalent grid mix in the Southern grid.

It is estimated that the proposed project activity will abate approximately 22,355 tCO2e per annum.

Sustainable development:

The project activity contributes to the sustainable development criteria set by the host country Designated National Authority (DNA), the National Clean Development Mechanism Authority (NCDMA), for CDM projects in the following manner:

Social well-being
The project activity is expected to contribute to social well-being by:
• Creating direct and indirect employment for the local rural population. Many people would be employed directly on site by the private entity (approx. 30), whereas numerous indirect jobs would be created in the collection and logistics activity of the biogas plants to ensure continuous substrate supply. Further, indirect jobs are needed in the upgrading, bagging and distribution of the organic fertilizer from the plant. Thus the project activity will contribute to raising the living standard of the local rural population.
• Improving the waste management practice and thereby improving the environmental quality of life of the local community: the frequent removal of poultry litter is required to sustain the continuous feeding of the biogas plant and would replace the otherwise uncontrolled disposal practices of the litter. This would lead to a reduction of bad odour and vector breeding in the surrounding areas of the poultry farm and help alleviate this clearly felt nuisance by the local population.

Economic well-being
The project activity is expected to contribute to economic well-being by:

[4] Biomass Energy Purchase Agreement document made available to DOE.

• Contributing to the economic development of the region through the capital investment required for the construction of the plant;
• Creating economic activities and thereby creating jobs for the rural population;
• Diversifying the national energy supply;
• Reducing the power deficit in the state of Tamil Nadu.

Environmental well-being

The project activity is expected to contribute to environmental well-being by:
• Utilizing biomass residues and poultry litter which, in the absence of the project activity, would be left to decay and thus lead to uncontrolled methane emissions to the atmosphere as a result of the decaying process;
• Displacing carbon intensive grid-based power supply and hence reduce the carbon intensity of power production in Tamil Nadu by generating electricity from a renewable source;
• Providing high quality organic fertilizer and soil conditioner to local farmers and traders, which is produced as a by-product of the biogas production process;
• Reducing the danger of disease in people and animals as the controlled two-stage anaerobic digestion process nearly completely eliminates pathogens, germs and parasites.

Technological well-being

The project activity is expected to contribute to technological well-being by:
• Disseminating technological knowledge and know-how by introducing state-of-the-art technology adapted to local circumstances;
• Promoting technology transfer and encouraging further project development by demonstrating the feasibility of such a biogas plant in India;
• Increase security of electricity supply by adding local generation capacity.

A.2. Location of project activity

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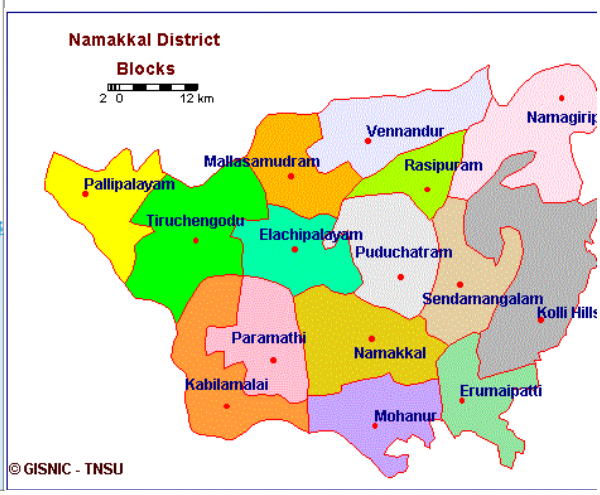
Thattayangarpatti Village, Pudhuchatram, Namakkal District, Tamil Nadu, India.

The project is located at SF. Nos.52/1, 52/2, 53/1A and 53/2A at Thattayangarpatti Village, Pudhuchatram block, Namakkal taluk in Namakkal District - 637018, Tamil Nadu, India. The unique coordinates (latitude and longitude) are 11°23'29.64"N by 78°10'41.44"E. The physical location of the project activity is indicated on the maps below.



A.3. Technologies/measures

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As per Appendix B of the Simplified Modalities and Procedures for Small-Scale clean development mechanism project activities, the proposed project activity belongs to the following types of small-scale project activity:

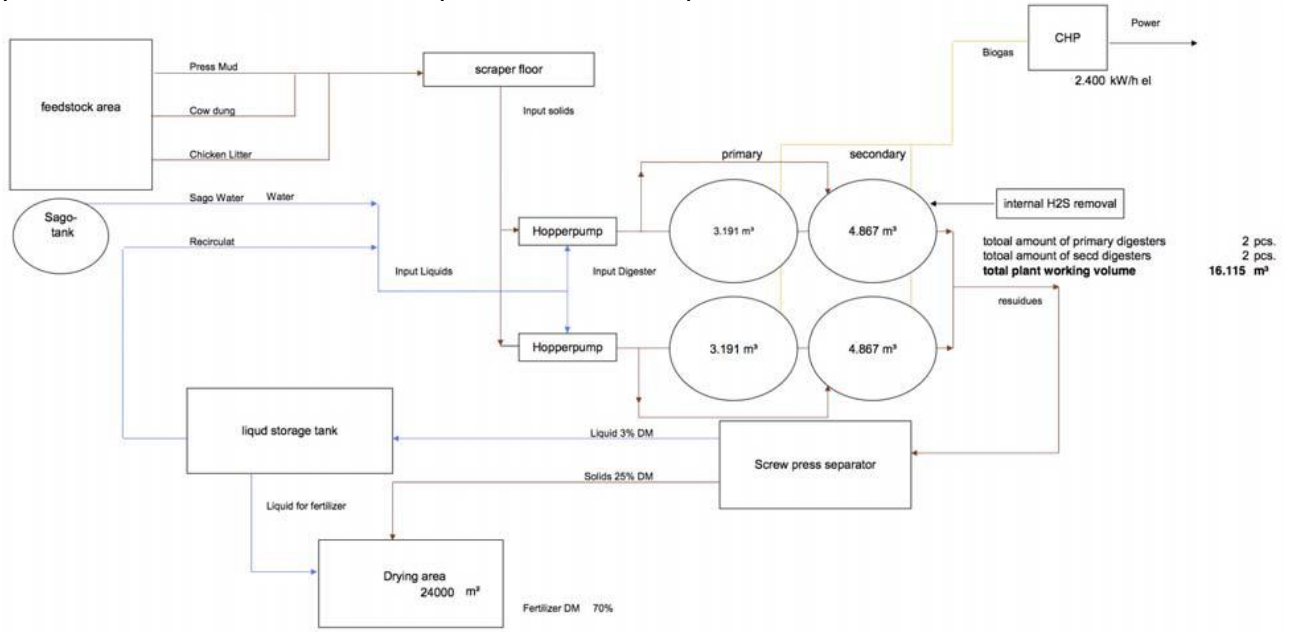
Type	Category	Sectoral scope
I: Renewable energy projects	D - Electricity generation for a system[5]	Scope 1, Energy industries (renewable / non-renewable sources)
III: Other project activities	M - Methane recovery[6]	Scope 13, Waste handling and disposal

Technology/ measures of the small-scale project activity

PROCESS PRINCIPLE

Biogas typically refers to gas produced by the biological break-down of organic matter by concerted action of various groups of anaerobic bacteria in the absence of oxygen (anaerobic process). The Gas comprises mainly of methane and carbon dioxide.

The Principle equipment for enabling the biogas production process is temperature controlled digesters to enable bacterial activity. The digesters are sealed vertical vessels, where fermentation takes place to produce CH4 (methane) and CO2 (carbon dioxide). A nutrient rich sludge is produced as a residue and continuously removed from the digesters. For efficient biogas production, various factors such as biogas potential of waste, design of digester, inoculums, nature of substrate, pH, temperature, loading rate, hydraulic retention time (HRT), C:N ratio, and volatile fatty acids (VFA) play a major role. The basic design of the biogas plant is based on these. A process scheme has been developed for its efficient production.



[5] http://cdm.unfccc.int/methodologies/DB/RSCTZ8SKT4F7N1CFDXCSA7BDQ7FU1X/view.html

[6] http://cdm.unfccc.int/methodologies/DB/F5U41CTG7ENWK9RSSL5BV1LUPDG76W/view.html

Figure 1: Process scheme[7]

PROCESS DESCRIPTION

Waste & Storage

The waste includes animal waste (poultry litter and cow dung) and industrial waste (press mud and sago water)[8] . It is brought from its source destination to the storage area of the plant by means of trucks and tankers. The storage area has a capacity of 1,950 m^3. The solid wastes are mixed at the storage area thus creating a solid substrate. The daily input of substrate will be 210 metric tonnes (300 m^3) hence the storage area is able to store substrate for 6.5 days. Sago water is stored in a tank with a capacity of 1,000 m3 . Sago water from the sago water tank is fed directly into the digesters. The re-circulate water (from the primary and secondary digesters) is fed to the feed mixing pump and pumped to feed hopper pump. It is mixed with the solid substrate in the feed hopper pump and fed to the primary digester. Using poultry litter as a mono substrate causes many problems. One is the high ammonia concentration. This will cause a slow down of the degradation process up to an intoxication of the bacteria. Second, due to its high dry matter content poultry litter needs a high dilution rate. If this is only achieved by water the organic load of the digester becomes too low or the retention time is to short. For this reason we are adding agricultural waste products which also stabilize the biological process The storage area stores poultry litter, press mud and cow dung. Substrate will be handled on a “first in, first out” base to avoid rotting of the substrate in the storage area. Two bunkers are provided for two Digester lines. Each bunker, rectangular box type is designed for a storage capacity of 12 hours provided with load cells for weighing. These bunkers have a scraper floor mechanism to transfer the feed to the Feed Hopper Pump.

Primary Digester

Two digester lines, with each one primary digester, will be running in parallel to ensure continuous running of the Biogas plant. The two digesters shall have a volume of 3,200 m3 volume each. The material of construction shall be carbon steel. Four agitators per digester shall be provided to achieve the uniform mixing. Agitators shall be propeller type. Double gas membranes shall be mounted on top of each digester to allow for gas storage for at least 3 hours operations. Digesters shall be envisaged as per the requirement of local and statutory authority to prevent ground water and soil contamination

Secondary Digester

Digesters shall be sized for 4,900 m3 volume each. The construction is similar to the primary digesters. Secondary digesters will each have five agitators per digester to achieve the uniform mixing. All other design parameters are similar to the primary digesters. In order to maintain the balance in organic loading, inter-tank transfer of the substrate will be done as and when required, with the aid of pumps and inter-connections provided. In the digester, the degradation process of the organic components is affected by means of microorganisms. The total retention time in the digesters is about 35 days during which biogas generation happens. With continuous feed and mixing arrangement within the digester, the generation of biogas is sustained as a continuous process.

Power Unit

The biogas collected at the gas membrane located on top of the primary & secondary digester, is directed to the 2 x 1.2 MWe (2.4 MWe) Power units. According to the O&M contract the engines are expected to run 8,000 hours per year and generate 18.2 GWh gross per year. After utilization for internal plant operation, approximately 15.6 GWh of electricity will be evacuated at 22 kV level to the power grid through a transformer and switch guard.

Manure Drying & Compost Upgradation

[7] Mass balance/ detailed project scheme is provided to the DOE

[8] As per SD_14 Mass balance, made available to DOE.

The digested slurry from the secondary digester is pumped by means of extruder pumps to a screw extruder. The solid phase (containing 70-80 % moisture) from the extruder will drop down into a dumper and be taken to the manure-drying yard, which is an open space drying area by natural solar drying process. The dried solid manure will be bagged and marketed. The liquid phase (containing 2 - 3 % dry solids) from the extruder will be collected in a liquid filtrate tank. The liquid is rich in organic matter. Part of the liquid will be used as process water for dilution; the rest of the liquid phase will be spread over the solid fertilizer to add the nutrients to the fertilizer. The expected volume of the liquid fraction is around 85,000 t/y of which 50% is recirculated into the digester system, and 50% is sprayed as liquid fertilizer on the drying compost.

Back-up & emergency flare

In case of prolonged maintenance schedules the gas can be stored in four gas holding roofs and if need be burnt in a dedicated on-site enclosed emergency flare to avoid methane emissions.

Technology Transfer

As described in the "Personal & Training plan"[9] the unique joint venture between Mabagas International and IOT will lead to one of the first large-scale indigenous biogas plants with a sophisticated process control system to deliver reliable level of automation (combining German process know-how, considering both local Indian Building & Process Standards and employment regulations). Over the past two years over 20 visits (with a total of over 150 man days) by Mabagas personnel to IOTM headquarters have taken place to develop and a design the plot and process layout between IOT Infra and Mabagas International. Mabagas International will continue this partnership to transfer the needed knowledge and technology for the complete plant operation. Further key plant staff of the Puduchatram biogas plant will be trained in Germany in process logic control and also in biogas plant management.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
India (host Party)	IOT Mabagas Limited (IML)	No
Germany	Carbonbay GmbH & Co. KG	No

A.5. Public funding of project activity

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The project activity does not receive any public funding.

A.6. History of project activity

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The proposed CDM project activity is neither registered as a CDM project activity nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA).

A.7. Debundling

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As per Appendix C of the Simplified Modalities and Procedures for Small-Scale clean development mechanism project activities and as per the Guidelines on assessment of debundling for SSC project activities (Version 03):

[9] IOTM training and org personnel 3.11.2011.pdf made available to the DOE.

"A proposed small-scale project activity shall be deemed to be a debundled component of a large project activity if there is a registered small-scale CDM project activity or an application to register another small-scale CDM project activity:

(a) With the same project participants;
(b) In the same project category and technology/measure; and
(c) Registered within the previous two years; and
(d) Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point".

In the case of the proposed project activity, there is no registered small scale CDM project activity or an application to register another small-scale CDM project activity:
• With the same project participants;
• In the same project category and technology/measure;
• Registered within the previous two years;
• Whose project boundary is within 1 km of the project boundary of the proposed small-scale activity at the closest point".

Therefore, the proposed project activity is not a debundled component of a larger project activity. Considering the above, the proposed project is not a debundled component of a larger project.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

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The approved baseline and monitoring methodologies and methodological tools applied to the project activity are:

Methodology number (and version)	Title
AMS-I.D (version 17)	Grid connected renewable electricity generation[10].
AMS-III.AO (version 01)	Methane recovery through controlled anaerobic digestion[11]

Title	Version
Tool to calculate the emission factor for an electricity system.	02.2.1
Tool to determine project emissions from flaring gases containing methane.	01
Tool to calculate project or leakage CO2 emissions from fossil fuel combustion.	02
Tool to calculate baseline, project and /or leakage emissions from electricity consumption	01

B.2. Applicability of methodologies and standardized baselines

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Justification of the choice of baseline methodology and its applicability to the project activity:

Applicability conditions of AMS-I.D (version 17):

10 http://cdm.unfccc.int/filestorage/V/9/L/V9LRSXKP24Q7YT6HZDUBO3C0ING8AJ.1/EB61_repan17_Revision_AMS-I.D_ver17.pdf?t=NEp8bTI3OXd0fDAURFeTc9mjSNFlv4Ut8sIc

11 http://cdm.unfccc.int/filestorage/C/D/M/CDM_AMSU745LJQM81SDJJOJ2S4G7ID9EIKFGD/EB58_repan16_AMS-III.AO.pdf?t=Vkh8bTI3OXlofDDDIH2CC5hdt_Ueh3CV_10i

The applicability conditions as per methodology AMS I.D. Grid connected renewable electricity generation (version 17), are as follows:

Table 3 Applicability conditions of AMS-I.D version 17

Nr	Applicability Conditions	Justifications
1	*This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass:* *(a) Supplying electricity to a national or a regional grid; or* *(b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.*	The project activity involves renewable energy generation by utilizing biogas originating from the digestion of renewable biomass and will supply electricity to the national grid of India (option a). The national grid of India is divided into two regional grids, the NEWNE Grid and the Southern Grid. The project will supply electricity to the Southern Grid.[12]
2	*Illustration of respective situations under which each of the methodology (i.e. AMS-I.D, AMS-I.F and AMS-I.A) applies* **Table 2: Applicability of AMS-I.D, AMS-I.F and AMS-I.A based on project types** Project type / AMS-I.A / AMS-I.D / AMS-I.F 1 Project supplies electricity to a national/regional grid / / √ / 2 Project displaces grid electricity consumption (e.g. grid import) and/or captive fossil fuel electricity generation at the user end (excess electricity may be supplied to a grid) / / / √ 3 Project supplies electricity to an identified consumer facility via national/regional grid (through a contractual arrangement such as wheeling) / / √ / 4 Project supplies electricity to a mini grid[17] system where in the baseline all generators use exclusively fuel oil and/or diesel fuel / / / √ 5 Project supplies electricity to household users (included in the project boundary) located in off grid areas / √ / /	As per *Definition of renewable biomass*, EB 23, Annex 18 and *Glossary of CDM terms* (Version 05) the renewable biomass used in the proposed project activity will fall under the renewable biomass sub-category "biomass residue", which is defined as biomass by-products, residues and waste streams from agriculture, forestry, and related industries. The generated electricity is sold to the Southern Grid of India, hence the project activity complies with this requirement.
3	*This methodology is applicable to project activities that: (a) Install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) Involve a capacity addition; (c) Involve a retrofit of (an) existing plant(s); or (d) Involve a replacement of (an) existing plant(s).*	The project activity comprises the installation of a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (greenfield plant, option (a)).
4	*Hydro power plants with reservoirs that satisfy at least one of the following conditions are eligible to apply this methodology:* *• The project activity is implemented in an existing reservoir with no change in the volume of reservoir;* *• The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m2;* *• The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m2.*	These conditions are not applicable as the project activity is not a hydro project.
5	*If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.*	The unit has only a renewable component. Its installed capacity will be 2.4MW and hence does not exceed 15MW.

[12] Biomass Energy Purchase Agreement dated 9th Feb 2011 made available to the DOE.

6	*Combined heat and power (co-generation) systems are not eligible under this category.*	The project activity will convert biogas to electricity using gas engines, and hence cannot be classified as a co-generation system.
7	*In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.*	The project activity comprises a Greenfield project; hence this criterion is not applicable.
8	*In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.*	The project activity envisages the installation of a new facility with a power generation potential of 2.4 MW. Throughout the project lifetime it will remain less than 15 MW. This criterion is therefore not applicable.

In sum, the project activity meets all applicability criteria of the methodology AMS I.D. Grid connected renewable electricity generation - version 17.

Applicability conditions of AMS-III.AO (version 01):

The applicability conditions as per methodology AMS-III.AO Methane recovery through controlled anaerobic digestion (version 01), are as follows:

Table 4 Applicability conditions of AMS-III.AO version 01

<table>
<tr><th>Nr</th><th colspan="2">Applicability Conditions</th><th>Justifications</th></tr>
<tr><td>1</td><td colspan="3">This methodology comprises measures to avoid the emissions of methane to the atmosphere from biomass or other organic matter that would have otherwise been left to decay anaerobically in a solid waste disposal site (SWDS), or in an animal waste management system (AWMS), or in a wastewater treatment system (WWTS). In the project activity, controlled biological treatment of biomass or other organic matters is introduced through anaerobic digestion in closed reactors equipped with biogas recovery and combustion /flaring system.

The project activity comprises of wastes that would most likely have otherwise been left to decay anaerobically in the baseline. For chicken litter the PP can prove this. Due to the lack of numeric data and scientific assessments the PP cannot prove this for the other waste streams considered (cow dung, agricultural waste). Hence – as per methodology – the baseline emissions for these other waste are assumed zero (see below under 1.c. for more details). The baseline emissions are avoided by introducing an anaerobic digestion system with closed reactors. The biogas is either combusted or flared.

The following conditions apply:</td></tr>
<tr><td></td><td>(a) Digestion of biomass or other organic matter (excluding animal manure and sludge generated in the wastewater treatment works) as a single source of substrate is included;</td><td>The project activity involves the co-digestion of multiple sources of biomass substrate i.e. poultry litter, cow dung and organic wastes from sugar and starch processing.
Hence, requirement 1(a) is not applicable.</td></tr>
<tr><td></td><td>(b) Co-digestion of multiple sources of biomass substrates, e.g. MSW, organic waste, animal manure, wastewater, where those organic matters would otherwise have been treated in an anaerobic treatment system without biogas recovery is also eligible;</td><td>The project activity involves the co-digestion of multiple sources of biomass substrate i.e. poultry litter, cow dung and organic wastes from sugar and starch processing.
In the absence of the project activity these biomass substrates would mostly be left to decay in uncontrolled manner, leading to (partial) anaerobic decomposition without biogas recovery (see also response under condition (c) below).

In the proposed project activity the recovered biogas will be fed into gas engines for power generation.
Hence, the proposed project activity meets requirement 1(b).</td></tr>
</table>

	(c) If for one or more sources of substrates, it cannot be demonstrated that the organic matter would otherwise been left to decay anaerobically, baseline emissions related to such organic matter shall be accounted for as zero, whereas project emissions shall be calculated according to the procedures presented in this methodology for all codigested substrates;	In the proposed project activity, emission reductions specific to methane avoidance are claimed only for poultry litter, and not for cow dung or agricultural waste. The baseline scenario related to methane emission is explained in detail only for poultry litter. Cow dung: Animal husbandry in India contributes overwhelmingly to the total greenhouse gas emissions of the Indian agricultural sector. The Federation of Indian Chamber of Commerce and Industry (FICCI)[13] reports (especially section 3.1 & 3.2) that manure management of livestock in India contributes 9% (or 1.09 Tg) of total methane emissions from the livestock sector (91% due to enteric fermentation). The FICCI report further describes that of the manure • 40% is aerobically treated for composting, • 40% is piled up or dumped in pits thus resulting in • CH4 emissions; and • 20% is used as cooking fuel or heating purposes It is evident from the animal husbandry practices in India that GHG emissions (both CO2 during combustion and CH4 in anaerobic condition of stockpiling (SWDS) and dumping (AWMS)) occur at the stage of manure management. Small holder farmers in the vicinity of the project location hold 1 to 5 cows in semi-confined conditions. Conditions are not equal in all situations; hence it is impossible for the PP to prove the baseline emissions. In line with §1 (c) of AMS-III.AO PP sets baseline emissions of cow dung to zero.	
		Agricultural wastes: The below links it is noted that there are no regulations from the Government of India for starch industry to recover methane from the waste water. http://envirocare.co.in/environmental-standards-inindia.htm http://cpcb.nic.in/Industry_Specific_Standards.php http://cpcb.nic.in/Industry-Specific-Standards/Effluent/453-1.pdf http://www.methanetomarketsindia.com/htm/indianregulation.htm The Indian Ministry of New and Renewable Energy reports that rapid industrialization is responsible for huge quantity of wastes, both solid and liquid, in industrial sectors such as sugar, sago / starch, poultries etc., which are typically dumped on land or discharged into water bodies, without the use of adequate treatment, thereby causing environmental pollution and hazard to health. Similarly, FICCI reports (section 3.3.4) that methane release during the treatment of press mud by sugar mills and distilleries during composting and ill-operated aerobic treatment is not uncommon in India (although the majority of methane release is from anaerobic open lagoons for the treatment of spent wash (WWTS)). Besides MNRE, the UNDP reports the GHG savings that can be made from switching from open lagoon systems as commonly used for sago waste water treatment to closed anaerobic digesters.	

