

**BEFORE THE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE,
CHENNAI**

**Original Application No.127 of 2022 (SZ) &
I.A. No.104 of 2025 (SZ)**

IN THE MATTER OF:

K.S. Mohan, Coimbatore.

Applicant

Versus

The Corporation of Coimbatore Represented by its Commissioner, Coimbatore and Ors.

...Respondent

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**COMMISSIONER
COIMBATORE CORPORATION**

2025/09/01 10:00 AM
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COMPREHENSIVE STATUS REPORT

This Status Report is respectfully filed on behalf of the Respondent – Coimbatore City Municipal Corporation (CCMC), through its Commissioner, Mr. M. Sivaguru Prabakaran, I.A.S., in compliance with the directions issued by this Hon'ble Tribunal in its order dated 03.09.2025 in Original Application No.127 of 2022 (SZ) & I.A. No.104 of 2025 (SZ).

1. The Coimbatore City Municipal Corporation (CCMC), the second largest city corporation in Tamil Nadu, is administratively divided into **five zones comprising 100 wards**. As per 2022 estimates, the city has a population of **21, 52,680**, with an annual growth rate of approximately **2.75%**. The urban composition includes **4,37,199 households** and **35,870 commercial establishments**, distributed across the five zones—East, West, North, South, and Central. This demographic and commercial spread underscores the increasing demand for efficient municipal services, particularly in the area of **solid waste management**, which has become a pressing urban challenge for CCMC.
2. It is respectfully submitted that while the Vellalore site has historically functioned as the principal municipal solid waste disposal facility for Coimbatore since 2003, the characterization of the operations as “entirely illegal” is not correct. The 1st Respondent (CCMC) has been consistently acting under the policy framework of the State Government and the directions of statutory authorities including the Tamil Nadu Pollution Control Board (TNPCB), and interim arrangements were made in view of the urgent and continuous nature of municipal solid waste management obligations under the Municipal Solid Wastes (Management and Handling) Rules, 2000 (now replaced by the Solid Waste Management Rules, 2016).
3. In compliance with the orders of this Hon'ble Tribunal dated 03.10.2018 in O.A. No. 524 of 2018 (PB), steps have been initiated for **bio mining and remediation of legacy waste**, and significant quantities of legacy waste have already been processed and land reclamation in Phase II is in process. Further, as a long-term sustainable solution, the CCMC, with approval of the State Government, has undertaken the establishment of a **250 TPD Bio-CNG plant at Vellalore under the DBFOT PPP model**, for which all statutory clearances including Environmental Clearance under the EIA Notification, 2006, consent orders under the Water and Air Acts, and authorisation under the SWM


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Rules, 2016 will be duly obtained from the competent authorities prior to commissioning.

4. It is further submitted that the proposed Bio-CNG project is a **scientific waste-to-fuel initiative** under Swachh Bharat Mission 2.0, designed to process biodegradable waste in full compliance with CPCB/TNPCB standards, thereby ensuring that open dumping is phased out in a time-bound manner. Thus, the Respondent is not continuing “illegal dumping,” but is actively transitioning towards a regulated, environmentally sound, and legally compliant waste management system as per the directions of this Hon’ble Tribunal and the Government of Tamil Nadu.
5. It is respectfully submitted that the contention of the Applicant that the establishment of the 250 TPD Bio-CNG plant at Vellalore is “illegal” or in violation of this Hon’ble Tribunal’s orders is wholly misconceived. The very object of the proposed Bio-CNG project is to **scientifically process biodegradable waste** and thereby **eliminate indiscriminate dumping**, in line with the directions of this Hon’ble Tribunal, the Central Pollution Control Board, and the State Government under Swachh Bharat Mission (Urban) 2.0.
6. The CCMC has not commenced any construction work in violation of law. All statutory approvals including **Consent to establish (CTE) under the Water Act, 1974 and the Air Act, 1981, and Environmental Clearance under the EIA Notification, 2006** will be duly obtained from the competent authorities before commencement of any activities as per the guidelines and regulations. The tender and Letter of Acceptance only signify the selection of a concessionaire under the DBFOT PPP model and do not amount to unauthorized construction. The appointed Concessionaire shall comply with his contractual obligations and the same will be carried out by CCMC.
7. It is further submitted that the **arrangement of the Bio-CNG plant at Vellalore is not to perpetuate dumping but to remediate the site and ensure scientific processing of waste** that is otherwise being generated daily. The plant will reduce the inflow of unprocessed waste, convert biodegradable fractions into clean fuel, and thereby aid in phasing out open dumping at the site. Far from frustrating the orders of this Hon’ble Tribunal, the project advances their very object by enabling long-term closure of indiscriminate dumping and ensuring sustainable waste management.
8. It is therefore humbly submitted that the balance of convenience lies in favour of allowing the Bio-CNG project to proceed, subject to statutory clearances, as it will substantially reduce the environmental and public health hazards presently faced by the