[13] www.globalmethane.org/Data/292_5_ficci_resource_assess_jan_10.pdf

			In consideration of the reported environmental pollution by MNRE (quoted by IBP)[14][15], the UNDP[16] and FICCI[17] for the current waste management practices of sugar starch mills and sago water, assuming a baseline of "zero" greenhouse gas emission is a conservative approach. A quantitative analysis of the described qualitative baseline practice cannot be computed due to the lack of numeric data and scientific assessment. Total gas production of all substrates is taken into account when calculating PE_{flare}, $PE_{leakage}$. PE for transport are calculated for each substrate. Therefore, the proposed project activity complies with this requirement.	
		(d) Project participants shall apply the procedures related to the "competing use for the biomass" according to the latest General guidance on leakage in biomass project activities;	In compliance with paragraph 18 of the General guidance on leakage in biomass project activities (Version 03), it is demonstrated at the beginning of the crediting period of the proposed project activity, that the quantity of available biomass in the region is at least 25% larger than the quantity of biomass that is utilised including the project activity. The quantities for the biomass generated in the region are as follows: -Poultry litter generated (tons/day): 436 tons; - Agricultural biomass residues (tons/day): 110-290 tons (depending on the season); - Agricultural biomass residues (m3/day): 775 m3 (approx. 775 tons when assuming density is close to 1 t/m3) -Cow dung generated (tons/day): 2242 tons; The quantities for the biomass required for the proposed project activity are as follows: -Poultry litter required (tons/day): 101 tons hence the quantity of available biomass in the region is more than 300% larger than the quantity needed by the project, this is more than the required 25% threshold; -Agricultural biomass residues mainly obtained from the sugar & starch industry (tons/day): 159 tons (hence the quantity of available biomass in the region (≈ 110 + 775 tons) is more than 450% larger than the quantity needed by the project, this is more than the required 25% threshold); -Cow dung required (tons/day): 5 tons (hence the quantity of available biomass in the region (2242 tons) is more than 447 times larger than the quantity needed by the project, this is more than the required 25% threshold; For the quantities of biomass generated in the region, reference is made to Tide Technocrats Private Limited (Bangalore), *Assessment Report of feedstock availability and market for biomethanation solids* (April 2011), which is the most recent relevant study available for the aforementioned biomass in the project region.[18] For the quantities required by the project plant reference is	

[14] International Business Publications paragraph 4.39 page 110 Energy Policy, Laws and Regulations Handbook,
Volume 1:
http://books.google.nl/books?id=nB2XgE_JvWcC&lpg=PA1&hl=nl&pg=PA20#v=onepage&q&f=false

[15] http://www.mnre.gov.in/related-links/offgrid/waste-to-energy

[16] see IRR Annex 15 page 33ff – report made available to the validator.

[17] section 3.3.4 http://www.globalmethane.org/Data/292_5_ficci_resource_assess_jan_10.pdf

[18] Tide Technocrats Private Limited (Bangalore), *Assessment Report of feedstock availability and market for biomethanation solids* (April 2011). Document made available to the DOE

		made to the Detailed Project Report of the proposed project activity, made available to the DOE.[19] The leakage referred to in General Guidance on leakage in biomass project activities (version 03), paragraph 18 is not applicable to the proposed project activity. The proposed project activity complies with the General guidance on leakage in biomass project activities. Hence the project complies with this requirement.	
	(e) Project activities treating animal manure as single source substrate shall apply AMS- III.D. Methane recovery in animal manure management systems, similarly projects only treating wastewater and/or sludge generated in the wastewater treatment works shall apply AMSIII. H.Methane recovery in wastewater _treatment.	The proposed project activity involves co-digestion of animal manure and other organic matters and as per §3 of AMS-III.Dv18, the proposed project activity shall use the methodology AMS-III.AO "Methane recovery through controlled anaerobic digestion". Therefore, condition 1(e) is not applicable to the proposed project activity.	
	(f) The project activity does not recover or _combust landfill gas from the disposal site (unlike AMS-III.G. Landfill methane recovery), and does not undertake controlled combustion of the waste that is not treated biologically in a first step (unlike AMS-III.E. Avoidance of methane production from decay of biomass through controlled combustion, gasification or mechanical/thermal treatment.). Project activities that recover biogas from wastewater treatment shall use methodology AMS-III.H.	The proposed project activity: • does not recover or _combust landfill gas from disposal site (unlike AMS-III.G); • does not undertake controlled combustion of the waste that is not treated biologically in a first step (unlike AMS-III.E); • does not recover biogas from solely wastewater treatment, therefore AMS-III.H is not applicable. Therefore, the proposed project activity complies with this requirement.	
2	*Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually.*	As per the calculation using equation 4 from methodology AMS-III.AOv01 PP have to take the minimal value resulting from equation 4, which makes it impossible that emission reductions cross the 60kt CO2 equivalent threshold[20]. Therefore, the proposed project activity complies with this requirement.	
3	*The location and characteristics of the disposal site of the biomass used for digestion in the baseline condition shall be known, in such a way as to allow the estimation of its methane emissions. Guidelines in AMS-III.G, AMS-III.D, AMSIII.*	The project activity involves anaerobic digestion of multiple sources of biomass substrates, like organic waste, animal manure and wastewater. However, in the proposed project activity, emission reductions specific to methane avoidance are claimed from poultry litter only. The locations of the disposal sites in the baseline are the participating poultry farms with whom a Memorandum of Understanding (MOU) is signed. The characteristics of these sites (AWMS) are described in section A.2 "Preproject scenario" and under Table 5. Section 1.a.	

[19] IOT Mabagas Limited, *Detailed Project Report of 2.0 MW biogas to power generation project at Puduchatram,*

Namakkal, Tamil Nadu, (13 December 2010) made available to the DOE.

[20] Additional demonstration that measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually has been provided in section B.7.2 page 82 (and to the DOE in supporting document SD_20).

	E (concerning stockpiles) and AMS-III.H (as the case may be) shall be followed in this regard. Project activities for co-digestion of animal manure shall also meet the requirements under paragraphs 1 and 2(c) of AMSIII. D. *The following requirement shall be* *checked ex ante at the beginning of each crediting period:* *(a) Establish that identified landfill(s)/stockpile(s) can be expected to accommodate the waste to be used for the project activity for the duration of the crediting period;* *or* *(b) Establish that it is common practice in the region to* *dispose off the waste in solid waste disposal site (landfill/stockpile).*	To enhance the reader-friendliness of this section of the PDD, the applicability and compliance check of the proposed project activity regarding the requirements under paragraphs 1 and 2(c) of AMS- III.D shall be presented in Table 5. With respect to condition 3 (a): the identified stockpile(s) can be expected to accommodate the waste to be used for the project activity for the duration of the crediting period. Reference is made to Tide Technocrats Private Limited (Bangalore), *Assessment Report of feedstock availability and market for biomethanation solids* (April 2011) which is the most recent relevant study available for the aforementioned biomass in the project region.[21] With respect to condition 3 (b): it is common practice in the region of Tamil Nadu, Republic of India to dispose off the waste in solid waste disposal site (landfill/stockpile)[22] Hence the proposed project activity complies with this requirement.
4	*The project participants shall clearly define the geographical boundary of the region referred to in 3(b), and document it in the CDM-PDD. In defining the geographical boundary of the region, project participants should* *take into account the source of waste, i.e. if waste is transported up to 50 km, the region may cover* *a radius of 50 km around the project activity. In addition, it should also consider the distances* *to which the final product after digestion will be transported. In either case, the region should cover a reasonable radius around the project activity that can be justified with reference to the project circumstances but in no case it shall be more than 200 km.* *Once defined, the boundary should* *not be changed amidst the crediting period(s).*	Project participants define the geographical boundary of the region referred to in 3(b) as having a radius of 200km around the project activity for the duration of the crediting period as per Tide Technocrats Private Limited (Bangalore), *Assessment Report of feedstock availability and market for biomethanation solids* (April 2011) Poultry litter will be transported within 15 km distance from the project location. Most of the poultry farms are less than 10 km and some are less than 5 km from the proposed project activity plant site. Cow dung will be transported within 15 km from the project location; Press mud will be transported within 55 to 60 km from the project location; Sago water will be transported within 15 km from the project location. Most of the sago water source locations are less than 10 km and some are less than 5 km from the proposed project activity plant site. Above distances are substantiated in the Detailed Project Report[23]. Compost will be transported within 50 km from the project location[24]. Hence as a conservative average incremental distance of 25 km is assumed for feed stock and 50 km is assumed for compost for ex-ante emission reduction calculations. Actual values will be monitored through sampling.

[21] Tide Technocrats Private Limited (Bangalore), *Assessment Report of feedstock availability and market for biomethanation solids* (April 2011). Document made available to the DOE (PP refer to SD_02 and acknowledged copy in SD_31).

[22] Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), *Methane Emission Potential of Poultry Litter* (October 2011). Document made available to the DOE as SD_04.

[23] Pages 54 through 64 of SD_60_DPR_addendum_pages_54_to_64_distances; document made available to the DOE.

[24] Page 25 table 10 of the Tide Technocrats Private Limited (Bangalore), *Assessment Report of feedstock availability and market for biomethanation solids* (April 2011). document made available to the DOE

5	*In case residual waste from the digestion is handled aerobically and submitted to soil application, the proper conditions and procedures (not resulting in methane emissions) for storage and transportation and soil application must be ensured.*	The proper conditions will be ensured. The residual waste from the digestion is handled aerobically: it will be spread out in thin layers on plateaus and dried in the sun (not resulting in methane emissions). When dried, the residual waste will be bagged and sold as compost for farm application. The farmers will also spread the compost in thin layers when using it on their farms (not resulting in methane emissions), this will be monitored through parameter APPCOMP the proper application of compost[25].
6	*In case residual waste from the digestion is treated thermally/mechanically, the provisions in AMS-III.E related to thermal/mechanical treatment shall be applied.*	The residual waste from the digestion is not treated thermally/ mechanically, hence this requirement is not applicable.
7	*In case residual waste from the digestion is stored under anaerobic conditions and/or delivered to a landfill, emissions from the residual waste shall to be taken into account and calculated as per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".*	Residual waste from biological treatment will not be stored under anaerobic conditions and not be delivered to a landfill. Hence this requirement is not applicable[26].
8	*In case the outflow from the digestion is discharged to a subsequent wastewater treatment system or to the natural water receiving body, relevant procedure in AMS-III.H shall be followed to estimate the resultant project emissions.*	PP has defined the condition of zero-liquid discharge in the DPR as has been consented by Pollution Control Board which copy has been handed over to the DOE PJRCDM[27]. Expected volume of the liquid fraction is around 85,000 t/y of which 50% is re-circulated into the project plant system and 50% is sprayed as liquid fertilizer on drying compost[28]. Therefore, condition 8 is not applicable to the proposed project activity.
9	*Technical measures shall be used to ensure that all biogas captured from the digester is combusted /flared.*	As per the project activity PP put up a power generation unit where all the biogas is combusted. Only in emergency situations, when the power generation through the combustion of biogas is not happening, the biogas is diverted to an enclosed flare. Hence all the biogas is either combusted or flared. Therefore, the proposed project activity complies with this requirement.
10	*All the applications to utilize the recovered biogas detailed in paragraph 3 of AMS-III.H are eligible for use under this methodology. The relevant procedure in AMS-III.H shall be followed in this regard.*	In the proposed project activity, all biogas captured shall be combusted/ flared and used for 'electrical energy generation directly' (paragraph 3 (a) of AMS-III.H Methane recovery in wastewater treatment (Version 16). Paragraph 4 of the same methodology states: "If the recovered biogas is used for project activities covered under paragraph 3 (a), that component of the project activity can use a corresponding methodology under Type

[25] SD_32 Tide Technocrats Private Limited (Bangalore), *Lifecycle of compost from production center to its final use and procedures to ensure aerobic Condition* (November 2011). Document made available to the DOE

[26] SD_32 Tide Technocrats Private Limited (Bangalore), *Lifecycle of compost from production center to its final use and procedures to ensure aerobic Condition* (November 2011). Document made available to the DOE.

[27] SD_03, Detailed Project Report (December 2010) made available to DOE.

[28] As per SD_14, Mass balance, made available to the DOE.

		I. Hence PP follows AMS-I.D Grid connected renewable electricity generation - version 17. Therefore, the proposed project activity complies with this requirement.

Applicability conditions of AMS-III.D (version 18), paragraphs 1 and 2(c)

The applicability conditions as per paragraphs 1 and 2(c) of methodology AMS-III.D Methane recovery in animal manure management systems (version 18) are as follows:

Table 5 Applicability conditions of AMS-III.D (version 18), paragraphs 1 and 2 (c)

Nr	**Applicability Conditions**	**Justifications**
1	*This methodology covers project activities involving the replacement or modification of anaerobic animal manure management systems in livestock farms to achieve methane recovery and destruction by flaring/combustion or gainful use of the recovered methane. It also covers treatment of manure collected from several farms in a centralized plant. This methodology is only applicable under the following conditions:*	
	a) The livestock population in the farm is managed under confined conditions;	In the typical poultry farm from which the proposed project activity will obtain the poultry litter, the birds (egg layers) are housed in cages. The cages are built in rows, with each cage containing 3 to 5 egg layers and each entire row (barn) containing between 25,000 and 50,000 birds. Large poultry farms will have up to several dozens of these barns. Cages are built at a maximum height of approximately 1.8 – 2.5 meters above the ground. Cages have openings in the bottom so that the poultry litter accumulates as droppings below. Hence, the livestock population in the farms from which the proposed project activity obtains poultry litter, is managed under confined conditions. Therefore, the proposed project activity complies with this requirement.
	(b) Manure or the streams obtained after treatment are not discharged into natural water resources (e.g. river or estuaries), otherwise AMS-III.H "Methane recovery in wastewater treatment" shall be applied;	The material resulting from the co-digestion process can be divided into residual waste and leachate. Neither will be discharged into natural water resources (e.g. river or estuaries). Of the expected liquid fraction, 50% is re-circulated into the project plant system and 50% is sprayed as liquid fertilizer on drying compost. Therefore the proposed project activity complies with this requirement.
	(c) The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5°C;	The minimal annual average temperature of baseline site where anaerobic manure treatment facility is located is above 20°C which is higher than 5°C required by methodology AMSIII. Dv18, applicability criterion 1 (c). This is substantiated by official measurements as explained in the footnote with weblinks to official data sources.[29] Therefore, the project activity complies with this requirement.

[29] PP refer to the following web links:
http://www.tn.gov.in/deptst/climateandrainfall.pdf
http://www.myweather2.com/City-Town/India/Namakkal/climate-profile.aspx?month=4

	(d) In the baseline scenario the retention time of manure waste in the anaerobic treatment system is greater than one month, and in case of anaerobic lagoons in the baseline, their depths are at least 1 m;	As confirmed by the TNAU report, in the region of Tamil Nadu the current practice of poultry litter management involves open dumping of litter posing negative health impacts to the poultry. The poultry litter in open dumps decomposes over a period of about six months liberating methane, carbon dioxide and nitrous oxide into the atmosphere as a consequence of anaerobic digestion of the organic fraction of waste by naturally present microbial consortia. Hence, in the baseline scenario the retention time of manure waste in the anaerobic treatment system[30] is greater than one month[31]. The baseline scenario does not involve anaerobic lagoons. Hence the proposed project activity complies with this requirement.
	(e) No methane recovery and destruction by flaring, combustion or gainful use takes place in the baseline scenario.	For poultry litter: In the typical poultry farm from which the proposed project activity will obtain the poultry litter, the birds (egg layers) are housed in cages. The cages have openings in the bottom so that the poultry litter accumulates as droppings below. Typically, the litter is left as such to accumulate for periods up to six months or more before it is cleared away manually to another area on the farm, awaiting removal by trucks outside the farm but within the project boundary. As a layered pile, with continuous fresh manure being dropped on top, the poultry litter it maintains a largely semi-solid consistency. This leads to natural decomposition of the poultry litter and methane is emitted into the atmosphere. Hence, in the baseline, for poultry litter, no methane recovery and destruction by flaring, combustion or gainful use takes place. For cow dung, PP is not required to demonstrate that in the baseline no methane recovery and destruction by flaring, combustion or gainful use takes place. This is because PP have clearly stated in the PDD that for the proposed project activity, methane emissions are claimed only for poultry litter and not for biomass residues or cow dung because PP can not demonstrate that the organic matter would otherwise been left to decay anaerobically. Hence, PP accounts baseline emissions for cow dung as zero, as per AMS-III.AOv01, §3 which states that if for one or more sources of substrates, it can not be demonstrated that the organic matter would otherwise been left to decay anaerobically, baseline emissions related to such organic matter shall be accounted for as zero. In light of the above, the proposed project activity complies with this requirement.
2	*The project activity shall satisfy the following conditions:* *(c) The storage time of the manure after removal from the animal barns, including transportation, should not exceed 45 days before being fed into the*	As described in PDD-section A.2 (under Post-Project Scenario), the storage time of the manure after removal from the animal barns, including transportation is 10-15 days before being fed into the anaerobic digester. Furthermore, in PDD-section A.4.2 (under Process Description) it is explained that: the storage area of the plant has a capacity of 1,950 m^3 and the daily input of substrate will be 210 metric tonnes (300 m^3) hence the storage area is able to store substrate for 6.5 days (= 1,950m3/300m3).

These web links indicate that the value of the minimal annual average temperature of baseline site where anaerobic manure treatment facility is located is above 20°C which is higher than 5°C. The period referred is 2009 and 2010.

[30] PP refer to the SD_03 Detailed Project Report (December 2010), especially to pages 53 to 63 listing sources of substrates, including manure waste for the proposed project activity; also reflected in SD_02 Tide Technocrats Report. The DPR has been consented by Pollution Control Board and copy has been handed over to the DOE.

[31] Chapter 3 in Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), *Methane Emission Potential of Poultry Litter* (October 2011). Document made available to the DOE as SD_04.

	anaerobic digester. If the project proponent can demonstrate that the dry matter content of the manure when removed from the animal barns is larger than 20%, this time constraint will not apply.	The timeframe specified above, ensures that the storage time of the manure will not exceed 45 days before being fed into the anaerobic digester. Therefore, the proposed project complies with this requirement.

B.3. Project boundary, sources and greenhouse gases (GHGs)

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The project boundary is defined as the spatial extent around a project within which the project's impact, in terms of carbon emission reductions, will be assessed. As referred to in Appendix B for small-scale CDM project activities[32], the project boundary shall be limited to the physical project activity. Project activities that displace energy supplied by external sources shall earn certified emission reductions (CERs) for the emission reductions associated with the reduced supply of energy by those external sources.

As mentioned in paragraph 9 of methodology AMS-I.D (Version 17): 'The spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to'. The grid boundary is defined as the Southern grid system in India, and will include all direct emissions related to the electricity produced by power plants to be displaced by the project activity.
As per paragraph 11 of methodology AMS-III.AO (Version 01): the project boundary includes the physical, geographical site:

AMS-III.AO (version 01), paragraph 11 Project boundary condition		**Compliance of the proposed project activity with the given condition**
11	*The project boundary is the physical, geographical site:*	The project boundary includes:
a	*Where the solid waste (including animal manure, where applicable) would have been disposed and the methane emission occurs in absence of the proposed project activity;*	<u>For poultry litter:</u> The open dumps at farms where the poultry litter would have been decomposing over a period of about six months and the open fields where – after the period of about six months at the farms – the poultry litter would have been dumped[33]. It is noted that for cow dung (which PP will obtain from gaushala cow farms), sago water (which PP will obtain from sago industries) and press mud (which PP will obtain from sugar industries) [34] PP states in this PDD that PP cannot demonstrate that this organic matter would otherwise have been left to decay anaerobically and that therefore, as per §1(c) of AMS-III.AOv01, baseline emissions related to such organic matter shall be accounted for as zero. In other words,

32 http://cdm.unfccc.int/methodologies/SSCmethodologies/approved/history/guid_ssc_meth/guid_ssc_v12_1.pdf (accessed November 18 2011)

33 PP refer to the SD_03 Detailed Project Report (December 2010), especially to pages 53 to 63 listing sources of poultry litter for the proposed project activity; also reflected in SD_02 Tide Technocrats Report. The DPR has been consented by Pollution Control Board and copy has been handed over to the DOE PJRCDM.

34 PP refer to the SD_03 Detailed Project Report (December 2010), especially to pages 53 to 63 listing sources of substrates for the proposed project activity; also reflected in SD_02 Tide Technocrats Report. The DPR has been consented by Pollution Control Board and copy has been handed over to the DOE PJRCDM. PP also refer to their response to applicability criterion 1(c) of methodology AMS-III.AOv01 in table 4 of this PDD.

		baseline emissions from cow dung, sago water and press mud are not claimed. Consequently, condition 11 (a) of AMSIII. AOv01 only applies to poultry litter as described above in this cell. It is noted that the transport emissions from transporting the substrates from the sources to the project plant are included in the project boundary as stated in PP's justification for boundary condition 11(f) of AMS-III.AOv01 as noted in the last row of this table.
b	*In the case of projects codigesting wastewater, where the wastewater would have been treated anaerobically in the absence of the project activity;*	In the absence of the project activity, treated sago water is discharged in ponds, With reference to the justification for project boundary condition 11(a), it is noted that for sago water no baseline emissions are claimed, because, as stated in this PDD, PP cannot demonstrate that this organic matter would otherwise have been left to decay anaerobically and that therefore, as per §1(c) of AMS-III.AOv01, baseline emissions related to such organic matter shall be accounted for as zero. It is noted that the transport emissions from transporting the sago water from the sago industries sources to the project plant are included in the project boundary as stated in PP's justification for boundary condition 11(f) of AMS-III.AOv01 and as referenced in the Detailed Project Report[35]
c	*Where the treatment of biomass or other organic matters through anaerobic digestion takes place;*	The four closed digesters and the power plant of which they are a part, are included in the project boundary.
d	*Where the residual waste from biological treatment or products from those treatments, like slurry, are handled, disposed, submitted to soil application, or treated thermally/mechanically;*	The dedicated drying yard for the residual waste from the digestion is included in the project boundary. The farmlands where the composted residual waste from the project plant is submitted to soil are not at the project site, they are included in the project boundary.
e	*Where biogas is burned/flared or gainfully used, including biogas sale points, if applicable;*	As described in the justification for applicability condition 1(c) of methodology AMS-III.AOv0[36] and in the justification to applicability condition 1(e) of methodology AMS-III.Dv18[37], for poultry litter, sago water, and press mud there is no burning/flaring or gainful use of biogas in the baseline scenario. In the project scenario, all biogas is burned/flared at the project plant, with the burning of biogas constitutes gainful use of biogas. There are no biogas sale points. Therefore, the project plant is included in the project boundary.
f	*And the itineraries between them (a, b, c, d and e), where the transportation of waste, wastewater, where applicable manure, residual waste after digestion, or biogas occurs.*	PP include in the project boundary, the itineraries between a, c, d and e, where the transportation of waste, wastewater, manure, residual waste after digestion, occurs[38].

The project boundary is graphically represented in below figure:

[35] SD_03, Detailed Project Report (December 2010) made available to the DOE

[36] Please refer to table 4 in this PDD.

[37] Please refer to table 5 in this PDD.

[38] PP refer to SD_03 Detailed Project Report (December 2010), especially to pages 53 to 63 listing sources of substrates for the proposed project activity; also reflected in SD_02 Tide Technocrats Report. The DPR has been consented by Pollution Control Board and copy has been made available to DOE.

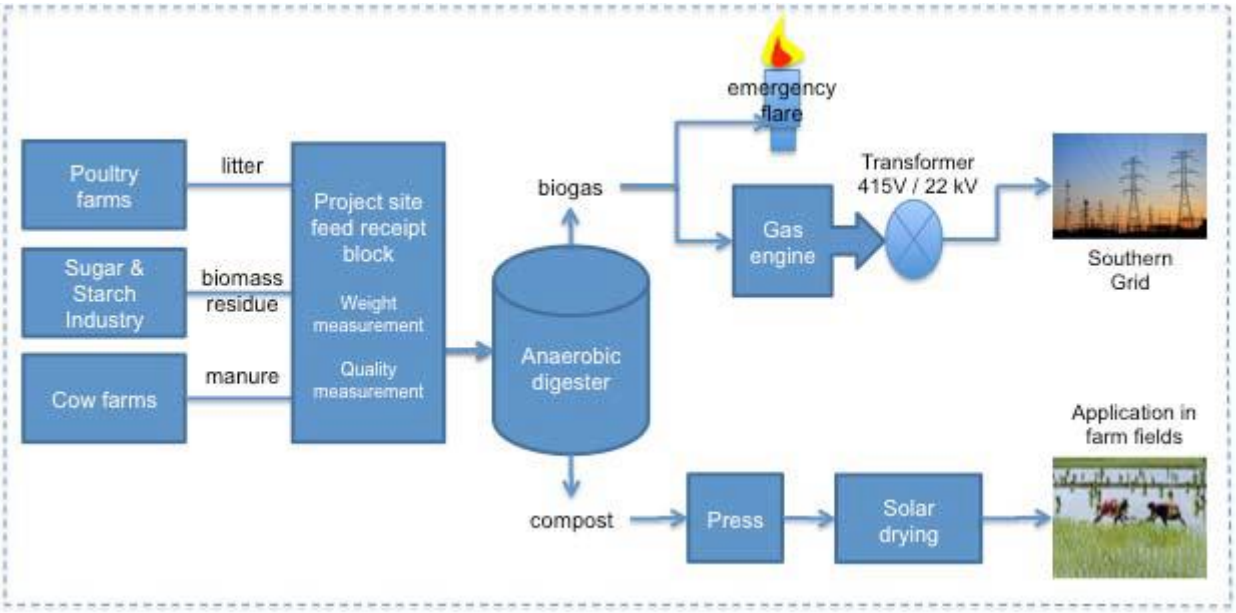

Figure 2: Project boundary

Table 6 Emissions sources

	Source	GHG	Included?	Justification/Explanation
Baseline	Emissions from decomposition of poultry litter	CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	N2O emissions are present in decaying poultry litter but few reliable studies are available for reliable quantification. Exclusion of this gas is conservative.
		CO_2	No	CO2 emissions from the decomposition of organic waste are not accounted
	Emissions from electricity consumption	CO_2	Yes	Electricity may be consumed from the grid or generated onsite/offsite in the baseline scenario
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project activity	On-site fossil fuel consumption due to the project activity other than for electricity generation	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.
	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.
	Emissions from transportation	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.
	Emissions from flaring	CO_2	No	CO2 emissions from the decomposition of organic waste are not accounted
		CH_4	Yes	May be an important emission source.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Project Emissions due to Physical Leakage of gas	CO_2	No	CO2 emissions from the decomposition of organic waste are not accounted

B.4. Establishment and description of baseline scenario

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As per the General Guidelines to SSC CDM methodologies (Version 17), paragraph 19, Type III Greenfield projects (new facilities) may use a Type III small- scale methodology provided that they can demonstrate that the most plausible baseline scenario for this project activity is the baseline provided in the respective Type III small-scale methodology.

As per General Guidelines to SSC CDM methodologies (Version 17) section 19 footnote 10: "Specific procedures for Greenfield project activities provided in the respective methodology have precedence".

Baseline for electricity:

As per AMS-I.D. version 17 section 10: "If the project activity is the installation of a new grid-connected renewable power plant/unit, the baseline scenario is the electricity delivered to the grid by the project activity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources."

The project activity comprises the installation of a new grid-connected renewable electricity generation plant. The baseline scenario of the electricity delivered to the grid by the project activity is established as electricity that otherwise would have been generated by the operation of grid-connected power plants and by the addition of new generation sources.

In accordance with methodology AMS I.D, Grid connected renewable electricity generation (Version 17), the baseline is developed in accordance with paragraph 11 of the methodology, where the baseline emissions are the product of electrical energy baseline EGBL,y expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor expressed in tCO2e/MWh.

The grid emission factor or CO2 emission factor of the grid is calculated in a transparent and conservative manner according to paragraph 12(a) or 12(b) of AMS I.D. Grid connected renewable electricity generation (Version 17).

Option 12 (a) has been chosen for the project activity and a Combined Margin (CM) according to the Tool to calculate the emission factor for an electricity system (Version 02.2.1). In India, the Central Electricity Authority (CEA) developed an official database of all grid-connected power stations in order to establish a consistent quantification of the CO2 emission baseline. The latest version of the database, the 'CO2 Emission Database Version 6.0, March 2011' has been used for the project activity: the megawatt hours (MWh) produced by the project activity multiplied by the grid emission factor of the Southern grid, calculated as a Combined Margin of the Operating Margin and the Build Margin.

Baseline for avoidance of methane production from biomass:

AMS-III.AO Methane recovery through controlled anaerobic digestion (Version 01) section 12 states: "The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter (including manure where applicable) are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass and other organic matter. Baseline emissions shall exclude emissions of methane that would have to be captured, fuelled or flared or gainfully used to comply with national or local safety requirement or legal regulations."

In the baseline, in the absence of the project activity, the following waste streams would be left to decay anaerobically within the project boundary causing methane emission to the atmosphere:

1. Poultry litter;
2. Agricultural biomass residues mainly obtained from the sugar & starch industry. From the sugar industry press mud can be obtained and from the starch industry sago water can be obtained;

3. Cow dung.

For the proposed project activity methane emissions are claimed only for poultry litter, and not for biomass residues or cow dung since the PP cannot quantify the described qualitative baseline practice and can hence not compute the baseline emissions caused by the degradation of agricultural biomass nor cow dung due to the lack of numeric data and scientific assessment as described in table 4 point (c) above. Hence the baseline scenario related to methane emission is explained in detail only for poultry litter.

In the typical poultry farm from which the proposed project activity will obtain the poultry litter, the birds (egg layers) are housed in cages. The cages are built in rows, with each cage containing 3 to 5 egg layers and each entire row (barn) containing between 25,000 and 50,000 birds. Large poultry farms will have up to several dozens of these barns. Cages are built at a maximum height of more than 1 meters above the ground. Cages have openings in the bottom so that the poultry litter accumulates as droppings below. Typically, the litter is left as such to accumulate for periods up to six months or more before it is cleared away manually to another area on the farm.

The poultry litter generates excessive odours. As a layered pile, with continuous fresh manure being dropped on top, it maintains a largely semi-solid consistency. This leads to natural decomposition of the poultry litter and methane is emitted into the atmosphere. After being cleared away after the accumulation period, the litter would mostly be stockpiled for another period of time[39].

In the baseline, no flaring/ combustion/ containment management for methane emissions takes place, and there is no regulatory requirement to recover or flare methane originating from the poultry litter management system[40].

The project activity/ power generation facility is located in a central location to collect the poultry litter from various farms. The distance between the project activity and the farms is less than 25 kilometres. A detailed analysis of the waste generation is presented in the third party biomass assessment report.[41]

B.5. Demonstration of additionality

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The chronology of events is represented in the below table:

Key event	Date	Comment/ supporting document
Letter from Tamil Nadu Electricity Board with approval for 2MW	17/09/2010	PP refer to SD_34 made available to DOE.
Investment decision at Board meeting.	28/01/2011	PP refer to SD_59 made available to DOE.
Prior consideration document submission with UNFCCC and NCDMA	22/02/2011	Prior consideration documentation signed by project participant & acknowledgement from UNFCCC dated 16.03.2011
LOI with EPC contractor	23/02/2011	LOI from IML to IOT IES for the total construction of the project.
Stake holders meeting	18/03/2011	MOM of stake holders meeting
Appointment of validation agency	03/05/2011	Contract agreement signed between IML and

[39] PP refer to Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), Methane Emission Potential of Poultry Litter (October 2011). Document made available to the DOE as SD_04.

[40] "The Ministry of Agriculture, Government of India does not have regulations, policies or programmes, which would directly address and encourage recovery and use of methane as an alternate source for clean energy from agriculture and livestock". http://www.methanetomarketsindia.com/htm/indian-regulation.htm

[41] Tide Technocrats Private Limited, Bangalore, Assessment report of feedstock availability and market for Biomethanation Solids, April 2011 - – Made available to the DOE

(DOE)		PJR
Board decision to increase from 2.0 to 2.4 MW	12/05/2011	PP refer to SD_77 made available to DOE.
Initial global stakeholder consultation	01-30/07/2011	Weblink[42]
Purchase Order for 2.4MW engines	22/07/2011	PP refer to supporting document SD_35a made available to DOE. This date is taken as the **start date** as per annex 63 of EB66
DOE site visit	07-08/09/2011	Email correspondence with DOE.
Issuance of draft validation report (version 01)	19/10/2011	Email correspondence with DOE.
Letter from TANGEDCO to PP for amendment of EPA to 2.4 MW	13/02/2012	PP refer to SD_40a made available to DOE.

CDM awareness and prior consideration
Since the PDD has been published for global stakeholder consultation[43] before the project activity start date (see section C.1.1), no prior consideration notification is necessary as per paragraph 2 of the Guidelines On The Demonstration And Assessment Of Prior Consideration Of The CDM Version 04 (EB62 annex 13)[44].

Barrier analysis
As per Attachment A to Appendix B the project participant provides an explanation to show that the project activity would not have occurred due to at least one of the barriers mentioned. Project participant opts to provide explanations on the following barriers: Technological barrier and investment barrier.

Technological barrier
The Ministry of New and Renewable Energy (MNRE) claims that technology barriers for biogas plant investment exist mainly due to difficulties in finance, technological process, lack of organic fertilizer markets etc[45].

Presently, small rural household biogas digesters (with a digester volume of several cubic meters) are common in India to generate biogas for cooking. Large scale biogas plants with a capacity of more than 1 Megawatt (electric) based on solid agricultural waste streams as a substrate are extremely few and rare (since they require technological processes not yet established in India). For example, one of the few large-scale biogas plants in Namakkal/Tamil Nadu that are based on poultry litter as a substrate is running at much lower than expected capacity[46]. This is most likely due to faulty technology design and insufficient operating and maintenance know-how.

The unique partnership between Mabagas International and IOT will transfer the needed knowledge and technology for the complete plant operation as described before.

Investment barrier
As per Attachment A to Appendix B the project participant provides an explanation to show that the project activity would not have occurred due the investment barrier. Best practice examples mentioned by name in paragraph 1 (a) of EB 35, Annex 34 are investment comparison analysis, benchmark analysis and simple cost analysis. The simple cost analysis is not applicable for the proposed project because the project activity will produce economic benefit other than the CDM related income, notably from electricity sale. Instead, the Benchmark Analysis will be used.

[42] http://cdm.unfccc.int/Projects/Validation/DB/O48X2OYZJE0Z9GM5X1PUXX8JD9MM83/view.html

[43] http://cdm.unfccc.int/Projects/Validation/DB/G3WO8B7ORRKL2GC0109MBN4AF65MCF/view.html

[44] http://cdm.unfccc.int/EB/062/eb62_repan13.pdf

[45] page 7: www.globalmethane.org/expo/docs/postexpo/ag_dhussa.pdf

[46] http://cdm.unfccc.int/UserManagement/FileStorage/TCMZPJK7OU0EDR9YH8QB63521NA4WI)

Paragraph 12 of the *Guidelines on the Assessment of Investment Analysis (Version 05)* states: "In cases where a benchmark approach is used the applied benchmark shall be appropriate to the type of IRR calculated. (…). Required/expected returns on equity are appropriate benchmarks for equity IRR. (…)". Paragraph 13 states: "In the cases of projects which could be developed by an entity other than the project participant the benchmark should be based on parameters that are standard in the market. (…)".

Hence project participant opts to benchmark post-tax equity IRR against the required/ expected returns on equity.

As per § 15 it is stated that if "the benchmark is based on parameters that are standard in the market, the cost of equity should be determined either by: (a) selecting the values provided in Appendix A; or by (b) calculating the cost of equity using best financial practices, based on data sources which can be clearly validated by the DOE, while properly justifying all underlying factors".

Project Participant will calculate cost of equity as per option (b) using the Capital Asset Pricing Model (CAPM) is used to determine the benchmark (cost of equity). This model takes into account the nondiversifiable risk of the asset, the expected return of the market and the expected return of a risk-free asset.

The equation is as follows[47]:

$$\bar{r}_a = r_f + \beta_a(\bar{r}_m - r_f)$$

Where:

r_f = Risk free rate

β_a = Beta of the security

$\bar{r}_m$ = Expected market return

(Equation 1)

Table 7 Main parameters to determine the Cost of Equity

Applicable Beta[48] **βa**	Risk Free Rate[49] rf	Market Return[50] rm	Market Risk Premium (rm – rf)	Cost of Equity
1.06	8.69 %	13.15%	4.46%	13.42%

Applicable Beta (1.06)

Beta is a measure of the volatility, or systematic risk, of a security or a portfolio in comparison to the market as a whole. Beta is used in the CAPM model[51]. Beta is Beta is calculated using regression analysis, and you can think of beta as the tendency of a security's returns to respond to swings in the market. A beta of 1 indicates that the security's price will move with the market. A beta of less than 1 means that the security will be less volatile than the market. A beta of greater than 1 indicates that the security's price will be more volatile than the market. For example, if a

[47] http://www.investopedia.com/terms/c/capm.asp#axzz1p4puxkch (accessed 14/03/2012)

[48] Data also provided in SD_16 CDM financial analysis.xlsx, made available to the DOE.

[49] Based on the average Yield on State Government Securities as provided in the Annual report of the Reserve Bank of India (see (table VII.6 http://rbidocs.rbi.org.in/rdocs/AnnualReport/PDFs/0RBIAN240810_F.pdf) for the year ended June 30, 2010. Data also provided in SD_16 CDM financial analysis.xlsx, made available to the DOE.

[50] Based on the average return of the SENSEX over a period of 15 years (between February 1996 and January 2011) http://beta.bseindia.com (select 'historical data'; select 'SENSEX', select 'Monthly; select range from February 1996; data also provided in SD_16 CDM financial analysis.xlsx, made available to the DOE.

[51] http://www.investopedia.com/terms/b/beta.asp#ixzz1yywHHv64

stock's beta is 1.2, it's theoretically 20% more volatile than the market. Many utilities stocks have a beta of less than 1. Conversely, most high-tech Nasdaq-based stocks have a beta of greater than 1, offering the possibility of a higher rate of return, but also posing more risk.

The two key revenue streams from operating a biogas plants are from the production and sale of electricity (power sector), as well as the sale of organic compost/fertilizer (fertilizer sector), but requires timely and cost effective construction of the plant.

The biogas industry (renewable energy sector) in India is in its very early stages and there is no single company listed at the Indian stock-markets yet that develops and operates biogas plants alone. The project proponent has therefore selected the business sectors that correspond to project activity (i.e. power sector and fertilizer sector). The PP uses the leveraged betas (including debt). PP has opted for leveraged beta vs unleveraged beta since the leveraged beta is most often lower than the unlevered beta (that is, the leveraged beta indicates less volatility) because debt can result in tax advantages that reduce volatility[52].

The beta is calculated over a representative period of time of 2 years. In determining this 2-year period of analysis, the project participant considered that the period should be "for as long as there is a [relevant] history" and that one should then account for the earnings (for the compared companies) "for the same time period"[53]. Since in this case the private company has no history, we assumed a 'relevant' assessment period (and for a period of which we have sufficient relevant data available). The beta reflects the firm's business mix over the period of the regression, not the current mix[54], and since the market is new and
dynamic; a long evaluation period is therefore not relevant and distorts the picture. Hence the PP opted a 2 year period as a relevant valuation period to determine the Beta; for this period data was available on the stock market of relevant sectors and companies and will reasonably well reflect the current business mix.

Sector	Beta	Description
Power Sector	0.95	BSE Power index
Fertilizer Sector	1.17	Beta of companies in the fertilizer sector with a listing on the BSE. The following companies have been taken into account: Coromandel International Ltd Chambal Fertlizers & Chemicals Ltd Deepak Fertilizers & Petrochemicals Corporation Ltd Gujarat Narmada Valley Fertilizers Co Ltd Gujarat State Fertilizers & Chemicals Ltd Mangalore Chamicals & Fertilizers Ltd National Fertilizers Ltd Rashtriya Chemicals & Fertilizers Ltd Southern Petrochemicals Ind Ltd TATA Chemicals Ltd Nagarjuna Fertilizers & Chemicals Ltd Zuari Industries Ltd
Average	**1.06**	

***As explained above, the beta expresses a tendency of a security's returns to respond to swings in the market, and as such one tries to calculate the beta over a prolonged period The Beta has been calculated over a period of approximately 2 years (2 year) as can be seen in the snapshot of each Beta calculation (i.e. from 1st February 2009 to 23 January 2011)[55]**

[52] http://financial-dictionary.thefreedictionary.com/Leveraged+Beta

[53] http://people.stern.nyu.edu/adamodar/pdfiles/eqnotes/pvt.pdf page 184

[54] http://people.stern.nyu.edu/adamodar/pdfiles/country/Indiaval04.pdf page 26

[55] See SD_68_Beta_Explanation

Risk Free Rate (8.69%)
The risk free rate is the theoretical rate of return of an investment with zero risk. The risk-free rate represents the interest an investor would expect from an absolutely risk-free investment over a specified period of time. Thus, the average Yield on State Government Securities[56] with a 10-year tenure is used as the risk-free rate, as it most closely represents a risk-free investment in the host country.

Market Return (13.15%)
To calculate the cost of equity, you must look at factors such as the return of the market as a whole, the rate you could get if you took on no risk (the risk free rate), and the overall cost of funding the project: the market return. The PP has analysed the average return of the BSE SENSEX over a period of 15 years and taken this as an objective and verifiable value for the market return and for a period of time similar to the expected lifetime of the project activity.

Market Risk Premium (4.46%)
The Market Risk Premium is a parameter required in the CAPM model. To obtain the value of this parameter the Risk Free Rate is subtracted from the Market Return.

Cost of Equity
Hence the Cost of Equity equals the risk free return plus the product of the beta and the market risk premium:

$$\overline{r_a} = r_f + \beta_a(\overline{r_m} - r_f)$$

= 8.69% + 1.06 * (4.46%) = 13.42%

Hence the benchmark applied for the comparison with the financial indicator – the equity IRR – is 13.42%.

The capital structure of the project involves both equity and debt. In line with the guidelines, in calculating the equity IRR only the portion of investment costs that is financed by equity is considered as the net cash outflow.

The assumptions used to calculate the equity IRR are as follows:

Table 8 Assumptions used to Calculate equity IRR

S No	Data/Parameters	Value (in INR)	Inflation (%)	Source/ remarks
Capital Expenditure				
1	Fixed Assets	284,000,000	-	The fixed costs stated in the board meeting of 28/01/2011 when the investment decision was made, related to an installed capacity of 2.0MW. As per board meeting dd May 12 2011[57] the the installed capacity was increased 2.4MW.
2	Land purchase cost	13,000,000	-	As per deed of sale and Land development agreement[58]

[56] State Government Securities - These are securities issued by the state governments and are also known as State
Development Loans (SDLs). The issues are also managed and serviced by the Reserve Bank of India
(http://www.rbi.org.in/scripts/FAQView.aspx?Id=48 accessed 28/9/2012).