residents. On the contrary, granting injunction to the project will delay remediation efforts, increase legacy waste accumulation, and prejudice the public interest.

9. It is respectfully submitted that, in order to place the true facts before this Hon'ble Tribunal, the Respondent is setting out in detail the entire background, planning and sanction process of the proposed 250 TPD Bio-CNG plant at Vellalore, including the preparation of the Detailed Project Report (DPR), the various Government Orders and administrative approvals, the tender and concession framework, and the statutory clearances being obtained. This submission also explains the technological features, environmental safeguards, and multiple advantages of Bio-CNG over conventional fuels, as well as its role in reducing pollution, reclaiming land, and ensuring scientific waste management in accordance with the directions of this Hon'ble Tribunal.
10. The Respondent respectfully submits that the project titled "**Establishment of a 250 TPD Bio-CNG Plant at Vellalore Dump Yard, Coimbatore**" has been duly sanctioned and entrusted to **M/s. Refex Green Power Ltd.**, the selected concessionaire, at an approved project cost of **₹69.20 crore**. The said project is to be implemented under the **Public-Private Partnership (PPP) framework on a Design, Build, Finance, Operate, and Transfer (DBFOT) basis**, with a concession period of **20 years inclusive of operation and maintenance obligations**. The plant is proposed to be established at the Vellalore site and is designed to process **250 tonnes of biodegradable waste per day** by employing **anaerobic digestion technology followed by upgrading to Compressed Biogas (CBG)**. The project, being a flagship initiative under Swachh Bharat Mission (Urban) 2.0, is intended to ensure scientific processing of municipal solid waste, reduce indiscriminate dumping, and generate clean energy. It is further submitted that the foundation stone of the project was laid on **28.08.2025** by the Hon'ble Minister for Municipal Administration, **Thiru K. N. Nehru**, evidencing the commitment of the State to implement the project in accordance with law.
11. It is respectfully submitted that the present project is not a private initiative but one **comprehended and sanctioned by the Central and State Governments** under the framework of the **Swachh Bharat Mission (Urban) 2.0**. The project has received administrative sanction through the Government Orders referred to supra, and is being implemented strictly under the Public-Private Partnership (PPP) model with due oversight of the Municipal Administration and Water Supply Department. In order to ensure transparency, accountability, and technical soundness, a **Detailed Project Report (DPR)** was prepared and submitted, setting out in comprehensive detail the objectives,


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feasibility, design, financial estimates, and environmental safeguards of the project. The **DPR** covers, inter alia, the following aspects:

- **Objectives of the Project** – To process **250 tonnes per day of biodegradable municipal solid waste**, convert it into compressed biogas of purity exceeding 90% methane (as per IS 16087:2016 standards), reduce legacy waste accumulation, and generate renewable energy while protecting public health and the environment.
- **Technical Design and Technology** – Adoption of **anaerobic digestion technology** followed by upgradation to Bio-CNG, with by-products of organic manure; inclusion of emission control systems, leachate management measures, and fire safety protocols to comply with CPCB/TNPCB norms and Indian Standards.
- **Project Cost and Financial Model** – An estimated cost of ₹69.20 crore, structured under the DBFOT PPP framework. The revenue streams from the sale of Bio-CNG and organic manure shall accrue exclusively to the Concessionaire, while the Corporation shall receive revenue through payment of royalty and its share from carbon credits, as stipulated in the Concession Agreement.
- **Institutional and Legal Framework** – Implementation under the **PPP Concession Agreement** between CCMC and the concessionaire; mandatory compliance with the **Water (Prevention and Control of Pollution) Act, 1974**, **Air (Prevention and Control of Pollution) Act, 1981**, **EIA Notification, 2006**, and the **Solid Waste Management Rules, 2016**.
- **Environmental and Social Benefits** – Reduction in open dumping and methane emissions, improvement in air and water quality, reclamation of valuable land at Vellalore, generation of green energy, and creation of employment opportunities.
- **Implementation Plan** – Construction period of **15 months** followed by an **operation and maintenance period of 20 years**, with continuous monitoring by an Independent Engineer and the Corporation to ensure quality, safety, and compliance.

Thus, the **DPR forms the backbone of the project** and demonstrates that the establishment of the Bio-CNG plant is a **scientifically planned, environmentally sound, financially viable, and government-sanctioned initiative**, aimed at ensuring long-term compliance


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with statutory mandates and the directions of this Hon'ble Tribunal. The DPR for this Bio CNG project is enclosed as **ANNEXURE I**.

12. It is respectfully submitted that the proposed **250 TPD Bio-CNG Plant at Vellore, Coimbatore**, is not a unilateral initiative of the 1st Respondent but a **Government-sanctioned project under the Swachh Bharat Mission (Urban) 2.0**, duly supported by Central and State authorities at every stage. The Government of Tamil Nadu, through **G.O. (D) No.145, MAWS (MC.7) Department dated 11.03.2024**, accorded **administrative sanction** for the establishment of Bio-CNG plants in Coimbatore, Madurai, and Tiruchirappalli Corporations under the DBFOT-PPP model. This sanction followed detailed appraisal of project feasibility, waste generation patterns, and alignment with SBM-U 2.0 objectives. It specifically authorized Coimbatore Corporation to proceed with procurement and concessionaire selection. In line with the above G.O., **tenders were floated on 26.06.2024**, evaluated by the **Tender Evaluation and Scrutiny Committee (TESC)** in meetings dated 02.09.2024 and 02.12.2024. The Tender Evaluation Scrutiny Committee (TESC) recommended **M/s Refex Green Power Ltd.** as the successful bidder (H1), quoting **₹468 per MT royalty** to CCMC. Consequent to TESC approval and Government concurrence, the **Letter of Acceptance was issued by CCMC in April 2025** to M/s Refex Green Power Ltd. The Letter of Acceptance is enclosed as **ANNEXURE II**.
13. It is respectfully submitted that the Letter of Acceptance (LOA) issued to M/s Refex Green Power Limited confirms the acceptance of their bid dated 26.06.2024 for the establishment of a 250 TPD Municipal Solid Waste (MSW) based Bio-CNG Plant at Coimbatore under PPP Mode on Design, Build, Finance, Operate, and Transfer (DBFOT) basis for a period of 20 years. The acceptance is subject to the fulfillment of conditions including obtaining all necessary permits, processing and disposal of all MSW generated during the contract period, formation of a Special Purpose Vehicle (SPV), execution of the Concession Agreement within 30 working days of receipt of the LOA, strict adherence to the RFP and Concession Agreement terms, mutually agreed work plan, and compliance with all Conditions Precedent as set forth in Article 4 of the Concession Agreement.
14. In accordance with the terms and conditions specified in the Letter of Acceptance (LOA) and the Request for Proposal (RFP), the concessionaire, M/s Refex Green Power Limited, has undertaken all necessary steps to ensure compliance with the concession