[57] SD_77 minutes of board meeting dd 12 May 2011 – Document made available to DOE

3	**Total capital expenditure**	**297,000,000**	-	
O&M cost (per annum)				
4	Power Unit O&M	(6,393,000)	5.0%	As per SD_03 DPR made available to DOE (page 129 for inflation rate & page 134 item 12 for Power Unit O&M costs).
5	Biogas Plant O&M (incl. Insurance)	(25,777,000)	5.0%	As per SD_03 DPR made available to DOE (page 129 for inflation rate & page 134 sub B + sub – item 12 for cost).
Tariffs and Receipts				
6	Biomass power tariff (INR/kWh) in 2012	4.92	3.0%	Escalation is assumed at 3%. Value as understood at time of the investment decision TNERC Tariff Orders[59].
	Fertilizer revenue	39,735,500		
7	Fertilizer sales price (INR/t)	1,750		Revenue based on consultant report (i.e. Tide Technocrats) which estimates the revenue of the digestate to be between 1400-1800 INR/t. PP estimates a price of 1750 to be realistic basis for estimating the economic yield in this yet unstructured and little organized organic fertilizer market.[60]
Financial parameters				
8	Tax rate year 1-10 (Minimum Alternate Tax)	19.9%		Under the section 80 IA of the Income Tax Act 1961, the project owner is exempted from income tax on all earning generated from the project for the period of 10 years. The owner can choose the tax holiday window for a single 10 year period anytime during the first 15 years of the project life. However, domestic companies are liable to pay a minimum alternate tax (MAT) which is currently pegged at 19.93% and has been considered under the financial analysis[61]
9	Tax rate year 11-15 (Corporate Tax)	32.4%		As per Income Tax Act 1961[62]
10	Interest Rate of Bank Loan	13.25%		As per the Central Electricity Regulatory Commission regulations 2009 (Terms and Conditions for Tariff determination from
11	Bank Loan Duration	10		

[58] IRR Annex 2 Deed of sale & SD_41_IML_LAND_Development_Agreement_22_09_2010 – Documents made available to DOE

[59] 1)

[60] Tide Technocrats Private Limited, Bangalore, *Assessment report of feedstock availability and market for Biomethanation Solids*, April 2011 – Made available to the validator

[61] http://www.incometaxindiapr.gov.in/incometaxindiacr/contents/forms2010/pamphets/COMPANIES_2012_13.htm (accessed November 3 2011)

[62] page#5http://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Tax/dtt_corporate_tax_rates_2011.pdf (accessed November 3 2011)

	(years)			Renewable Energy Sources)[63]
12	Equity (%)	30.0%		
13	Debt (%)	70.0%		
14	Benchmark	13.42%		See Table 7 above
15	Exchange rate 1 EUR	63		INR EUR Exchange rate on 28 January 2011[64]
16	One time subsidy	36,000,000		See page 46 of SD_03 Detailed Project Report of 2.0 MW biogas to power generation project at Puduchatram which states 15,000 INR per kW installed. As PP schedules to install 2.4 MW subsidy is expected to be 15,000 INR/kW x 2400 kW = 36,000,000 INR
17	Lifetime of system (years)	20		TNERC note on lifetime[65]
18	Depreciation Rate (digressive, in years) for tax calculations	15		Indian Tax Act always states digressive depreciation rules, depreciation is calculated as digressive depreciation over the project lifetime in the Indian Tax calculation. Otherwise a SLM has been opted over 20 years (i.e. 5% p.a.).A annual depreciation of approximately 5% is also in line with proposed depreciation recommendations by Indian Government Institutions being between 4.5% to 7.84%[66]
19	Depreciation rate to determine fair value (years)	20		to determine fair value the depreciation has been taken over the life time of the system (assumption 17 above).
20	Salvage value after 20 years:	5%		According to Indian company act sec 205
21	Fair value of the project activity assets used in the last year in the financial model = (Investment (assumption 1 – ass. 2 = 29.7 cr) – Capital Assistance (ass. 16 = 3.6 cr) – Depreciation (15 years (=last year of the fin. model) x ((ass. 1 – ass. 2) / ass. 19) = 1.178 cr)).	84,300,000		As per paragraph 3 of the GUIDELINES ON THE ASSESSMENT OF INVESTMENT ANALYSIS (Version 05), EB62 annex 05 "(…) Both project IRR and equity IRR calculations shall as a preference reflect the period of expected operation of the underlying project activity (technical lifetime), or - if a shorter period is chosen - include the fair value of the project activity assets at the end of the assessment period. In general a minimum period of 10 years and a maximum of 20 years will be appropriate. (…)".

[63] See IRR Annex 11 Annexure 3H – made available to the DOE (Date of order: 15th September, 2010) (http://www.cercind.gov.in/2010/November/Signed_Order_256-2010_RE_Tariff_FY_11-12.pdf)

[64] SD_21 INR EUR Exchange rate on 28 January 2011

[65] Page 14 of Comprehensive Tariff Order for Biomass based power plants", TNERC 2009 http://tnerc.tn.nic.in/orders/Tariff%20Order%202009/Bio%20Mass%20Order%2027.04.2009.pdf (accessed November 3 2011)

[66] Page 29 Petition No. 256/2010, Central Electricity Regulatory Commission New Delhi http://www.cercind.gov.in/2010/ORDER/Sept10/Order_256-2010_RE_Tariff_FY_11-12.pdf (accessed November 3, 2011)

				PP has taken a fair value of the assets at the end of the assessment period and hence complies with paragraph 3 of the guidelines.

As per point 10 of the Guidelines on the assessment of investment analysis (Version 05; EB 62 annex 5) the calculation of equity IRR only the portion of investment costs which is financed by equity should be considered as the net cash outflow, the portion of the investment costs which is financed by debt should not be considered a cash outflow. Hence the PP only considered equity injection and dividend as net cash flow in calculating equity IRR. The summary of the financial analysis is provided below:

Equity IRR without CERs	**Return on Equity – Benchmark**
6.71%	**13.42%**

Therefore, it may be concluded that the project activity has a less favourable indicator than the benchmark.

Sensitivity analysis

As per paragraph 20 of Guidelines on the assessment of investment analysis (Version 05; EB 62 annex 5), only those variables, that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation. The following variables constitute more than 20% and are therefore subjected to reasonable variation:

• Capital expenditure (more than 20% of the project costs)
• Biogas Plant O&M (more than 20% of the project costs)
• Substrate purchase (more than 20% of the project costs)
• Revenue from fertilizer sales (more than 20% of project revenue)
• Revenue from electricity sales[67] (more than 20% of project revenue)

As per guidance the results of this variation are presented in the table below and in SD_16 CDM Financial Analysis made available to the DOE.

The sensitivity analysis is performed by increasing and decreasing the assumptions for the above factors to the level where they would equal the benchmark:

At the following percentages the equity IRR equals 13.42%			
Critical Items		**Comment**	**Justification of probability of occurrence**
Capital expenditure	**-26.6%**	cost reduction needed	A reduction in the capital expenditure of 26.6% is not possible due to a turnkey delivery contract with IOT Infrastructure and Energy Services Ltd. which clearly defines a fixed lump sum payment.
Biogas Plant & Power Plant O&M	**-33.0%**	cost reduction needed	A cost reduction of 33% in the O&M expenditure seems highly unlikely if not impossible since 30% of the total O&M costs are based on agreed fixed cost as per O&M contract with Greenpower Int. Therefore a cost reduction of 47% would be required on the remaining 70% O&M proportion which is not achievable without severely jeopardizing efficient operation, since it would necessitate the discontinuation of required maintenance and repair of technical equipment.
Substrate cost	**-32.0%**	cost reduction needed	The assumed substrate cost in the model as presently applied are already conservative estimates since the economic assessment does

[67] As noted in the *Biomass Energy Purchase Agreement* between the project participant and the regional generation and distribution corporation, the rate of electricity could be subject to changes, such as policy changes in electricity tariffs. Document made available to DOE.

			not take into consideration the inflationary trend observed in India at present. A cost reduction of 32% therefore seems highly unlikely.
Fertilizer Revenue	**37.5%**	revenue increase needed	The fertilizer market for organic fertilizer is in its infancy and currently unstructured. While a price increase is not unrealistic it is the PPs conviction that an increase in the price for organic fertilizer will go hand in hand with a cost increase for the substrate, which would result in a balanced margin. Currently the PP is assuming fertilizer revenues of 1750 INR/tonne. A required increase of 37.5% would result in the need to sell organic fertilizer (untreated or upgraded – i.e. raw dried bio-digestate in bulk) at 2406 INR/tonne which is above the estimated maximum value of 2100 INR/t by Tide Technocrats – the lowest value is at 1400 INR/tonne. [68]
Electricity Revenue	**16.8%**	revenue increase needed	The electricity tariff is fixed by the TNERC and the expectation of an increase in 16.8% is therefore not applicable.

In accordance to paragraph 21 of the Guidelines on the assessment of investment analysis (Version 05; EB 62 annex 5) the above sensitivity analysis covers the required range of +10% and -10%.

Outcome of sensitivity analysis:
From the sensitivity analysis it is concluded that the proposed project activity is financially not attractive under all assumed parameter variations: the equity IRR remains below the benchmark.

The registration of the CDM project activity will overcome the investment barrier that prevents the proposed project activity from occurring in the absence of the CDM.

Conclusion on the Investment Analysis
Based upon the above analysis it may be concluded that the project activity has a less favourable indicator (post-tax equity IRR = 6.71 %) than the benchmark (13.42 %). When varying the main variables the above analysis proves that the project activity still remains less favourable than the benchmark and hence the project activity is deemed additional.

National and/or sectoral policies applicable to project activity
Taking into account the clarifications on the consideration of national and/or sectoral policies and circumstances in baseline scenarios (Version 02) (EB22 annex 3) the project participant has assessed the national and/ or sectoral policies applicable to the project activity. No policies have been identified to be applicable to project activity as has been justified in table 4 1.c. in section B.2.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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The proposed project activity will use two approved small-scale baseline methodologies, namely AMSI.D, Grid connected renewable electricity generation (Version 17) (to account for CO2 emission reductions as result of electricity generation) and AMS-III.AO, Methane recovery through controlled anaerobic digestion (Version 01)(for CH4 avoidance from decay of poultry manure). In the following, the procedures of how to calculate baseline emissions, project emissions, and emission reductions are explained.

[68] Tide Technocrats Private Limited, Bangalore, *Assessment report of feedstock availability and market for Biomethanation Solids*, April 2011 – Made available to the DOE

Baseline Emissions:

$BEy = BE_{Elec,y} + BE_{CH4,y}$ (Equation 2)

Where,

BEy	Baseline emissions in year y, in tCO_2/y
$BE_{Elec,y}$	Baseline CO2 emissions from electricity used in the baseline, in tCO_2/y
$BE_{CH4,y}$	Baseline methane emissions in year y, in tCO_2/y

Baseline CO_2 emissions from electricity ($BE_{Elec,y}$) is calculated as per AMS-I.D Grid connected renewable electricity generation, version 17 as follows:

The baseline emissions are the product of electrical energy baseline $EG_{BL,y}$ expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor.

$BE_{Elec,y} = EG_{BL,y} * EF_{CO2,grid,y}$ (Equation 3)

Where:

$EG_{BL,y}$	Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year *y* (MWh)
$EF_{CO2,grid,y}$	CO2 emission factor of the grid in year *y* ($t\ CO_2/MWh$)

Calculation of CO2 emission factor of the grid:
Based on methodology AMS I.D. "Grid connected renewable electricity generation version 17", paragraph 12, the Emission Factor can be calculated in a transparent and conservative manner as follows:

(a) By calculating the Combined Margin (CM), consisting of the Operating Margin (OM) and the Build Margin (BM) according to the procedures prescribed in the "Tool to calculate the emission factor for an electricity system – version 02.2.1", or;

(b) By calculating the weighted average emissions (in tCO2/MWh) of the current generation mix. The data of the year in which the project generation occurs must be used.

For the proposed project activity, option (a) is chosen.

The baseline data are taken from the CO_2 Emission Database Version 6.0, March 2011, by the Central Electricity Authority (CEA), Ministry of Power, Government of India.[69] The grid emission factor determined by the CEA follows the procedure as stipulated in the "Tool to calculate the emission factor for an electricity system- version 02.2.1" and the procedures are outlined below:

Step 1: Identify the relevant electricity systems.

The project, setup in the state of Tamil Nadu, falls under the Southern grid of India and the electricity generated by the project activity displaces the electricity from that grid. Each state that is part of a regional grid meets its own electricity demand, having its own generation facilities as well as allocation from power plants owned by the central sector. Due to the displacement of electricity the project activity would have impact on the Southern grid, serving the four Southern states and one union territory, namely Pondicherry. Hence the project also has an impact on all the generation facilities of the Southern grid.
Since the Southern grid is the relevant electricity system for evaluating the baseline emissions, all the power generation facilities connected to the Southern grid fall within the project boundary.

[69] http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm (accessed November 3 2011)

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional).

Project participants can choose between the following two options to calculate the OM and BM emission factor:

Option I: Only grid power plants are included in the calculation.
Option II: Both grid power plants and off-grid power plants are included in the calculation.
Since only grid power plants are included in the calculation of the CEA, and in the statistical data available, option I is chosen.

Step 3: Select a method to determine the Operating Margin

According to the tool, the following four methods can be used to calculate the OM emission factor ($EF_{grid,OM,y}$):

a) Simple Operating Margin;
b) Simple Adjusted Operating Margin;
c) Dispatch data analysis Operating Margin;
d) Average Operating Margin;

According to the tool, the Simple OM method (a) is applicable to the project if the low-cost resources constitute less than 50% of the total grid generation. Since the five most recent years average percentage contribution of low- cost / must run resources is 25.2% for the project activity, which is less than 50% of the total generation of the Southern grid, option a) is chosen. As stipulated in the tool, the data vintage option of an *ex-ante* approach with a 3-year generation weighted average value based on the most recent data available will be used, without the necessity to recalculate during the chosen crediting period. Hence,
the parameters for the calculation of OM do not need to be monitored and the OM does not need to be calculated during the chosen first crediting period.

	2005-06	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**5-years average**
South	27.0%	28.3%	27.1%	22.8%	20.6%	25.2%

Source: the CEA's CO2 Emission Database Version 6.0, March 2011[70]

Step 4: Calculate the Operating Margin emission factor according to the selected method.

The Simple OM emission factor is calculated as the generation-weighted average CO2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, excluding low-cost/ must-run power plants / units.

The simple OM may be calculated by one of the following two options:

Option A: Based on the net electricity generation and a CO2 emission factor of each power unit;
or
Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

As per tool PP choses option A as option B can only be chosen if the information under option A is not available. Hence PP has to opt for Option A under step 4 and the following equation is used:

[70] http://www.cea.nic.in/reports/planning/cdm_co2/Database_publishing_ver6.zip

$$EF_{grid,OMsimple,y} = \frac{\sum_{m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

(Equation 4)

Where:

$EF_{grid,OMsimple,y}$ Simple operating margin CO2 emission factor in year *y* (t CO_2/MWh)
$EG_{m,y}$ Net quantity of electricity generated and delivered to the grid by power unit m in year *y* (MWh)
$EF_{EL,m,y}$ CO_2 emission factor of power unit m in year *y* (t CO_2/MWh)
m All power plants/units serving the grid in the year *y* except low-cost/must-run power plants/units
Y Three most recent years for which data is available at the time of submission of the project (2007-08, 2008-09, 2009-10)

Net generation of power plants included in the operating margin is presented in the table below.

Net Generation in Operating Margin (GWh)				
	2007-08	**2008-09**	**2009-10**	**Total**
South	114,634	121,471	134,717	370,822

Source: CEA's CO2 Emission Database Version 6.0, March 2011[71]

The OM in the three most recent years for which the data are available, i.e. 2007-08, 2008-09, and 2009-10, is presented in the following table:

Simple Operating Margin (tCO2/MWh) (excl. Imports)				
	2007-08	**2008-09**	**2009-10**	**Weighted average**
South	0.991	0.970	0.941	0.966

Source: CEA's CO2 Emission Database Version 6.0, March 2011[72]

Step 5: Calculate the Build Margin (BM) emission factor

In terms of vintage data, option 1 is selected: for the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group "m" at the time of CDM-PDD submission to the DOE for validation.

According to the "Tool to calculate the emission factor for an electricity system- version 02.2.1", the sample group of power units "m" is determined by:
(a) Identifying $SET_{5\text{-}units}$: the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently, and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in MWh);
(b) Identifying SET≥20%: the set of power units, excluding power units registered as CDM project activities, that started to supply the grid most recently and that comprise 20% of the annual electricity generation of the project activity system (AEG_{total}, in MWh), and determine their annual electricity generation (AEGSET≥20%, in MWh);
(c) Determining SET_{sample} from $SET_{5\text{-}units}$ and SET≥20%, by selecting the set of power units that comprises the larger electricity generation.

SET_{sample} is determined by comparing $AEG_{SET\text{-}5\text{-}units}$ to AEG_{SET}≥20%. The data are sourced from the CEA CO2 Emission Database Version 6.0, March 2011.

[71] http://www.cea.nic.in/reports/planning/cdm_co2/Database_publishing_ver6.zip

[72] http://www.cea.nic.in/reports/planning/cdm_co2/Database_publishing_ver6.zip

The dataset for $AEG_{SET\text{-}5\text{-}units}$[73]

Name of power plant	Data of commissioning	Electricity generation [MWh]
KONDAPALLI GT	05-12-09	462,713
VIJAYWADA TPP-IV	08-10-09	615,630
TORANGALLU EXT	24-08-09	2,904,960
PRIYADARSHNI JURALA	27-06-09	79,248
GAUTAMI CCCP	03-05-09	2,880,880
	AEGSET-5-units	**6,943,431**

The data set for $AEG_{SET\geq 20\%}$

	Electricity generation [MWh]
AEG_{total}	169,765,092
20% of AEG_{total}	33,953,018
$AEG_{SET\geq 20\%}$	**36,099,907**

Hence, the data show that $AEG_{SET\geq 20\%}$ is higher than $AEG_{SET\text{-}5\text{-}units}$, therefore SET≥20% (the set of power units, excluding power units registered as CDM project activities, that started to supply the grid most recently and that comprise 20% of the annual electricity generation of the project activity system) is the right sample group of power units.

SET_{sample} therefore equals SET≥20%. All power plants included in the SET_{sample} group started to supply electricity to the grid less than 10 years ago. Therefore, SET_{sample} can be used to calculate the build margin for each grid.

According to the tool, the BM emissions factor is the generation-weighted average emission factor (tCO_2e /MWh) of all power units *m* during the most recent year y for which power generation data are available.

The latest available data for the BM emission factor for SET_{sample} were used for an ex-ante estimation of emission reduction estimates for the entire crediting period. These data comprise the years 2009-2010.

The Build Margin emission factor for SET_{sample} of the Southern grid (not adjusted for imports), as calculated by the CEA is given below:

Build Margin for 2009-10	**0.763 tCO2e / MWh**

Step 6: Calculate the Combined Margin emissions factor

For the calculation of the Combined Margin emission factor ($EF_{grid,CM,y}$), the weighted average CM is chosen (option A), since it is stated in the "Tool to calculate the emission factor for an electricity system version 02.2.1", as the 'preferred option'.

The CM emission factor is calculated as:

$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$ (Equation 5)

$EF_{grid,BM,y}$ = Build Margin CO2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$ = Operating Margin CO2 emission factor in year y (tCO_2/MWh)
w_{OM} = Weighting of Operating Margin emissions factor (%)
w_{BM} = Weighting of Build Margin emissions factor (%)

[73] See tab BM in SD_13 Database_ver6-1.0_calculations_JM.xls, which is provided to the DOE

The "Tool to calculate the emission factor for an electricity system - version 02.2.1" states that as default values should be used: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, if the project is other than Wind or Solar. Hence the grid emission factor for the Southern grid equals:

$EF_{grid,CM,y}$ = 0.966 x 0.5 + 0.763 x 0.5 = 0.865 tCO2/MWh = **865 tCO2/GWh**

The Combined Margin emission factor ($EF_{grid,CM,y}$) refers to the CO_2 emission factor of the grid in year *y* ($EF_{CO2,grid,y}$) as stated in the equation 3 above. This will be the grid emission factor for the entire crediting period.

Baseline Methane Emissions (*BECH4,y*) are calculated as per approved methodology AMS-III.AO. Methane recovery through controlled anaerobic digestion, version 01 as follows:
According to methodology AMS-III.AO., Methane recovery through controlled anaerobic digestion,version 01, paragraph 12, the baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter (including manure where applicable) are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass and other organic matter. Baseline emissions shall exclude emissions of methane that would have to be captured, fuelled or flared or gainfully used to comply with national or local safety requirement or legal regulations.

BE_{CH4} = $BE_{SWDS,y}$ + $BE_{ww,y}$ + $BE_{manure,y}$ – $MD_{reg,y}$ * GWP_{CH4} (Equation 6)

Where:

BE_{CH4} *BEy* in equation (1) of methodology AMS-III.AO (Version 01)
$BE_{SWDS,y}$ Where applicable, yearly methane generation potential of the solid waste anaerobically digested by the project activity during the year *x* from the beginning of the project activity (*x*=1) up to the year *y* estimated as per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (tCO2e). The tool may be used with the factor "f=0.0" assuming that no biogas is captured, flared or used. With the definition of year *x* as the base year since the project activity started diverting wastes from the SWDS/landfill site. *x* runs from the first year of the crediting period(*x*=1) to the year for which emissions are calculated (*x=y*). Where applicable, baseline emission determination of digested waste that would otherwise have been disposed in stockpiles shall follow relevant procedures in AMS-III.E
$BE_{manure\ y}$ Where applicable, baseline emissions from the manure co-digested by the project
activities, calculated as per the relevant procedures of AMS-III.D
$BE_{ww\ y}$ Where applicable, baseline emissions from the wastewater co-digested, calculated as per the procedures of AMS-III.H
$MD_{reg\ y}$ Amount of methane that would have to be captured and combusted in the year *y* to comply with the prevailing regulations (tonne)
GWP_{CH4} *GWP* for CH_4 (value of 21 is used)

The project activity is not claiming methane avoidance from biomass residues; therefore *BESWDS,y* is considered zero.

The project activity involves treatment of wastewater but it is not considered for claiming methane avoidance. Moreover there is no regulatory compliance to capture and combust methane. Therefore, *MDreg,y* and $BE_{ww,y}$ will be zero.

Hence:
BE_{CH4} $BE_{manure,y}$[74] (Equation 7)

[74] (note GWP_{CH4} is already taken into account when calculating $BE_{manure,y}$;
see $BE_{manure,y} = GWP_{CH4} * D_{CH4} * UF_b * \Sigma\, j,LT\ MCF_j * B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS_{\%Bl,\,j}$ (Equation 8**)**)

***$BE_{manure,y}$* is calculated as per AMS-III.D Methane recovery in animal manure management systems, version 18:**

As per methodology AMS-III.AO Methane recovery through controlled anaerobic digestion, version 01, $BE_{manure,y}$ will be calculated as per the relevant procedures of AMS-III.D. version 18.

According to paragraph 9 of methodology AMS-III.D. Methane recovery in animal manure management systems - version 18, $BE_{manure,y}$ can be calculated by using one of the following two options:

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

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

The project participant has chosen the option (a). Therefore, for the proposed project activity, the baseline emissions for poultry litter are calculated according to the following equation:

$$BE_{manure,y} = GWP_{CH4} * D_{CH4} * UF_b * \Sigma j,LT\ MCF_j * B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS_{\%Bl,j}$$ (Equation 8)

Where:

$BE_{manure,y}$ *BEy* in AMS-III.D version 18

GWP_{CH4} Global Warming Potential (GWP) of CH_4 (21)

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

LT Index for all types of livestock

j Index for animal manure management system

MCF_j Annual methane conversion factor (MCF) for the baseline animal manure management system *j*

$B_{0,LT}$ Maximum methane producing potential of the volatile solid generated for animal type *LT* (m3 CH_4/kg dm) LT is poultry.

$N_{LT,y}$ Annual average number of animals of type *LT* in year *y* (numbers)

$VS_{LT,y}$ Volatile solids for livestock *LT* entering the animal manure management system in year *y* (on a dry matter weight basis, kg dm/animal/year)

$MS_{\%Bl\,j}$ Fraction of manure handled in baseline animal manure management system

UF_b Model correction factor to account for model uncertainties (0.94)[75]

In paragraph 10 (a) of AMS-III.D, version 18, it is stated that:

The maximum methane-producing capacity of the manure (B_o) varies by species and diet. The preferred method to obtain B_o measurement values is to use data from country-specific published sources, measured with a standardised method (B_o shall be based on total as-excreted VS). These values shall be compared to IPCC default values and any significant differences shall be explained. If country specific B_o values are not available, default values from tables 10 A-4 to 10 A-9 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 can be

[75] Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

used, provided that the project participants assess the suitability of those data to the specific situation of the treatment site;

PP's genetic source does not originate from an Annex 1 country. PP does not use formulated feed rations. PP cannot validate this, and as no country specific B_o values are available for India, default value is used from table 10 A-9 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10. The data are suitable to the specific situation of the treatment site as they concern poultry in warm developing countries, which includes the project location.

In paragraph 10 (b) of AMS-III.D, version 18, it is stated that:

Volatile solids (VS) are the organic material in livestock manure and consist of both biodegradable and non-biodegradable fractions. For the calculations the total VS excreted by each animal species is required. The preferred method to obtain VS is to use data from nationally published sources. These values shall be compared with IPCC default values and any significant differences shall be explained. If data from nationally published sources are not available, country-specific VS excretion rates can be estimated from feed intake levels, via the enhanced characterisation method (tier 2) described in section 10.2 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10. If country specific VS values are not available IPCC default values from 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10 table 10 A-4 to 10 A-9 can be used provided that the project participants assess the suitability of those data to the specific situation of the treatment site particularly with reference to feed intake levels;

PP's genetic source does not originate from an Annex 1 country. PP does not use formulated feed rations. PP cannot validate this, and as no country specific VS values are available for India, default value is used from table 10 A-9 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10) $VS_{default}$ = 0.02 kg VS/d. The data are suitable to the specific situation of the treatment site, as they concern poultry in developing countries, which includes the project location.

In paragraph 10 (f) of AMS-III.D, version 18, it is stated that:

Methane Conversion Factors (MCF) values are determined for a specific manure management system and represent the degree to which Bo is achieved. Where available country-specific MCF values that reflect the specific management systems used in particular countries or regions shall be used. Alternatively, the IPCC default values provided in table 10.17 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10 can be used;

For the proposed project activity data for MCFj (22.84%) is derived from a report from Tamil Nadu Agricultural University based on field studies of a sample of poultry farms in the Namakkal district. The report from Tamil Nadu Agricultural University constitutes the most recent and most relevant data source for the proposed project activity.[76]

$$N_{LT,y} = N_{da,y} * \left(\frac{N_{p,y}}{365} \right)$$

(Equation 9)

Where:

$N_{da,y}$	Number of days animal is alive in the farm in the year "y" (numbers)
$N_{p,y}$	Number of animals produced annually of type "LT" for the year "y" (numbers)

Project Emissions (PE_y)

For AMS-I.D. Grid connected renewable electricity generation – version 17 the project emissions are zero as per paragraph 20 of AMS-I.D.

[76] Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), *Methane Emission Potential of Poultry Litter* (October 2011). Document made available to the DOE as SD_04.

For AMS-III.AO Methane recovery through controlled anaerobic digestion, version 01, project emissions can consist of:
(a) CO2 emissions due to incremental transportation distances;
(b) CO2 emissions from electricity and/or fossil fuel consumption by the project activity facilities;
(c) In case the residual waste from the digestion is stored under anaerobic conditions and/or delivered to a SWDS, or treated in a WWTS: the methane emissions from the disposal/storage/treatment of these residual waste;
(d) Methane emissions from physical leakages of the anaerobic digester;
(e) Methane emissions due to flare inefficiency;

$$PE_y = \begin{Bmatrix} PE_{transp,y} + PE_{power,y} + PE_{res\ waste,y} \\ + PE_{phy\ leakage,y} + PE_{flaring,y} \end{Bmatrix} \quad \text{(Equation 10)}$$

Where:
PE_y Project activity emissions in the year *y* (tCO_2e)
$PE_{transp\ y}$ Emissions from incremental transportation in the year *y* (tCO_2e)
$PE_{power\ y}$ Emissions from electricity or fossil fuel consumption in the year *y* (tCO_2e)
$PE_{res\ waste\ y}$ In case residual wastes are subjected to anaerobic storage, or disposed in a landfill: methane emissions from storage/disposal/treatment of waste (tCO_2e)
$PE_{phy\ leakage\ y}$ Methane emissions from physical leakages of the anaerobic digester in year *y* (tCO_2e)
$PE_{flaring\ y}$ Methane emissions due to incomplete flaring in year *y* as per the "Tool to determine project emissions from flaring gases containing methane"(tCO_2e)

Project emissions due to incremental transport distances ($PE_{transp,y}$) :

$PE_{transp,y}$ are calculated based on the incremental distances between:
(i) The collection points of biomass and/or manure and the digestion site as compared to the baseline solid waste disposal site or manure treatment site;
(ii) When applicable, the collection points of wastewater and treatment site as compared to baseline wastewater treatment site;
(iii) Treatment sites and the sites for soil application, landfilling and further treatment of the residual waste.

$$PE_{transp,y} = (Q_y / CT_y) * DAF_w * EF_{CO2,transport} + (Q_{res\text{-}waste,y} / CT_{res\text{-}waste,y}) * DAF_{res\text{-}waste} * EF_{CO2,transport} \quad \text{(Equation 11)}$$

Where:
Q_y Quantity of raw waste/manure treated and/or wastewater co-digested in the year *y* (tonnes)
CT_y Average truck capacity for transportation (tonnes/truck)
DAF_w Average incremental distance for raw solid waste/manure and/or wastewater transportation (km/truck)
$EF_{CO2transport}$ CO2 emission factor from fuel use due to transportation ($kgCO_2$/km, IPCC default
values or local values may be used)
$Q_{res\ waste\ y}$, Quantity of residual waste produced in year *y* (tonnes)
$CT_{res\ waste\ y}$ Average truck capacity for residual waste transportation (tonnes/truck)
$DAF_{res\ waste}$ Average distance for residual waste transportation (km/truck)

Project emissions from electricity and/or fossil fuel consumption ($PE_{power,y}$):

$PE_{power} = PE_{power\_own\ gen} + PE_{power\_elec} + PE_{power\_DG}$ (Equation 12)

$PE_{power\_own\_gen}$

The project activity operations will be mainly powered by the Power Units. As per methodology AMSIII.AO (Version 01), paragraph 15, project emissions for *PEpower_own_gen* uses zero as its emission factor.

***PE**power_elec*

As per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01) scenario A applies when the onsite Power Units are not operating formula 1 applies:

$$PE_{EC,y} = \sum_{i} EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{i,y})$$

(Equation 13)

Where

$PE_{EC,y}$ $PE_{power,elec}$ = Project emissions from electricity consumption in year *y* (tCO_2/yr)

$EC_{PJ,j,y}$ Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/yr). ECPJ is monitored in line with $EG_{BL,y}$

$EF_{EL,j,y}$ Emission factor for electricity generation for source *j* in year *y* (tCO2/MWh). Defined as $EF_{grid,CM,y}$ in equation 5 of this PDD

$TDL_{j,y}$ Average technical transmission and distribution losses for providing electricity to source *j* in year *y.* Default values of 20% are used as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01).

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,y}$$

(Equation 14)

Where:

$PE_{FC,j,y}$ Are the CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr);

$FC_{i,j,y}$ Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr);_

$COEF_{i,y}$ Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit);

i Are the fuel types combusted in process *j* during the year *y*;

The CO_2 emission coefficient COEF*i,y* can be calculated using one of the following two Options, depending on the availability of data on the fossil fuel type *i*, as follows:

Only a diesel back-up power generator is available. Hence *i* is diesel.

As per "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 02)

Option A should be the preferred approach, if the necessary data is available. Since wC,i,y (the weighted average mass fraction of carbon in fuel type *i* in year y (tC/mass unit of the fuel) is not available to the project participant option B is used.

Option B = The CO2 emission coefficient COEFi,y is calculated based on net calorific value and CO2 emission factor of the fuel type *i*, as follows:

$COEF_{diesel,y} = NCV_{diesel,y} \times EF_{CO2,diesel,y}$ (Equation 15)

Where:

$COEF_{diesel,y}$ Is the CO2 emission coefficient of diesel in year y (tCO2/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)

Project emissions from anaerobic storage and/or disposal in a landfill of the residual waste from the digestion ($PE_{res\ waste,y}$):
In the proposed project activity, residual waste from the digestion is not subjected to anaerobic storage, or disposed in a landfill, therefore $PE_{res\ waste,y}$ will be considered zero.

Project emissions from physical leakages of the anaerobic digester ($PE_{phy\ leakage,y}$):
In the proposed project activity, these shall be estimated using a default factor of 0.05 m³ biogas leaked/m³ biogas produced. For *ex ante* estimation the expected biogas production of the digester may be used, for *ex post* calculations the effectively recovered biogas amount shall be used for the calculation.

Project emissions due to flare inefficiency
According to paragraph 13 of methodology AMS-III.AO (Version 01):
Methane emissions due to incomplete flaring in year y (in tCO2), represented as $PE_{flaring,y}$ is determined as per the *Tool to determine project emissions from flaring gases containing methane*(Version 01).

According to the *Tool to determine project emissions from flaring gases containing methane* (Version 01), The emissions resulting from the flaring ($PE_{flare,y}$) will be calculated with the tool *ex-post*.

This tool is applicable since:
• The residual gas stream to be flared contains no other combustible gases than methane, carbon monoxide and hydrogen;
• The residual gas stream to be flared is recovered from decomposition of organic materials.

Emissions from flaring of the residual gas stream are calculated based on the flare efficiency and the flow rate of methane in the residual gas stream that is flared. The flare efficiency depends on both the actual efficiency of combustion in the flare and the time that the flare is operating. Steps 3 and 4 of the Tool to determine project emissions from flaring gases containing methane (Version 01) are only applicable in case of both enclosed flares and continuous monitoring of the flare efficiency. Since PP opts for option (a) of the tool (hence to use 90% default value) steps 3 and 4 are not applicable. Since steps 1 and 2 are
only required to calculate data for steps 3 and 4.

Steps 5-7 of the Tool to determine project emissions from flaring gases containing methane (Version 01) will be used to determine default values and project emissions from flaring.

Step 5. Determination of methane mass flow rate in the residual gas on a dry basis
To determine of methane flow rate in the residual gas the following equation will be used:

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

(Equation 16)

Where:
$TM_{RG,h}$ Mass flow rate of methane in the residual gas in the hour h (kg/h)
$FV_{RG,h}$ Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h (m3/h)
$fv_{CH4,RG,h}$ Volumetric fraction of methane in the residual gas on dry basis in hour h
$\rho_{CH4,n}$ Density of methane at normal conditions (kg/m3), referred to as D_{CH4} in AMS-III.D (Version 18) and AMS-III.AO (Version 01)

Step 6. Determination of the hourly flare efficiency

According to this step of the Tool to determine project emissions from flaring gases containing methane (Version 01) the determination of the hourly flare efficiency depends on the operation of flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).

Under the proposed project activity an enclosed flare will be installed. For enclosed flares the Tool to determine project emissions from flaring gases containing methane (Version 01) stipulates two options:
a) to use default values of the flare efficiency; or
b) continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).

For determination of the flare efficiency option (a) – use of default values – has been chosen for the proposed project activity.

In case of enclosed flares and use of default values the following flare efficiency values shall be applied:
• 0% if the temperature in the exhaust gas of the flare (Tflare) is below 500 °C for more than 20 minutes during the hour h;
• 50%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h;
• 90%, if the temperature in the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h.

Step 7. Calculation of annual project emissions from flaring
The following equation will be applied to calculate project emissions from flaring:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000}$$

(Equation 17)

Where:
$PE_{flare,y}$ Project emissions from flaring of the residual gas stream in year *y* (tCO2e)
$TM_{RG,h}$ Mass flow rate of methane in the residual gas in the hour *h* (kg/h)
$\eta_{flare,h}$ Flare efficiency in hour *h*, referred to as FEy in methodology AMS-III.AO (Version 01)
GWP_{CH4} Global Warming Potential of methane valid for the commitment period (tCO2e/tCH4)

Leakage
As per AMS-III.AO (Version 01), leakage effects are to be considered if the project technology is the equipment transferred from another activity or if the existing equipment is transferred to another activity. In the case of the proposed project activity, all equipment is new and not transferred from another activity. Therefore, leakage is considered as zero.

Emission reductions (ERy)
$ER_y = BE_y – (PE_y + LE_y)$ (Equation 18)

Where:
ER_y Emission reductions in year y, in tCO_2/y
BE_y Baseline emissions in year y, in tCO_2/y
PE_y Project emissions in year y, in tCO_2/y
LE_y Leakage emissions in year y, in tCO_2/y

B.6.2. Data and parameters fixed ex ante

Data/Parameter	ID. 1./ $EF_{grid,CM,y} = EF_{EL,y}$
Data unit	tCO_2/GWh
Description	EF_y is the CO_2 emission factor of the Southern grid, in which the project activity displaced the electricity during the year y.
Source of data	The CEA CO_2 Emission Database Version 6.0, March 2011
Value(s) applied	865
Choice of data or measurement methods and procedures	Since the CEA is the prime authority for publishing all relevant data regarding the Indian power sector, the choice of the data is conservative. The emission factor is calculated from the CEA's OM and BM values of the Indian regional grid systems. The parameter is calculated according to the guidelines of CDM modalities and procedures.
Purpose of data	Determination of Baseline Emission
Additional comment	In equation 5 of this PDD defined as $EF_{grid,CM,y}$ and in equation 13 defined as $EF_{EL,y}$

Data/Parameter	ID. 2./ $EF_{grid,OM,y}$
Data unit	tCO2/GWh
Description	Operating Margin Emission Factor of the Southern grid.
Source of data	The CEA CO_2 Emission Database Version 6.0, March 2011[77]
Value(s) applied	966
Choice of data or measurement methods and procedures	Since the CEA is the prime authority for publishing all relevant data regarding the Indian power sector, the choice of the data is conservative. The emission factor is calculated from the CEA's data. The parameter is calculated according to the guidelines of CDM modalities and procedures.
Purpose of data	Determination of Emission Reductions
Additional comment	-

Data/Parameter	ID. 3./ $EF_{grid,BM,y}$
Data unit	tCO_2/GWh
Description	Build Margin Emission Factor of the Southern grid.
Source of data	The CEA CO_2 Emission Database Version 6.0, March 2011[78]
Value(s) applied	763
Choice of data or measurement methods and procedures	Since the CEA is the prime authority for publishing all relevant data regarding the Indian power sector, the choice of the data is conservative. The emission factor is calculated from the CEA's data. The parameter is calculated according to the guidelines of CDM modalities and procedures.
Purpose of data	Determination of Emission Reductions
Additional comment	-

[77] http://www.cea.nic.in/reports/planning/cdm_co2/Database_publishing_ver6.zip

[78] http://www.cea.nic.in/reports/planning/cdm_co2/Database_publishing_ver6.zip

Data/Parameter	ID. 4./ GWP_{CH4}
Data unit	CH_4
Description	Global Warming Potential (GWP) of methane. The factor describes the conversion of 1 tCH4 into 1 tCO2equivalent emissions.
Source of data	AMS-III.AO version 01
Value(s) applied	21
Choice of data or measurement methods and procedures	as per methodology AMS-III.AO version 01, equations 1 where GWP_{CH4} = 21
Purpose of data	Determination of Emission Reductions
Additional comment	-

Data/Parameter	ID. 5./ $D_{CH4} = \rho_{CH4,n}$
Data unit	kg/m^3
Description	Density of methane at normal conditions (20 ºC and 1 atm) pressure)
Source of data	IPCC 2006 default factor, see Equation 10.23 on pg.10.41 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use.
Value(s) applied	0.67
Choice of data or measurement methods and procedures	The value is taken from the IPCC 2006 tables, see above. In absence of choice of data, the IPCC default value is the best option to use.
Purpose of data	Determination of Emission Reductions
Additional comment	

Data/Parameter	ID. 6./ MCF_j
Data unit	%
Description	Methane conversion factor for manure management. Only for poultry litter.
Source of data	Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), Methane Emission Potential of Poultry Litter (October 2011)
Value(s) applied	22.84%
Choice of data or measurement methods and procedures	The data is derived from a report from Tamil Nadu Agricultural University based on field studies of a sample of poultry farms in the Namakkal district. This report is the most recent relevant source for the project activity.
Purpose of data	Determination of Emission Reductions
Additional comment	-

Data/Parameter	ID. 7./ $B_{o,LT}$
Data unit	$m^3_{CH_4}/kg$
Description	Maximum methane production potential (in the baseline situation). LT = Livestock = poultry.
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories under the volume 'Agriculture, Forestry and other Land use' for 'Emissions from Livestock and Manure Management' Table 10A-9, page 10.82.
Value(s) applied	0.24
Choice of data or measurement methods and procedures	As no country specific factor is available, the IPCC 2006 default factor is used
Purpose of data	Determination of Emission Reductions
Additional comment	-

Data/Parameter	ID. 8./ $VS_{default}$
Data unit	Kg/head/day
Description	Volatile solids for livestock LT
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories under the volume 'Agriculture, Forestry and other Land use' for 'Emissions from Livestock and Manure Management', Table 10A-9, page 10.82.
Value(s) applied	0.02
Choice of data or measurement methods and procedures	As no country specific factor is available, the IPCC 2006 default factor is used.
Purpose of data	Determination of Emission Reductions
Additional comment	-

Data/Parameter	ID. 9./ $MS\%_{BI,j,y}$
Data unit	%
Description	Fraction of manure handled in baseline animal manure management system j in year y.
Source of data	Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), Methane Emission Potential of Poultry Litter (October 2011). Document made available to the DOE as SD_04.
Value(s) applied	100%
Choice of data or measurement methods and procedures	100% of the poultry litter at poultry farms sourced by PP is managed under anaerobic conditions. PP refer to Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), Methane Emission Potential of Poultry Litter (October 2011). Document made available to the DOE as SD_04.
Purpose of data	Determination of Emission Reductions
Additional comment	-

<table>
<tr><td>Data/Parameter</td><td>ID. 10./ $EF_{CO2,diesel,y}$</td></tr>
<tr><td>Data unit</td><td>tCO_2/TJ</td></tr>
<tr><td>Description</td><td>CO_2 emission factor of diesel used in the year y.</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 guidelines.</td></tr>
<tr><td>Value(s) applied</td><td>74.8</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>As per tool “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” the following data sources may be used if the relevant conditions apply:

<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table>

As Project Participants do not have invoices from suppliers (option a), they have opted for option (d), the IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td></tr>
<tr><td>Purpose of data</td><td>Determination of Emission Reductions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>ID. 11./ NCV_{Diesel}</td></tr>
<tr><td>Data unit</td><td>GJ/t</td></tr>
<tr><td>Description</td><td>Net calorific value of diesel.</td></tr>
<tr><td>Source of data</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Table 1.2</td></tr>
<tr><td>Value(s) applied</td><td>43.3</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>As per tool “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” the following data sources may be used if the relevant conditions apply:

<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A)</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available

These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table>

As Project Participants do not have invoices from suppliers (option a), they have opted for option (d). The IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.2 of Chapter 1 of
Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td></tr>
<tr><td>Purpose of data</td><td>Determination of Emission Reductions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data/Parameter	ID. 12./ ρ_{diesel}
Data unit	t/m^3
Description	Density of diesel.
Source of data	CEA's CO_2 Emission Database Version 6.0, March 2011. Appendix B (page 25)of the CO_2 Baseline Database for the Indian Power Sector User Guide, accessed at: http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver6.pdf
Value(s) applied	0.83
Choice of data or measurement methods and procedures	As per tool "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" the following data sources may be used if the relevant conditions apply: **Data source** / **Conditions for using the data source** a) Values provided by the fuel supplier in invoices — This is the preferred source b) Measurements by the project participants — If a) is not available c) Regional or national default values — If a) is not available These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances). Since (a) is not available to the PP, option (c) is opted and the value from the Central Electricity Authority (CEA) is used. The CEA is the statutory organisation under Ministry of Power who collects and records data concerning the generation, transmission, trading, distribution and utilization of electricity.
Purpose of data	Determination of Emission Reductions
Additional comment	-

Data/Parameter	ID. 13./ $EF_{CO2,transport}$
Data unit	$kgCO_2/km$
Description	CO_2 emission factor from fuel use due to transportation.
Source of data	Based on 8.25 km/ litre of average fuel consumption ($F_{diesel,avg}$) value determined as per contracts obtained from logistics company[79]
Value(s) applied	0.326
Choice of data or measurement methods and procedures	Transport is subcontracted; value determined as per contracts obtained from logistics company[80].
Purpose of data	Determination of Emission Reductions
Additional comment	$EF_{CO2,transport}$ = (NCV_{Diesel} x ρ_{Diesel} x $EF_{CO2,diesel,y}$)/ $F_{diesel,avg}$ / liter x 1/1000 hence since: NCV_{Diesel} = ID.11 ρ_{Diesel} = ID.12 $EF_{CO2,diesel,y}$ = ID.10 $F_{diesel,avg}$ = km/liter, as per SD_28. The result = (43,3*0.83*74.8)/8.25/1000 = 0.326

[79] Substrate Transport Quotation. Document made available to DOE.