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requirements for the establishment of the 250 TPD Municipal Solid Waste (MSW) based Bio-CNG Plant at Coimbatore. To facilitate project execution, the concessionaire has incorporated a dedicated **Special Purpose Vehicle (SPV)**, solely responsible for undertaking all activities related to the project. The Concessionaire is **REFEX CBG SPV (COIMBATORE) LIMITED**, a special purpose company incorporated under the Companies Act, 2013, with Corporate Identity Number (CIN) U38210TN2025PLC180102 and having its registered office at 2nd floor, Refex Towers, 313, Valluvar Kottam High road, Nungambakkam, Chennai- 600034, and Tamil Nadu. In further compliance with the agreement, the concessionaire has furnished a Performance Bank Guarantee (PBG) amounting to Rs. 3,45,00,000/- (Rupees Three Crore Forty-Five Lakhs Only) from an Indian Nationalized/Scheduled Commercial Bank, thereby securing all performance obligations and guaranteeing adherence to the project timelines and milestones. Additionally, the Concession Agreement (CA), which clearly delineates the rights, responsibilities, and obligations of both the Coimbatore City Municipal Corporation (CCMC) and the concessionaire, including the fulfillment of all Conditions Precedent as stipulated in Article 4, has been duly executed on 06.08.2025. This execution formally marks the commencement of the concession period and establishes the legal and operational framework for the implementation, operation, and maintenance of the Bio-CNG plant in accordance with the terms agreed upon in the LOA, RFP, and other governing documents.

15. Further it is humbly informed to the Hon'ble Tribunal that the concessionaire, M/s Refex Green Power Limited, is presently at the stage of executing the Land Lease Agreement (LA), for 14.08 acres at Vellalore Compost Yard, pursuant to the minutes of the Government Order dated 25.08.2025. This agreement secures the possession of the project site and establishes the legal framework for commencement of construction activities. In parallel with the land lease execution, the concessionaire is undertaking all preparatory steps required to ensure timely and compliant implementation of the 250 TPD Bio-CNG Plant at Vellalore Compost Yard.

16. It is respectfully submitted that the agreements for the provision of electricity and water supply connections will be initiated with the respective authorities by the Concessionaire. These connections are critical to ensuring uninterrupted operation of the plant upon commissioning, and all formalities are being completed in strict accordance with the relevant municipal and statutory procedures. An escrow account is being opened, and an escrow agreement executed with the Coimbatore City Municipal Corporation (CCMC) to


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ensure transparency in all project-related financial transactions. This measure ensures proper fund management and adherence to the financial covenants stipulated in the Concession Agreement. The concessionaire has executed requisite financing agreements with lenders to secure project funding. These agreements ensure that the financial resources necessary for the design, construction, and operational phases of the project are available in a timely manner, thereby mitigating any delays in project execution.

17. Detailed technical design, drawings for process, civil, mechanical, and electrical systems will be prepared and submitted to CCMC for approval. These designs have been developed in strict compliance with the standards prescribed by the Central Pollution Control Board (CPCB), Tamil Nadu Pollution Control Board (TNPCB), and relevant Indian Standards (IS codes). Approval of these drawings will enable the concessionaire to commence construction in accordance with regulatory norms. Qualified subcontractors have been engaged for specialized civil, mechanical, and electrical works. All subcontractor engagements are subject to approval by CCMC to ensure adherence to technical standards, safety protocols, and quality control requirements throughout the construction phase.
18. It is humbly submitted that the concessionaire, in accordance with statutory requirements and best practices, will follow a structured approach to obtain all necessary approvals from the competent authorities, including the Central Pollution Control Board (CPCB) and Tamil Nadu Pollution Control Board (TNPCB). The process involves the following steps:

a) Consent to Establish (CTE):

The Consent to Establish is the initial statutory approval required prior to the commencement of construction. The steps are as follows:

- Submission of a formal application to TNPCB, including project details, site layout, raw material usage, and expected emissions.
- Preparation and submission of detailed plans for pollution control systems, effluent treatment, solid waste management, and safety measures.
- Payment of prescribed application and processing fees.
- Site inspection by TNPCB officials to verify compliance with pollution control requirements.
- TNPCB evaluation of technical details and mitigation measures.