[80] Substrate Transport Quotation. Document made available to DOE.

Data/Parameter	ID. 14./ $\eta_{flare,h} = FE_y$
Data unit	%
Description	Flare efficiency in hour h based on measurements or default values.
Source of data	Default values given in the Methodological Tool to determine project emissions from flaring gases containing methane (Version 01).
Value(s) applied	90%
Choice of data or measurement methods and procedures	Under the project activity an enclosed flare will be installed. For enclosed flares the Tool to determine project emissions from flaring gases containing methane (Version 01) stipulates two options: a) To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour; or b) Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency). For determination of the flare efficiency option (a) – use of default values – has been chosen for the project activity In case of enclosed flares and use of default values the following flare efficiency values shall be applied: • 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500°C for more than 20 minutes during the hour h; • 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour h, but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour h; • 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour h and the manufacturer's specifications on proper operation of the flare are met continuously during the hour h. • As per paragraph 19 (b) of AMS-III.AO (Version 01) if the biogas is combusted for gainful purposes, e.g. fed to an engine, an efficiency of 100% may be applied Based on continuous measured T_{flare}, η_{flare} is determined based upon above default values.
Purpose of data	Determination of Emission Reductions
Additional comment	Used to calculate Project Emissions from flaring ($PE_{flare,y}$) as per Methodological Tool to determine project emissions from flaring gases containing methane (Version 01) (formula 15); Used to calculate Methane destructed in year y (MD_y) as per AMS-III.D (formula 18).

Data/Parameter	ID. 15./ $fv_{CH4,RG,h}$
Data unit	mg/m^3
Description	Volumetric fraction of CH4 in the residual gas in the hour h.
Source of data	Page 2, 2nd line below figure 01 of TNAU report[81]
Value(s) applied	60%
Choice of data or measurement methods and procedures	Only used for ex-ante estimation of the methane content in the residual gas since PP opts to use option (a) page 3 of the "Tool to determine project emissions from flaring gases containing methane" (version 01), $fv_{CH4,RG,h}$ is only required in step 5 to calculate the ex-ante value of $TM_{FG,h}$ since under step 6 PP opts to use default values and enclosed flare.
Purpose of data	Determination of Emission Reductions
Additional comment	-

[81] Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), *Methane Emission Potential of Poultry Litter* (October 2011). Document made available to the DOE as SD_04.

<table>
<tr><td>Data/Parameter</td><td>ID. 16./ $TDL_{j,y}$</td></tr>
<tr><td>Data unit</td><td>-</td></tr>
<tr><td>Description</td><td>Average technical transmission and distribution losses for providing electricity to source j in year y.</td></tr>
<tr><td>Source of data</td><td>Use as default values of 20% for project or leakage electricity consumption sources as per methodological tool “Tool to calculate baseline, project and/or leakage emissions from electricity consumption (Version 01).</td></tr>
<tr><td>Value(s) applied</td><td>20%</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>As per methodological; “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (Version 01) in case of scenario B and scenario C, case C.II, assume $TDL_{j/k/l,y}$ = 0 as a simplification.
In case of other scenarios (scenario A and scenario C, cases C.I and C.III), choose one of the following options:,

• Use recent, accurate and reliable data available within the host country;
• Use as default values of 20% for
(a) project or leakage electricity consumption sources;
(b) baseline electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is larger than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies.
• Use as default values of 3% for
(a) baseline electricity consumption sources;
(b) project and leakage electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies.

In light of the options above, Project Participants have opted for the following:

<table>
<tr><td rowspan="2">TDL,j,y</td><td>Grid</td><td>20%</td><td>as per tool 2nd bullet option (a) above</td></tr>
<tr><td>Gen Set</td><td>3%</td><td>as per tool 3rd bullet option (b) above</td></tr>
</table>
</td></tr>
<tr><td>Purpose of data</td><td>Determination of Emission Reductions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

B.6.3. Ex ante calculation of emission reductions

>>

Baseline emissions:

Baseline emissions from electricity generation (from equation 3 above)

Input data

biogas production	m3/y	7,585,568

Calorific value Biogas LHV	kWh/m3	6.0
biogas production	kWh/y	45,354,384
biogas needed for gas engine	kWh/y	43,478,261
gas engine PLF	%	86%
gas engine	kW	2,400
gas engine efficiency	%	41.4
Gross power production	kWh/y	18,000,000
Electricity auxiliary consumption	kWh/y	2,602,979
Electricity auxiliary consumption	%	14.5%
Net power sales (EGBL,y)	kWh/y	**15,397,021**

$EG_{BL,y}$: 15.4 GWh/y – monitored

$EF_{CO2,grid,y}$: 865 tCO_2/GWh – ex-ante

Calculations

$BE_{Elec,y} = EG_{BL,y} * EF_{CO2,grid,y}$ (Equation 3)

Results

BEElec,y = 13,318 tCO2e/y

Baseline emissions from poultry litter

The table below provides the anticipated quantities of substrate to the anaerobic digester:

Sr. No.	Waste	Quantity (t/y)
1	Poultry Litter	37,000
2	Agricultural biomass residue	58,000
3	Cow Dung	1,825

As mentioned in chapter B4, baseline emissions of waste types 2 and 3 are not taken into account (conservative assumption).

The table below provides the overview of data used to determine the baseline emission related to avoidance of methane production.

Input data

Variable	Value applied	Unit	Source
$VS_{default}$[82]	0.02	kg	IPCC
days per year	365	d	Default

$VS_{LT,y} = VS_{default} * 365$

$VS_{LT,y} = 7.3$ kg/y

Input data

Variable	Value applied	Unit	Source
GWP_{CH4}	21	-	ex-ante
D_{CH4}	0.67	kg/m3	ex-ante
UF_b	0.94		ex-ante;Model correction factor to account for model uncertainties (0.94) [83]
MCF_j	22.84	%	ex-ante

[82] As PP doesn't use developed country VS values section 25. (b) of AMS-III.D doesn't apply. Likewise, as per section 27 W_{site} doesn't have to be monitored since IPCC values of VS are not adjusted.

[83] Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

$B_{0,LT}$	240	m3 CH4/t	ex-ante
NLT,y	2,500,000	birds	Calculated
$VS_{LT,y}$	7.3	kg/y	Calculated
$MS\%_{BI,u}$	100%		ex-ante

$BE_{manure,y} = GWP_{CH4} * D_{CH4} * UF_b * \Sigma j,LT\ MCF_j * B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS\%_{Bl,j}$ (Equation 8)

$BE_{manure,y}$ = 13,231 tCO2e/y

Hence baseline emissions are:
$BE_{Elec,y}$ = **13,318** tCO2e/y
$BE_{manure,y}$ = **13,231** tCO2e/y

$BEy = BE_{Elec,y} + BE_{manure,y}$

Results
BE_y = 26,549 tCO2e/y

Project emissions:

Emissions due to transportation ($PE_{transp,y}$)

Calculate parameter EF_{CO2}

Input data

Variable	Value applied	Unit	Source
NCV_{Diesel}	43.3	GJ/t	ex-ante
ρ_{Diesel}	0.83	t/m3	ex-ante
$EF_{CO2,diesel,y}$	74.8	tCO_2/TJ	ex-ante
$F_{diesel,avg}$	8.25	km/l	ex-ante

$EF_{CO2} = ((NCV_{Diesel} * \rho_{Diesel} * EF_{CO2,diesel,y})/ F_{diesel,avg})/1000$
$EF_{CO2} = 0.326\ kgCO_2/km$

Calculate parameter $PE_{transp,y}$

Variable	Value applied	Unit	Source
Q_y	96,825	t/y	Monitored
CT_y	8	t/truck	Monitored
DAF_w	25	km	Monitored
$Q_{res\ waste,y}$	22,706	t/y	Monitored
$CT_{res\ waste,y}$	8	t/truck	Monitored

$$PE_{transp,y} = (Q_y / CT_y) * DAF_w * EF_{CO2,transport} + (Q_{res-waste,y} / CT_{res-waste,y}) * DAF_{res-waste} * EF_{CO2,transport}$$
(Equation 11)

$PE_{transp,y} = PE_{y,transp,litter} + PE_{y,transp,treatment} = 149.36\ tCO_2e/y$

Project emissions from electricity and/or fossil fuel consumption ($PE_{power,y}$)

Variable	Value applied	Unit	Source
$PE_{power\_own\ gen}$	0	tCO2e/y	own generation is renewable energy, hence 0
PE_{power_elec}	0	tCO2e/y	Monitored
PE_{power_DG}	0	tCO2e/y	Monitored

Calculations

$PE_{power} = PE_{power\_own\ gen} + PE_{power\_elec} + PE_{power\_DG}$ (Equation 12)

Results
$PE_{power,y}$ = 0 tCO_2e/y

Since Project Participant expects to use 100% of the auxiliary power from its own Power Units, if diesel
and/ or electricity from the grid are used during operations, then these will be monitored and the actual
emissions will be calculated at the project site after implementation of the project activity).

Project Emissions due to physical leakage of biogas in the year y ($PE_{phy\ leakage,y}$)

Variable	Value applied	Unit	Source
Biogas	7,984,808	m3/y	$BG_{flared,y} + BG_{combusted,y}$
biogas leaked/ m^3 biogas	0.05	m3/y	as per AMS-III.AO
biogas leaked	399,240	m3/y	Calculated
w_{CH4}	60%		monitored
methane leaked	239,544	m^3/y	Calculated
$\rho_{CH4,n}$	0.67	kg/m^3	IPCC ex-ante see parameter ID.5
methane leaked	160.49	t/y	Calculated
GWP_{CH4}	21		IPCC ex-ante; see parameter ID.4

Calculations
$PE_{phy\ leakage,y}$ = methane leaked (t/y) * GWP_{CH4}
Results
$PE_{phy\ leakage,y}$ = 3,370 tCO_2e/y

Project Emissions due to flaring ($PE_{flare,y}$)
Input data

Variable	Value applied	Unit	Source
$FV_{RG,h}$	912	m^3 /h	monitored
$fv_{CH4,RG,h}$	60%	-	ex-ante
$\rho_{CH4,n}$	0.67	kg/m^3	ex-ante; see parameter ID.5

Calculations

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$ (Equation 16)

Results
$TM_{RG,h}$= 366 kg/h

Input data

Variable	Value applied	Unit	Source
$TM_{RG,h}$	366	kg/h	calculated above
$\eta_{flare,h}$	90%	-	ex-ante
GWP_{CH4}	21		IPCC ex-ante; see parameter ID.4
time flare is burning	876	h	ex-ante assumption (10%); actual operating hours are determined through monitoring of ID. 17./ ηflare,h = FEy.

Calculations

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH4}}{1000}$$ (Equation 17)

Results
$PE_{flare,y}$ = 674.08 tCO_2e/y

Project Emissions due to storage ($PE_{res\ waste,y}$)

As per methodology AMS-III.AO version 01 paragraph 16, the methane emissions from anaerobic storage and/or disposal in a landfill of the residual waste from the digestion (PEres waste,y) are to be calculated as per the latest version of the tool "Emissions from solid waste disposal sites" (version 06.0.1). As detailed in table 4, application condition 5, no residual waste will be stored, hence:

$PE_{res\ waste,y}$ = 0 tCO_2e/y

Leakage:
LE_y = 0 tCO2e/y

Emission reductions:
$ER_y = BE_y – PE_y - LE_y$= 26,549 - 4,189 - 0 = 22,355 tCO_2e

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2013	26,549	4,194	0	22,355
2014	26,549	4,194	0	22,355
2015	26,549	4,194	0	22,355
2016	26,549	4,194	0	22,355
2017	26,549	4,194	0	22,355
2018	26,549	4,194	0	22,355
2019	26,549	4,194	0	22,355
2020	26,549	4,194	0	22,355
2021	26,549	4,194	0	22,355
2022	26,549	4,194	0	22,355
Total	265,494	41,938	0	223,550
Total number of crediting years	10			
Annual average over the crediting period	265,494	41,938	0	223,550

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

(Copy this table for each piece of data or parameter.)

Data/Parameter	ID. 18./ $EG_{gross,y}$
Data unit	GWh/y
Description	The gross electricity generated by the project activity.
Source of data	Energy meter.
Value(s) applied	18.00
Measurement methods and procedures	The gross electricity generated by the project activity would be monitored based on an energy meter on the generator panel of the engines which is logged on PLC (programmable logic controller).
Monitoring frequency	Monthly Report on PLC

QA/QC procedures	The data is monitored continuously. The Operator reports the readings on a monthly basis. Based on the logged data, a monthly report is prepared by Manager-in-Charge and is forwarded to CDM Coordinator through email on monthly basis. The data used is reviewed by conducting an inter department review meeting once in 6 months. The Coordinator CDM will discuss the data (received from respective departments) with the operators of the concerned departments. Accuracy class is 0.2S class as per IEC62053-22. Once the data is compiled and checked, it will be handed over to Verifier for verification. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 19./$EG_{BL,y}$**
Data unit	GWh/y
Description	Net electricity supplied by the project activity to the grid.
Source of data	TANGEDCO (Tamil Nadu Generation and Distribution Corporation) report based on this which PP will raise the invoice to TANGEDCO along with duly signed report.
Value(s) applied	15.26
Measurement methods and procedures	The energy meter operates continuously. TANGEDCO official will check the energy meter (primary) once per month and the reading will be recorded in the log books. The TANGEDCO official will issue a monthly consumption statement, which will be used as source of data. Based on this statement PP will raise the invoice to TANGEDCO along with the monthly consumption statement.
Monitoring frequency	Monthly basis
QA/QC procedures	If primary energy meter fails to read then TANGEDCO will refer the secondary energy meter. If both energy meters fails then source of data will be used from the previous last 3 months reports mutually agreed by PP & TANGEDCO. Based on the logged data, a report is prepared by Manager-in-Charge and is forwarded to CDM Coordinator through email on monthly basis. The data used is reviewed by conducting an inter department review meeting once in 6 months. The Coordinator CDM will discuss the data (received from respective departments) with the operators of the concerned departments. Once the data is compiled and checked, it will be handed over to Verifier for verification. The metering arrangements with facilities to record export and import of energy shall be provided in accordance with the Central Electricity Authority (installation and Operation of Meters) Regulations, 2006, Commission's Intra State Open Access Regulations 2005. Tamil Nadu Electricity Distribution Code, 2004 and Tamil Nadu Grid Code, 2004 in consultation with Distribution Licensee / State transmission Utility. The periodicity of testing, checking, calibration etc., will be governed by the Regulations issued by the Central Electricity Authority / Commission[84] The energy meters healthiness will be checked by TANGEDCO at regular intervals will be decided by TANGEDCO on time to time basis. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once five years as per section 4.1 & 4.6 of the PPA.
Purpose of data	Determination of Emission Reductions
Additional comment	The above methodology is accepted by PP in EPA signed with TANGEDCO. The data will be archived electronically until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later as per § 17.a of the general guidelines to SSC CDM methodologies (version 17).

[84] Biomass Energy Purchase Agreement. Document made available to DOE.

Data/Parameter	ID. 20./ECPJ,y
Data unit	GWh/y
Description	Net electricity imported from the grid in case the Power units are not operating.
Source of data	TANGEDCO (Tamil Nadu Generation and Distribution Corporation) report based on this which PP will raise the invoice to TANGEDCO along with duly signed report.
Value(s) applied	0
Measurement methods and procedures	The energy meter operates continuously. TANGEDCO official will check the energy meter (primary) once per month and the reading will be recorded in the logbooks. The TANGEDCO official will issue a monthly consumption statement, which will be used as source of data. Based on this statement TANGEDCO will raise an invoice along with duly signed report if the Net electricity supplied by the project activity to the grid minus the net electricity imported is negative over the reporting period (if more electricity is imported than supplied).
Monitoring frequency	Monthly basis
QA/QC procedures	If primary energy meter fails to read then TANGEDCO will refer the secondary energy meter. If both energy meters fail then source of data will be used from the previous last 3 months reports mutually agreed by PP & TANGEDCO. The metering arrangements with facilities to record export and import of energy shall be provided in accordance with the Central Electricity Authority (installation and Operation of Meters) Regulations, 2006, Commission's Intra State Open Access Regulations 2005. Tamil Nadu Electricity Distribution Code, 2004 and Tamil Nadu Grid Code, 2004 in consultation with Distribution Licensee / State transmission Utility. The periodicity of testing, checking, calibration etc., will be governed by the Regulations issued by the Central Electricity Authority / Commission[85] The energy meters healthiness will be checked by TANGEDCO at regular intervals will be decided by TANGEDCO on time to time basis. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in five years as per section 4.1 & 4.6 of the PPA.
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	ID. 21./Qi,y
Data unit	t/y
Description	Amount of waste type *i* (poultry litter, agricultural wastes, and cow dung) used at the plant.
Source of data	Weigh bridge records
Value(s) applied	37,000 for poultry litter 58,000 Agricultural biomass residue 1,825 for cow dung
Measurement methods and procedures	All incoming trucks transporting poultry litter shall be directly measured using the onsite weighbridge. The delta in weight between the empty truck and the loaded truck is taken as the weight of the poultry litter.
Monitoring frequency	Each truck loading is monitored and then monthly reports

[85] Biomass Energy Purchase Agreement; Document made available to DOE.

QA/QC procedures	Each weigh instance is monitored and logged in the log book by the Operator. Based on the logged data, a monthly report is prepared by Manager-in-Charge and is forwarded to CDM Coordinator through email on monthly basis. Once the data is compiled and checked, it will be handed over to Verifier for verification. The measuring equipment (electronic weigh bridge) is designed as per IS: 9281 manufacturing standard specifications (+/- 0.025% of FS)[86]. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 22./$Q_{res\ waste,y}$**
Data unit	t/y
Description	Amount of treated residue (compost) shipped off.
Source of data	Weigh bridge records.
Value(s) applied	22,706
Measurement methods and procedures	All trucks transporting compost would be measured for both empty weight and also with loaded compost. The difference is the weights would be measured for amount of treated compost shipped off from the plant. This is also substantiated with invoices/payment receipts to the buyers of the treated compost.
Monitoring frequency	Each truck, daily report and monthly report
QA/QC procedures	Each weigh instance is monitored and logged in the log book on a daily basis by the Operator. Based on the logged data, a monthly report is prepared by the Manager-in-Charge and is forwarded to the CDM Coordinator through email on monthly basis. Once the data is compiled and checked, it will be handed over to the Verifier for verification. The measuring equipment (electronic weigh bridge) is designed as per IS:9281 manufacturing standard specifications (+/- 0.025% of FS). The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 23./w_{CH4}**
Data unit	%
Description	Methane content in the biogas (dry).
Source of data	Gas analyser.
Value(s) applied	60%
Measurement methods and procedures	Data is monitored continuously. Values are logged every half hour. The CH4 content is analysed by NDIR (non-dispersive infrared sensor) and is hence measured directly and the measurement point is close to the biogas flow rate measurement point (ID.24).
Monitoring frequency	Hourly basis

[86] SD_76 Weigh bridge data sheet provided to the DOE

QA/QC procedures	The 30 minutes interval assures a confidence/ precision level higher than the 90/10 level required (see appendix 4 regarding the required sample size). Based on the logged data, a monthly report is prepared by Manager-in-Charge which is forwarded to the CDM Coordinator. The data used is reviewed by conducting a inter department review meeting once in 6 months. Once the data is compiled and checked, it will be handed over to the Verifier for verification. The measuring equipment (Gas analyser) is designed as per ANSI/API RP 555-2001 manufacturing standard specifications. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later as per § 17.a of the general guidelines to SSC CDM methodologies (version 17).

Data/Parameter	**ID. 24./FVRG,h**
Data unit	m^3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h
Source of data	Measurements by project participants using a Thermal mass flow meter.
Value(s) applied	912 (sourced from SD_16 CDM financial analysis, on the tab-sheet “CER”; SD_16 made available to DOE).
Measurement methods and procedures	Will be continuously measuring the gas flow rate and the value will be logged in PLC on a half hourly basis. Accuracy measurement: ± 1.8% of reading + 0.1% full scale[87]. PP will ensure that the same basis (dry) is considered for this measurement.
Monitoring frequency	Half hour values, based on which monthly report is generated from PL
QA/QC procedures	Data is monitored continuously. Values are logged every half hour. Based on the logged data, a monthly report is prepared by Manager-in-Charge which is forwarded to CDM Coordinator. The measuring equipment is designed using IS/ANSI manufacturing standard specifications. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later as per § 17.a of the general guidelines to SSC CDM methodologies (version 17). In § III of the “Tool to determine project emissions from flaring gases containing methane” (version 01) in the parameter box for FVRG,h under “Measurement procedures” the following sentence is included (“[…] and the measurement of volumetric fraction of all components in the residual gas (fvi,h) when the residual gas temperature exceeds 60 o C]. Since PP opts to use option (a) page 3 of the “Tool to determine project emissions from flaring gases containing methane” (version 01), this part of the sentence is not relevant and has hence been left out.

Data/Parameter	**ID. 25./$BG_{combusted,y}$**
Data unit	m^3/y (normalized)
Description	The amount of the biogas combusted, measured on a dry basis.

[87] SD_69_Flow_meter_spec_sheet

Source of data	Flow meter
Value(s) applied	7,186,328 (sourced from SD_16 CDM financial analysis, on the tab-sheet 'Energy & Mass Balance'; SD_16 made available to DOE).
Measurement methods and procedures	The quantity of biogas generated is measured using a calibrated flow meter. The flow meter values are logged in the system. The accuracy class of the flow meter for is +0.1% of full scale.
Monitoring frequency	Half hour values, based on which monthly report is generated from PLC
QA/QC procedures	Data is monitored continuously. Values are logged every half hour. Based on the logged data, a monthly report is prepared by Manager-in-Charge which is forwarded to CDM Coordinator. The data used is reviewed by conducting a inter department review meeting once in 6 months. Once the data is compiled and checked, it will be handed over to Verifier for verification. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 26./BGflared,y**
Data unit	m^3/y (normalized)
Description	The amount of biogas generated that is flared, measured on a dry basis.
Source of data	Flow meter
Value(s) applied	798,481 (sourced from SD_16 CDM financial analysis, on the tab-sheet "CER"; SD_16 made available to DOE).
Measurement methods and procedures	The quantity of biogas flared is measured using a calibrated flow meter. The flow meter values are logged in the system. The accuracy class of the flow meter for is ±0.1% of full scale.
Monitoring frequency	Half hour values, based on which monthly report is generated
QA/QC procedures	Data is monitored continuously. Values are logged every half hour.. Based on the logged data, a monthly report is prepared by Manager-in-Charge which is forwarded to CDM Coordinator. The data used is reviewed by conducting a inter department review meeting once in 6 months. Once the data is compiled and checked, it will be handed over to Verifier for verification. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 27./ Frequency of tilling**
Data unit	Number
Description	Number of times each batch is tilled.
Source of data	Plant records (Log book maintained at drying yard).
Value(s) applied	Once per day
Measurement methods and procedures	The digester sludge output will be separated in a common separation system. The solid phase will be solar dried in a dedicated fertilizer yard. The piles are regularly turned (once or twice in a day) to improve porosity and oxygen content of the piles, thus ensuring that the solids are aerobically handled. Each batch is dried for approximately 12 - 13 days.

Monitoring frequency	Once per day
QA/QC procedures	The Operator reports the readings at each tilling in the plant records, as well as when the sludge is removed. Based on the logged data, a monthly report is prepared by the Manager-in-Charge and is forwarded to the CDM Coordinator. The data used is reviewed by conducting a inter department review meeting once in 6 months. Once the data is compiled and checked, it will be handed over to the Verifier for verification. The measuring equipment used for monitoring data is calibrated as per manufacturers specifications, but at least once in three years as per § 17.c of the general guidelines to SSC CDM methodologies (version 17).
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 28./FC_{Diesel}**
Data unit	Litres
Description	Amount of diesel consumption for operation at site for e.g. tillers and diesel generator set.
Source of data	Plant records
Value(s) applied	Zero
Measurement methods and procedures	Monthly stock balance shall be used for calculating quantity of diesel consumed during operation of tillers and DG set at the site.
Monitoring frequency	Daily monitoring and Monthly compilation
QA/QC procedures	This can be cross checked with the fuel receipts / invoices raised.
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 29./T_{flare}**
Data unit	°C
Description	Temperature in the exhaust gas of the flare.
Source of data	Measurements by project participants.
Value(s) applied	> 500°C
Measurement methods and procedures	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 500 o C indicates that a significant amount of gases are still being burnt and that the flare is operating.
Monitoring frequency	Half hour values, based on which monthly report is generated from PLC
QA/QC procedures	Data is monitored continuously. Values are logged every half hour. Based on the logged data, a monthly report is prepared by the Accounts Manager in hard or soft copy and is forwarded to the CDM Coordinator through email on monthly basis. Once the data is compiled and checked, it will be handed over to the Verifier for verification. The thermocouples are manufactured as per ANSI standard specifications. Thermocouples are replaced or calibrated every year as per the manufacturer recommendations.
Purpose of data	Determination of Emission Reductions

Additional comment	An excessively high temperature at the sampling point (above 700 oC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later.

Data/Parameter	**ID. 30./NLT,y**
Data unit	Individual bird.
Description	Livestock population.
Source of data	Based on back-calculation of poultry litter requirement of the plant (i.e. design capacity) and average generation data (i.e. 40g/head/day)
Value(s) applied	2,500,000
Measurement methods and procedures	As per report from Tamil Nadu Agricultural University, poultry produces 35 – 40 grams of litter per day per head[88]. The value NLT,yis determined through back-calculation of the poultry litter requirement of the plant on an annual basis. In addition, each farm has records for its livestock population. Through sampling, the records can be compared with sales records of manure from the respective farm and the data can be compared to calculate livestock population.
Monitoring frequency	Annual report
QA/QC procedures	The consistency between these values and indirect information (records of sales, records of food purchases) shall be assessed. Significant changes in livestock population will be explained.
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later. For 100% of the population the used value is then based on the following back calculation: ~ 2.5 million heads * ~ 40 grams per head per day * 365 operational days ≈ 37,000 tonne of poultry litter per year. As the animal manure is not treated in different treatment systems, the parameter MS%i,y doesn't have to be monitored as is defined in section 26 no. 15 of AMS-III.D version 18.

Data/Parameter	**ID. 31./DAFw,i**
Data unit	km/truck
Description	Average incremental distance for waste type *i* (poultry litter, agricultural waste and cow dung) transportation.
Source of data	Records (TRIPSHEETS) showing from which location the waste originates.
Value(s) applied	25

[88] Department of Bioenergy, Tamil Nadu Agricultural University (Tamil Nadu), Methane Emission Potential of Poultry Litter (October 2011). Document made available to the DOE as SD_04.

Measurement methods and procedures	The "average incremental distance" of 25 km is taken as a conservative average. This is as per SD_03, Detailed Project Report, pages 53 through 63 and also based on TIDE Technocrat report; Since PP cannot calculate the baseline distance; PP has opted to monitor (sample) the distances and use the sampled values without subtracting the baseline (original) distance. Hence the "average incremental distance was determined based on all the distances provided in pages 53 through 63 of the DPR, which are based on SD_02 Tide Technocrats Report. The average distance is less, which is below 25 km. PP considering a conservative value of 25 KM, and therefore; the proposed project activity complies with this requirement.
Monitoring frequency	Sampling from complete set of records of each truck loading
QA/QC procedures	Since PP cannot calculate the baseline distance; PP has opted to monitor (sample) the distances and use the sampled values without subtracting the baseline (original) distance. The distance travelled by each type of waste is determined on sample basis and same distance is considered for respective type of waste transported. Please refer excel sheet of ER calculations for the distances considered for each type of waste.
Purpose of data	Records (TRIPSHEETS) showing from which location the waste originates. Through statistically sound sampling the distance between those locations and the project (plant) site is determined and verified. The distance considered for project emissions are without subtracting any baseline distance, thus conservative in nature. Also sample size is selected to achieve 90/10 confidence precision level. The average value of distance is considered for project emission calculations.
Additional comment	Determination of Emission Reductions

Data/Parameter	**ID. 32./DAFres waste**
Data unit	km/truck
Description	Average incremental distance for compost transportation.
Source of data	Records i.e. TRIPSHEETS
Value(s) applied	50
Measurement methods and procedures	50 km is taken as a conservative average. The parameter will be determined through sampling (see Annex 4 sampling plan). For determining the ex-ante value: this was based on SD_02 Tide Technocrats Report: the survey conducted for compost sales. The area covered for 50 kms radius distance from project site, the compost can be sold to farmers for agricultural purpose. Page 25 table 10 of the Tide Technocrats Private Limited (Bangalore), Assessment Report of feedstock availability and market for biomethanation solids (April 2011). Document made available to the DOE
Monitoring frequency	Sampling from complete set of records of each truck loading
QA/QC procedures	The location of each batch of compost sold will be registered and documented via sales records and TRIPSHEETS. The distances from the project (plant) site to these sample soil application locations of the compost are averaged and cross-referenced with the compost sales records. The sample size is selected to achieve 90/10 confidence precision level. The average value of distance is considered for project emission calculations.
Purpose of data	Determination of Emission Reductions
Additional comment	-

Data/Parameter	**ID. 33./ APPcomp**
Data unit	%-age
Description	Proper application of compost
Source of data	An external local expert shall execute the sampling.

Value(s) applied	100%
Measurement methods and procedures	The soil application should be monitored to ensure that there is proper application of compost. A sample of 20 hectares of land per annum to check on proper application of compost and condition during application which does not lead to any further emissions. Final crop for which compost is used should be recorded.
Monitoring frequency	Sampling from complete set of records of each truck loading
QA/QC procedures	The location of each batch of compost sold will be registered and documented via sales records and TRIPSHEETS. A statistically sound test sample land area totalling 20 hectares is determined from locations where soil application of the compost takes place.
Purpose of data	Determination of Emission Reductions
Additional comment	The data will be archived until two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later as per § 17.a of the general guidelines to SSC CDM methodologies (version 17).

B.7.2. Sampling plan

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(i) The purpose of sampling is to obtain unbiased and reliable estimates of the mean value of parameters used in the calculations of greenhouse gas emission reductions. 'Unbiased' in this case indicates that the sampling will not systematically underestimate or overestimate the mean value determined. The design of the sampling plan follows the outline set in Appendix 3 of the 'standard for sampling and surveys for CDM project activities and programme of activities (Version 2.0)'.

(ii)

The sampling plan contains information relating to: (a) sampling design; (b) data to be collected; and (c) implementation plan.

(a) Sampling design

(iii) Objectives and Reliability Requirements

objective of determining the:

1. Average incremental distance for waste type i (poultry litter, agri waste and cow dung) transportation ($DAF_{w,i}$)
2. Average incremental distance for compost transportation ($DAF_{res\ waste}$)
3. Compost application (APP_{comp})

These values are determined for every monitoring period. As there is no specific guidance in the applicable methodologies, project proponents will use 90/10 confidence/precision as the criteria for reliability of sampling efforts for small-scale project activities as per paragraph 9 of the Standard for sampling and surveys for CDM project activities and programme of activities (Version 2.0).

(iv) Target Population

Target population for DAFw,i comprises the incremental distances (in kilometres) the incoming waste streams (in tonnes) are transported under the project activity. The waste will be transported using trucks. The average capacity is 8 tonnes per truck (CT_y; monitored). The incoming waste (Q_y; monitored)= 95.000 tonnes/ year, hence an approximate 11.900 truck movements will be required. These consist of the following waste types (stata):

Waste type (Qy,i)	Tonnes	Annual truck movements (rounded)

$Q_{y,poultry\ litter}$	37,000	4,630
$Q_{y,cow\ dung}$	1,825	230
$Q_{y,agri\ agricultural\ wastes}$	58,000	7,250
Total (rounded up)	95,000	12,150

Target population for DAFres waste an approximate 3000 truck movements will be required (Qy,treatment ~24.000 tonnes per year/ 8 tonnes per truck = 3000 trucks per year). For compost application the volume is approximately 110.000 hectares on which the compost is applied. This compost is expected to be very homogeneous throughout the year.

(iii) Sampling Method

Parameter	Sampling Method	Comment
$DAF_{w,i}$	Stratified Random Sampling	The average incremental distance is expected to be different for each strata (but homogeneous within the strata).
$DAF_{w,\ poultry}$	Stratum	
$DAF_{w,cow\ dung}$	Stratum	
$DAF_{w,\ agri}$	Stratum	
$DAF_{res,\ waste}$	Simple Random Sampling	The average incremental distance is expected to be homogeneous within sample group.
APP_{comp} Compost application	Simple Random Sampling	The application is expected to be homogeneous within sample group.

(iv) Sample Size

The sample size is determined based on a 10% error margin at 90% confidence level. Per sample (or stratum) the sample size is determined based on the formula for either percentage data or numerical data. The results are presented in the table below.

Parameter	sampling type	N (population)	p (expected proportion)	z @ 90% conf. interval	mean	SD	Sample size
Average incremental distance for poultry litter, agri waste and cow dung transportation ($DAF_{w,i}$)							
$DAF_{w,\ poultry}$	numerical data	4900 truck movements		1.645	15km	5km	30 truck movements (rounded-up to 32)
$DAF_{w,\ cow\ dung}$	numerical data	280 truck movements		1.645	15km	5km	28 truck movements (rounded-up to 30)
$DAF_{w,\ agri}$	numerical data	7250 truck movements		1.645	46km	12km	19 truck movements (rounded-up to 20)
$DAF_{w,\ waste}$	percentage data	3000 truck movements	0.95 (expected	1.645			13 truck movements

			proportion of the sites within 50 km distance)				(rounded-up to 20)
APP_{comp}	percentage data	110.000 hectares	0.95	1.645			20 ha (see Tide compost application report)

(v) Sampling Frame

Parameter	Sampling Frame
DAF_{w}	
$DAF_{w,\ poultry}$	records of all incoming trucks from poultry farms (Trip sheet)
$DAF_{w,cow\ dung}$	records of all incoming trucks from dairy farms (Trip sheet)
$DAF_{w,\ agri}$	records of all incoming trucks from agri waste factories (Trip sheet)
$DAF_{res,\ waste}$	records of outgoing trucks carrying compost (Trip sheet)
APP_{comp}	records of outgoing trucks carrying compost (Trip sheet)

(b) Data

(i) Field measurements

Parameter	Field measurements
DAF_{w}	
$DAF_{w,\ poultry}$	the samples are selected randomly from the sample frame. The travelled distance will be determined based on GPS/Google Maps directions or similar of the shortest route between the respective poultry farm and the site.
$DAF_{w,cow\ dung}$	the samples are selected randomly from the sample frame. The travelled distance will be determined based on GPS/Google Maps directions or similar of the shortest route between the respective poultry farm and the site.
$DAF_{w,\ agri}$	the samples are selected randomly from the sample frame. The travelled distance will be determined based on GPS/Google Maps directions or similar of the shortest route between the respective factory and the site.
$DAF_{res,\ waste}$	During operations the samples are selected randomly from the sample frame. The distance will be measured/recorded to derive the incremental distance.
APP_{comp}	See Tide report [source] for data form.

(ii) Quality Assurance/Quality Control

Sample size is increased to 20 samples per sample (32 for poultry litter). The two most extreme outliers (lowest and highest sampling result) are subsequently eliminated. The effect of this is that potential sampling errors are further minimised. The following Quality Assurance/Quality Control procedures have to be in place.

Table 9: QA/QC

Parameter to be sampled	Quality Assurance/Quality Control
$DAF_{w,\ poultry}$	Tripsheet data will be checked on regular basis by Manager in Charge and during the interdepartmental review meeting by the CDM coordinator as per PDD

$DAF_{w, cow\ dung}$	Tripsheet data will be checked on regular basis by Manager in Charge and during the interdepartmental review meeting by the CDM coordinator as per PDD
$DAF_{w, agri}$	Tripsheet data will be checked on regular basis by Manager in Charge and during the interdepartmental review meeting by the CDM coordinator as per PDD
$DAF_{res, waste}$	If the DAFres, waste value calculated based on the samples is larger than the expected value (50km), then the larger value will be used as the new value for DAFres, waste. Also the sample size will be increased to 68 (= sample size at 90/10 for p equals 0.5; which is statistically the lowest expected proportion.
APP_{comp}	For each improper soil application determined, the related leakage emissions will be calculated and taken into account when claiming emission reductions. Also if more than 1 improper application is determined, the sample size will be increased to 68 (= sample size at 90/10 for p equals 0.5; which is statistically the lowest expected proportion.

(iii) Analysis: Describe how the data will be used

Parameter to be sampled	**How data will be used**
$DAF_{w, i}$	The average value calculated from the sample size will be used as DAFw,i value
$DAF_{res, waste}$	Data will be used to verify the assumed average value of 50km incremental distance.
APP_{comp}	Data will be used to conclude that soil is properly applied.

(c) Implementation

The PP will train the CDM team members to perform the sampling. The sampling will be embedded in the operational procedures and in the monitoring plan as per PDD.

Verification

Based on the data gathered a written monitoring report will be provided to the verifying DOE to demonstrate compliance with the monitoring requirements corresponding to the preceding monitoring period.

Sample size numerical data

$$n = \frac{1.645^2 N(\frac{SD}{mean})^2}{(N-1)\times 0.1^2 + 1.645^2(\frac{SD}{mean})^2}$$

Qpoultry litter

N	4630	truck movements
z	1.645	
SD	5	km
mean	15	km
	29.8793631	samples
	30	**sample size (rounded up to the nearest interger)**

Qcow dung

N	280	truck movements
z	1.645	
SD	5	km
mean	15	km
	27.2392263	samples
	28	**sample size (rounded up to the nearest interger)**

Qagri waste

N	7250	truck movements
z	1.645	
SD	12	km
mean	46	km
	18.3711635	samples
	19	**sample size (rounded up to the nearest interger)**

Sample size (percentage)

Compost distance

$$n >= \{1.645^2 Np(1-p)\} / \{0.1^2 (N-1) + 1.645^2 p(1-p)\}$$

N	km	3000	
z		1.645	is the value belonging to the 90% probability i http://answers.yahoo.com/question/index?qid=20070815181914AATob1F
p		0.95	http://en.wikipedia.org/wiki/P-value
		12.8522338	sample size
		13	**sample size (rounded up to the nearest interger)**

Compost application

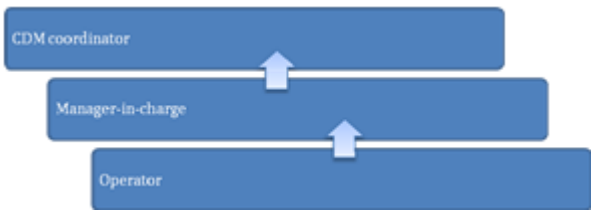
$$n >= \{1.645^2 Np(1-p)\} / \{0.1^2 (N-1) + 1.645^2 p(1-p)\}$$

N	ha	110000	
z		1.645	is the value belonging to the 90% probability i http://answers.yahoo.com/question/index?qid=20070815181914AATob1F
p		0.95	http://en.wikipedia.org/wiki/P-value
		12.8522338	sample size
		13	**sample size (rounded up to the nearest interger)**

B.7.3. Other elements of monitoring plan

>>

IOT Mabagas will ensure accuracy of the measurement system by adopting the following operational and management structure.



The parameters mentioned above are monitored and recorded electronically and / or in log sheets by the Operator. Based on the logged data recorded in the panel log sheets, a monthly report consisting of above parameters is prepared by the manager-in-charge in a soft copy and is forwarded to the CDM coordinator through email on monthly basis. The report received from

respective department through e-mail is compiled by the CDM Coordinator. The reports will be retained till two years after the end of crediting period or the last issuance of CERs for this project activity, whichever occurs later. A CDM Manual is prepared, which illustrates the detailed roles and responsibilities of individuals involved in the project activity.

To ensure Quality Control and Quality Assurance of the monitored parameters following procedures is adopted:

• The data used is reviewed by conducting a inter department review meeting once in 6 months. The CDM Coordinator will discuss the data (received from respective departments) with the Operator of concerned departments. Once data is compiled and checked, it will be handed to verifying DOE for verification.

• As per §17 of the General Guidelines to SSC CDM methodologies (Version 17):

Monitoring: while monitoring the emission reductions from the small-scale project activity, project participants shall:

(a) Electronically archive all data collected as part of monitoring for a period of two years from the end of the crediting period;

All data will be archived until two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

(b) Data variables that are most directly related to the emission reductions (e.g. quantity of the fuel inputs, the amount of heat or electricity produced, gas captured) should be measured continuously. Data elements that are generally constant and indirectly related to the emission reductions (e.g. emission factors, calorific value, system efficiencies) should be measured or calculated at least once a year, unless detailed specifications are provided as part of the indicated methodology;

The measuring of the data variables is in line with this requirement as elaborated in Section B.7.1

(c) Measuring equipment should be certified to national or IEC standards and calibrated according to the national standards and reference points or IEC standards and recalibrated at appropriate intervals according to manufacturer specifications, but at least once in three years.

All the measuring equipment will be calibrated as per manufacturers specification and recommendation and the calibration report will be maintained by the project participant. This would be done at a frequency of less than 3 years in line with the guidance.

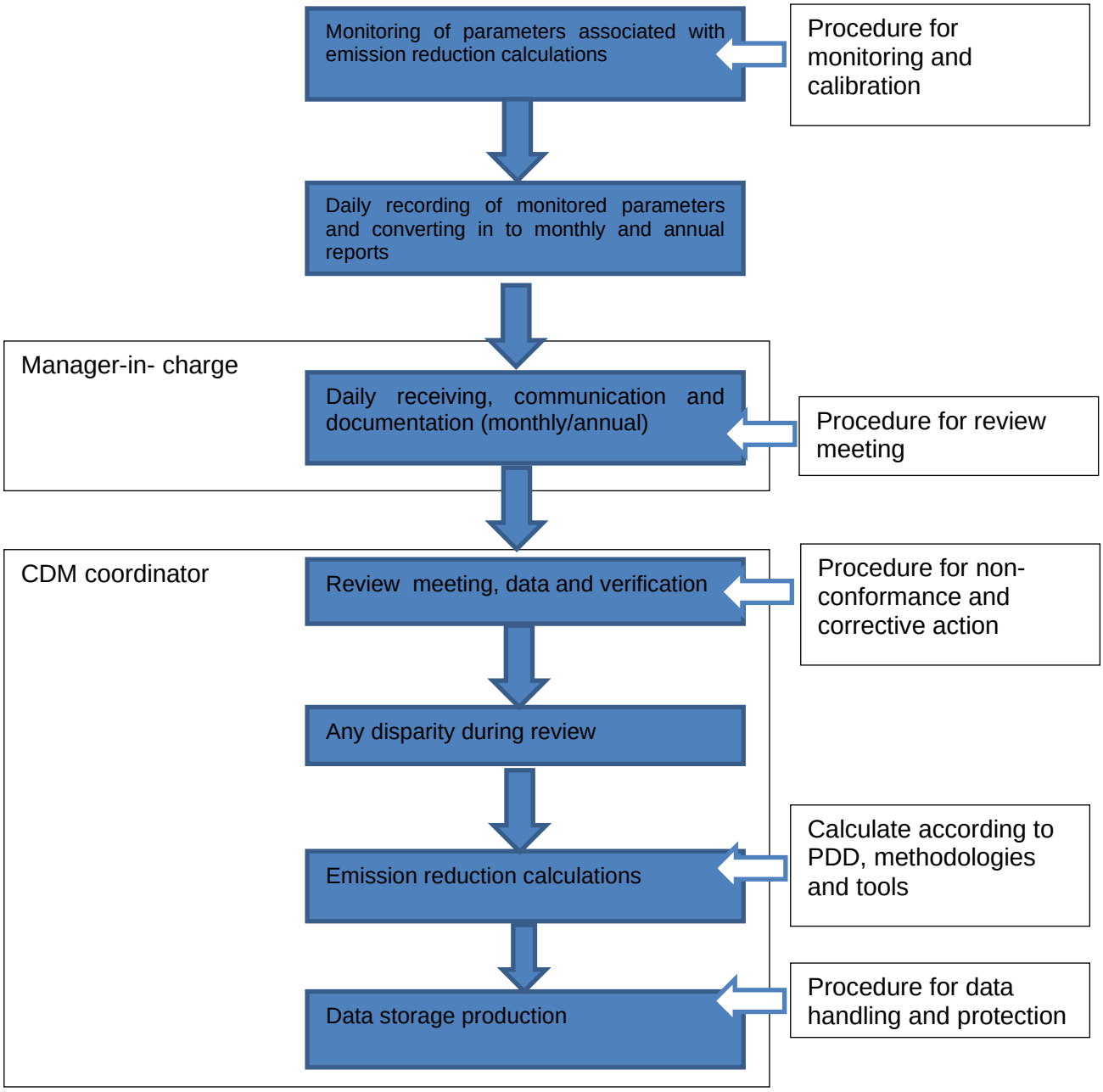
(d) The measured data with high levels of uncertainty or without adequate calibration should be compared with location/national data and commercial data to ensure consistency;

Not applicable.

(e) Wherever a statistical sample is proposed for monitoring, the 'General guidelines for sampling and surveys for small-scale CDM project activities' shall be referred.

Project participant will refer to the general guidelines for sampling when using statistical sampling.

Flow chart for CDM Data monitoring & recording



Specific monitoring aspects regarding AMS-III.D. Methane recovery in manure management systems – version 18.

The emission reductions achieved by the project activity will be determined ex post through direct measurement of the amount of methane fuelled, flared or gainfully used. It is likely that the project activity involves manure treatment steps with higher methane conversion factors (MCF) than the MCF for the manure treatment systems used in the baseline situation, therefore the emission reductions achieved by the project activity is limited to the ex post calculated baseline emissions minus project emissions using the actual monitored data for the project activity. The emission reductions achieved in any year are the lowest value of the following:

$$ER_{y,ex\ post} = min\left[\begin{array}{l}(BE_{y,ex\ post} - PE_{y,ex\ post} - LE_{y,ex\ post}),(MD_y - PE_{y,power,ex\ post} - \\ PE_{y,transp,ex\ post} - PE_{y,res\ waste,ex\ post} - PE_{y,phy\ leakage,ex\ post} - LE_{y,ex\ post})\end{array}\right]$$

(Equation 19)

Where:
$ER_{y,ex\ post}$ Emission reductions achieved by the project activity based on monitored values for year y (tCO_2e)
$BE_{y,ex\ post}$ Baseline emissions calculated using equation 6 using ex post monitored values (e.g. Q_y) (tCO_2e)

$PE_{y,ex\ post}$ Project emissions calculated using ex post monitored values (e.g. Qy, transport distances, the amount of electricity/fossil fuels used, emissions from anaerobic storage). This calculation shall include project emissions from physical leakage (tCO_2e)
$LE_{y,ex\ post}$ Leakage emissions calculated using ex post monitored values (tCO_2e)
MD_y Methane captured and destroyed or used gainfully by the project activity in year y (tCO_2e)
$PE_{y,transp,ex\ post}$ Emissions from incremental transportation based on monitored values in the year y (tCO_2e)
$PE_{y,\ power,ex\ post}$ Emissions from the use of fossil fuel or electricity for the operation of the installed facilities based on monitored values in the year y (tCO_2e)
$PE_{y,res\ waste,expost}$ Methane emissions from the anaerobic decay/treatment of the residual waste/products based on monitored values in the year y (tCO_2e)
$PE_{y,phyleakage,expost}$ Methane emissions from physical leakages of the anaerobic digester based on monitored values in year y (tCO_2e)

Total biogas production and electricity generation will be monitored as part of standard operating procedures of the project. Methane destruction will occur primarily through the combustion of biogas in the gas engines. Only in case of emergency biogas will be flared. The operations of the flare will be monitored separately.

Formulae to determine $PE_{y,ex\ post}$
$PE_y = PE_{transp,y} + PE_{power,y} + PE_{res,waste,y} + PE_{phyleakage,\ y} + PE_{flaring,y}$ (Equation 10)

$PE_{power,y}$

Monitoring parameters to determine ex-post methane capture & destroyed (MDy)
According to paragraph 19 (b) of AMS-III.AO (Version 01): flaring/ combustion MDy will be measured using the conditions of the flaring process:

$MDy = BG_{burnt\ y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4}$ (Equation 20)

Where:
$BG_{burnt,y}$ Biogas[89] flared/combusted in year y (m^3)
$w_{CH4,y}$ Methane content in the biogas in the year y (volume fraction)
D_{CH4} Density of methane at normal conditions (20°C at 1 atmosphere) (tonnes/m^3)
FE Flare efficiency in the year y (fraction). If the biogas is combusted for gainful purposes, e.g. fed to an engine, an efficiency of 100% may be applied (see parameter ID.14)

As per paragraph 19 (c) of AMS-III.AO (Version 01):

The method for integration of the terms to calculate MDy to obtain the results for one year of measurements within the confidence level, as well as the methods and instruments used for metering, recording and processing the data obtained, shall be described in the project design document and monitored during the crediting period;

[89] Biogas and methane content measurements shall be on the same basis (dry).

The methods and instruments used for metering, recording and processing are described in the relevant parameter boxes for $BG_{flared,y}$, $BG_{combusted,y}$, w_{CH4}, D_{CH4} and FE. The monitored parameters are w_{CH4} (ID.23) $BG_{combusted,y}$ (ID.25), $BG_{flared,y}$ (ID.26) and T_{flare} (ID.29).

ID	Parameter	Description	Measurement point	How monitored
23	w_{CH4}	Methane content in the biogas	Control room	Values are logged every half hour. This results in 17520 measurement points (365 days * 24 hours * 2 measurements per hour) values. These values are then exported using a CSV file into Excel.
25	$BG_{combusted,y}$	The total amount of the biogas combusted	Control room	Values are logged every half hour. This results in 17520 measurement points (365 days * 24 hours * 2 measurements per hour) values. These values are then exported using a CSV file into Excel.
26	$BG_{flared,y}$	The amount of biogas generated that is flared	Control room	Values are logged every half hour. This results in 17520 measurement points (365 days * 24 hours * 2 measurements per hour) values. These values are then exported using a CSV file into Excel.
29	T_{flare}	Temperature in the exhaust gas of the flare	Flare	Using a Type N thermocouple the temperature is monitored continuously; the average value is logged every half hour by the system. This results in 17520 measurement points (365 days * 24 hours * 2 measurements per hour) values. These values are then exported using a CSV file into Excel. Here the project participant checks if they should be taken into account (see parameter box ID.14 FEy) and then averages all values into one annual value.

The data is integrated as per below table. The logged data are matched for each interval. Per interval the FE is determined. The MD is calculated as per equation 23 for each interval. MDy is calculated by summing all MD values for the monitoring period.

Time interval	BG_{flared}	$BG_{combusted}$	T_{flare}	w_{CH4}	FE	MD
	Monitored	Monitored	Monitored	Monitored	Default (see parameter box ID.14)	Calculated
00:30:00	m3	m3	oC	%	100%; 90%; 50%; 0%	tCO_2e
01:00:00	m3	m3	oC	%	100%; 90%; 50%; 0%	tCO_2e
Etc.						
…						

Annual Total	**TOTAL** **tCO2e/y (sum of above)**

Since BG_{flared}, $BG_{combusted}$ and T_{flare} are monitored continuously, confidence level is 100% (no statistical sampling; entire population is measured), hence the results for one year of measurements are within the confidence level.

As per paragraph 19 (d) of AMS-III.AO (Version 01):

Project activities where a portion of the biogas is destroyed through flaring and the other portion is used for energy may consider to apply the flare efficiency to the portion of the biogas used for energy, if separate measurements are not performed; When the amount of methane that is combusted for energy and that is flared is separately monitored, a destruction efficiency of 100% can be used for the amount that is combusted for energy;

A portion of the biogas is destroyed through flaring and another portion us used for energy generation.

Hence:
$BG_{burnt,y} = BG_{combusted.y} + BG_{flared,y}$ (Equation 21)

Hence equation (18) is rewritten:

$MD_y = (BG_{flared,y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4}) + (BG_{combusted,y} * w_{CH4,y} * D_{CH4} * GWP_{CH4})$ (Equation 22)

As per paragraph 19 (e) of AMS-III.AO (Version 01):
Flow meters, sampling devices and gas analysers shall be subject to regular maintenance, testing and calibration to ensure accuracy;

The devices used to monitor the following parameters are subject to regular maintenance, testing and calibration as per §17 of the General Guidelines to SSC CDM methodologies (Version 17):

ID. 23	w_{CH4}	gas analyser	see parameter box
ID. 24	$FV_{RG,h}$	flow meter	see parameter box
ID. 25	$BG_{combusted,y}$	flow meter	see parameter box
ID. 26	$BG_{flared,y}$	flow meter	see parameter box

As per paragraph 19 (f) of AMS-III.AO (Version 01):

The monitoring plan should include onsite inspections for each individual digester included in the project boundary where the project activity is implemented for each verification period.

Each individual digester included in the project boundary will be inspected on site for each verification period.

Monitoring requirement for verification of proper soil application
As per AMS-III.F paragraph 25 the project participant will archive all sales records for the treated residue (compost). The conditions for proper soil application ensuring aerobic conditions have been established by a local expert[90].

[90] Tide Technocrats Private Limited, Bangalore, Assessment report of feedstock availability and market for Biomethanation Solids, April 2011 - – Made available to the DOE

Baseline emissions (BE) are discussed in table 4.1.c. in the PDD. Since PP cannot demonstrate the BE for agri waste or cow dung, the BE has been set to zero in line with the methodology (conservative approach).

To further show that the methodology is conservative below argument shows that using (Equation 19 will always result in a conservative approach, in line with CDM:

$$ER_{y,ex\ post} = min\begin{bmatrix}(BE_{y,ex\ post} - PE_{y,ex\ post} - LE_{y,ex\ post}),(MD_y - PE_{y,power,ex\ post} - \\ PE_{y,transp,ex\ post} - PE_{y,res\ waste,ex\ post} - PE_{y,phy\ leakage,ex\ post} - LE_{y,ex\ post})\end{bmatrix}$$

Based on the mass balance (supporting document SD_14) the MDy of the gas will be 7.5 mln m^3 * density * methane content * 21 ~ 65,000 CERs. Equation (6) would result in ~ 13,200 CERs claimed ($BE_{y,expost}$), in which case ER would equal MIN ($BE_{y,expost}$, MD_y) = 13,200 CERs.

$BE_{y,expost}$ will basically always be more conservative than MD_y:
• If $Q_{chickenlitter,expost}$ would be 100% of Q_{total} then MD_y would still be approx 65,000 BE would be approx 26,400[91];
• Hence $BE_{y,expost}$ would still be more conservative;
• If $Q_{chickenlitter,expost}$ would be 0%, then $BE_{y,expost}$ would be 0 CERs. In every case $BE_{y,expost}$ would be more conservative; hence project is in line with methodology.

Apportioning Procedure
If $EG_{BL,y}$ is does not cover the monitoring period, e.g. the period is two weeks shorter, the project participant may opt to extrapolate the measured data to cover the short fall. Any discrepancy will be corrected in the following monitoring period.

To determine electricity consumed on site:

Partial days of generation as per the log book records	= X
Total Generation as per the log book records	= Y
Generation for partial days	= Z = (X / Y) * 100
Total Generation as per generation statement	= G
Partial days of generation as per Generation statement	= (G * Z/100)

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
22/07/2011

C.2. Expected operational lifetime of project activity

>>
20 years 0 months

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Fixed crediting period

[91] Assuming that the performance would not suffer from a mono-waste stream, which in practice it will as is shown in the PDD.

C.3.2. Start date of crediting period

>>
01/01/2013

C.3.3. Duration of crediting period

>>
10 years 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The Ministry of Environment and Forests (MoEF), Government of India, under the Environment Impact Assessment Notification vide S.O. 1533(E) dated 14/09/2006 has listed a set of activities in Schedule I of the notification which, for setting up new projects or modernization/ expansion, which require prior environmental clearance[92]. The proposed project activity is not listed in this schedule. Hence PP is not required to provide an Environmental Impact Assessment.

The project is situated at Pudhuchatram Village, Namakkal District, Tamil Nadu. The project is a CO2 neutral power plant designed to envisage poultry litter and other biomass types for energy generation. As such, there is no emission of poisonous gases or effluents to pollute the atmosphere, water etc. Therefore, no additional anthropogenic emissions of GHGs due to the project activity are expected to be generated within the project boundary.

The proposed project will not undertake any other activity, which will adversely affect the ecological balance in area. The project will have local environmental benefits associated with the improved management of poultry litter waste. Poultry litter, composed of poultry faces, waste food and litter materials, is currently disposed of in an uncontrolled fashion, presenting an environmental and health hazard. It may present a hazard to human health as it is currently disposed of in open air. The project will collect poultry litter waste from nearby poultry farms, and transport the waste in such a manner to ensure that no waste spills from the trucks en route to the project site. The waste will then be digested anaerobically where during the project harmful bacteria and contaminants are destroyed. The remaining sludge is dried and is used as organic fertilizer.

Moreover, the project activity has obtained approval from the Tamil Nadu Pollution Control Board for setting up of the project. Towards this end the state government has given Consent for Establishment for the project activity. The project activity will reduce the carbon intensive nature of the Southern grid, which is dominated by fossil fuels such as coal and gas. The project activity will not cause any negative impact on the environment both on a local as well as on a global level.

D.2. Environmental impact assessment

>>
The environmental impacts anticipated from the project activity are not significant.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>
IOT Mabagas Ltd. organized a local stakeholder meeting on the 18thof March 2011 at the plant site in the village Pudhuchatram. Invitations were given to local villagers, direct stakeholders and government officials. The invitation was pasted at the village panchayat notice board on 10th March 2011, and an advertisement was printed in the local and national newspaper on 16th March 2011.

[92] http://moef.nic.in/legis/eia/so1533.pdf

During the stakeholder consultation Mr. Dr. A. Beer Ali informed the stakeholders about the project activity on behalf of the project participants and its impact on the environment, and mentioned the potential benefits of the project activity. Representatives from various groups attended the meeting to share their views on the project activity and provide comments. The project participants briefed the stakeholders about the objective, project description, environmental impacts and benefits, applicability of technology, global and local benefits, contribution towards sustainable development, and status of the project activity.

The list of identified stakeholders is given below:
(a) Village public
(b) Panchayat Officials
(c) Poultry Farm owners & association officials
(d) Sago Factory owners& association officials
(e) Sugar farmers (suppliers of press mud)
(f) Tamil Nadu pollution control board officials
(g) Tamil Nadu Electricity generation and distribution company, Namakkal circle office officials.
(h) District Industrial Centre, Namakkal officials
(i) Village administration officer (Pudhuchatram Panchayat union)
(j) Revenue department
(k) Salem Cooperative Sugar mills officials
(l) Jai shakti enterprises owner (logistics company)

After the introduction, a detailed open discussion took place with the identified stakeholders. All stakeholders have issued their approvals/consents/licenses for setting up the project and no comments were received on the project. The stakeholder's minutes of the meeting report will be made available to the DOE (Designated Operational Entity) for validation.

E.2. Summary of comments received

>>
No comments were received from the stakeholders, only a number of queries were raised. These were answered in a satisfactory manner by the project promoter during the meeting, see the summary below.

Question 1by Mr. Kumaresan – Vice president, Thattayangarpatti Panchayat: What would be the benefit of this project to the society?

The positive sustainable development effects of the project activity, as well as the negative impacts in absence of the project activity on human being health and atmosphere were explained by the project promoter.

Question 2 by a villager: Will IOT Mabagas consider providing the Organic Compost to the local farmers?

IOT Mabagas officials explained that they are very interested to sell the Organic Compost to the local farmers at a very competitive price. Furthermore they explained that the organic compost from a biomethanation plant is a very good soil conditioner.

Question 3 by Mr. Shanmugam (Jai Shakti Enterprises) to IML & Tamilnadu Electricity Board: How will this project help in solving the power load shutdown pattern in the Village?

IOT Mabagas Limited officials explained how the project will augment the power supplied to the grid through a local substation and that it will not only contribute to enhancing the power availability but also reduce voltage fluctuations as experienced in others regions where decentralized power projects are implemented both within and outside Tamil Nadu.

The proceedings of the stakeholder consultation will be furnished to DOE.

E.3. Consideration of comments received

>>

No comments or concerns were raised during the consultation with stakeholders except for a number of questions, which were clarified during the consultation, which is captured in the minutes of the meeting. The minutes have been circulated to all the stakeholders who attended the meeting. Hence no actions were necessary in order to take due account of comments. Thus, the local stakeholder consultation process was adequate with respect to the identification of local stakeholders, seeking their views and taking due account of any comments and was conducted in a transparent manner. Further, as required by the CDM modalities and procedures, the PDD will be published at the Designated Operational Entity's (DOE) website for public comments.

SECTION F. Approval and authorization

>>

The letters of approval from the Parties that are involved in the project activity are available at the time of submitting the PDD to the DOE for validation

Appendix 1. Contact information of project participants

Organization name	IOT Mabagas Limited (IML)
Country	India
Address	Spectra, Hiranandani Business Park, Powai, Mumbai
Telephone	+91 22 66772700
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E-mail	marketing.india@oiltanking.com
Website	www.iotinfraenergy.com
Contact person	R Mahes

Organization name	Carbonbay GmbH & Co. KG
Country	Germany
Address	Große Theaterstr. 14, Hamburg
Telephone	+49 173 341 2363
Fax	+49 3222 196 9974
E-mail	wolfgang.brueckner@carbonbay.com
Website	www.carbonbay.com
Contact person	Wolfgang Brueckner

Appendix 2. Affirmation regarding public funding

The IOT Mabagas Limited power plant, Pudhuchatram project does not make use of public funding from Parties included in Annex 1, hence no public funding results in a diversion of official development assistance and is separate from and is not counted towards the financial obligations of those Parties (EB 41, Annex 12, Part II).

Appendix 3. Applicability of methodologies and standardized baselines

The baseline data are taken from the CO2 Emission Database Version 6.0, March 2011 by CEA (CEA Database). The data can be accessed through the following link: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm

Appendix 4. Further background information on ex ante calculation of emission reductions

NA

Appendix 5. Further background information on monitoring plan

NA

Appendix 6. Summary report of comments received from local stakeholders

No comments were received from the stakeholders, only a number of queries were raised. These were answered in a satisfactory manner by the project promoter during the meeting, see the summary below. Question 1by Mr. Kumaresan – Vice president, Thattayangarpatti Panchayat: What would be the benefit of this project to the society? The positive sustainable development effects of the project activity, as well as the negative impacts in absence of the project activity on human being health and atmosphere were explained by the project promoter. Question 2 by a villager: Will IOT Mabagas consider providing the Organic Compost to the local farmers? IOT Mabagas officials explained that they are very interested to sell the Organic Compost to the local farmers at a very competitive price. Furthermore they explained that the organic compost from a biomethanation plant is a very good soil conditioner. Question 3by Mr. Shanmugam (Jai Shakti Enterprises) to IML & Tamilnadu Electricity Board: How will this project help in solving the power load shutdown pattern in the Village? IOT Mabagas Limited officials explained how the project will augment the power supplied to the grid through a local substation and that it will not only contribute to enhancing the power availability but also reduce voltage fluctuations as experienced in others regions where decentralized power projects are implemented both within and outside Tamil Nadu. The proceedings of the stakeholder consultation will be furnished to DOE.

Appendix 7. Summary of post-registration changes

1. Correction:
   (a) The inputs in calculation of parameter $EF_{CO2,transport}$ is corrected and consistently reported in the PDD now.
   (b) The ID number of parameters have been updated under section B.7.3.
   (c) The contact details of PP have been under Appendix 1.

2. Permanent changes to the registered monitoring plan, or permanent deviation to monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents:

As per the PPA (section 4.1& 4.6), the meter is supposed to be tested/calibrated as per central electricity authority (CEA) regulation therefore the calibration frequency of ID.19./$EG_{BL,y}$ (Net electricity supplied by the project activity to the grid) and ID. 20./ECPJ,y (Net electricity imported from the grid in case the Power units are not operating) has been permanently changed to once in five years as calibration is not under the control of PP.

3. Temporary deviation from the registered monitoring plan:

The data for the parameter- ID.23./w_{CH4} (methane %), which does not have any influence on the emission reduction calculation, could not be recorded between the periods 01 May to 18 August 2016 11:30 am, and 15 December 2016 to 20 April 2017 because of hardware & software failures from PLC/SCADA system. To be most conservative and to comply with the relevant provision of the project standard v2 the value has been set to “0” for the mentioned period. The values of the parameter ID. 24./$FV_{RG,h}$, ID.25./$BG_{combusted,y}$ and ID.26./$BG_{flared,y}$ were also not recorded as per the set frequency.

For the purpose of PE calculation (in the first calculation method) from flaring the maximum value out of monitored data has been applied.

For the purpose of baseline emission calculation (in the second calculation method), the totalised value was noted from the flow meters at the end of every month were used.

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Document information

Version	*Date*	*Description*
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for project activities" (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for project activities" and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the "CDM project standard for project activities" (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the "Project design document form for small-scale CDM project activities" (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).

Version	*Date*	*Description*
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document