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- Issuance of CTE upon satisfactory compliance, authorizing the concessionaire to commence construction activities at the specified site.

b) Consent to Operate (CTO):

Consent to Operate is required prior to starting commercial operations. The steps are as follows:

- Submission of a CTO application to TNPCB after completion of construction and installation of pollution control equipment.
- Submission of performance reports, test results, and calibration certificates for emission and effluent monitoring systems.
- On-site inspection and verification by TNPCB officers to ensure that all installed equipment complies with approved CTE conditions and standards.
- Corrective measures and compliance reporting in case of deviations.
- Grant of CTO upon verification, authorizing the commencement of operations.

c) Environmental Clearance (EC):

Environmental Clearance is required for projects likely to have significant environmental impact. The process involves:

- Preparation of a comprehensive project report and application to the State Environment Impact Assessment Authority (SEIAA) or Ministry of Environment, Forest & Climate Change (MoEFCC), as applicable.
- Submission of detailed environmental management plans, baseline environmental data, and predicted impacts on air, water, soil, flora, and fauna.
- Public hearing or stakeholder consultation conducted as per statutory requirements.
- Review and evaluation of the project by Expert Appraisal Committee (EAC).
- Issuance of Environmental Clearance specifying conditions to be adhered to during construction and operation.

d) Environmental Management Plan (EMP):

The EMP ensures continuous compliance with environmental standards. The steps include:

- Development of an EMP detailing mitigation measures, monitoring plans, resource efficiency, and waste management practices.
- Submission of the EMP to TNPCB and CCMC for review and approval.
- Integration of EMP measures into the project design and operational procedures.


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- Periodic reporting to TNPCB on implementation and effectiveness of the EMP measures.

c) Environmental Impact Assessment (EIA):

EIA assesses the potential environmental consequences of the project. The procedure involves:

- Conducting a detailed environmental study covering air quality, water quality, soil, biodiversity, and socio-economic aspects.
- Preparation of an EIA report, including predicted impacts and proposed mitigation measures.
- Public consultation and hearing with local stakeholders to gather feedback.
- Submission of the final EIA report to SEIAA or MoEFCC for appraisal.
- Review by Expert Appraisal Committee, followed by recommendations for approval, conditions, or modifications.

19. It is humbly submitted that the proposed 250 TPD Bio-CNG Plant at Vellalore has been designed and shall operate in strict compliance with the statutory purity standards prescribed under IS 16087:2016 for use as fuel in combustion engines. The Bio-CNG produced from the plant shall maintain methane (CH₄) content exceeding 90%, carbon dioxide (CO₂) below 4%, hydrogen sulphide (H₂S) less than 16 ppm, nitrogen (N₂) and oxygen (O₂) below 0.5%, with negligible ammonia (NH₃) and virtually zero moisture content. Such adherence to the prescribed purity standards ensures that the Bio-CNG is safe, efficient, and fully compliant with environmental and safety requirements.

20. Bio-CNG possesses a substantially higher energy density compared to untreated biogas, resulting in superior fuel efficiency and increased mileage when utilized in vehicular applications. Consequently, Bio-CNG represents an optimal fuel for transportation, offering both operational efficiency and effective utilization of energy resources. Unlike raw biogas, Bio-CNG can be compressed to high pressures and stored in compact high-pressure cylinders. This characteristic allows for convenient storage, reduced spatial requirements, and efficient transportation to distribution points, thereby enabling large-scale deployment and practical operational management. Accordingly, the use of Bio-CNG contributes meaningfully to environmental protection and statutory compliance with pollution control standards. Bio-CNG, after undergoing purification, meets automotive and industrial fuel standards by eliminating harmful components such as carbon dioxide and hydrogen sulphide. This ensures that its combustion is far cleaner,

resulting in lower greenhouse gas intensity and reduced release of conventional air pollutants. Studies consistently demonstrate that Bio-CNG, when compared to diesel, natural gas, and raw biogas, offers superior environmental performance with marked reductions in CO, NO_x, HC, and particulate matter.

21. Being chemically similar to natural gas, Bio-CNG is fully compatible with the existing CNG infrastructure. Vehicles designed for operation with CNG can utilize Bio-CNG without modification. This compatibility reduces infrastructural adaptation costs and supports the rapid adoption of Bio-CNG as a renewable fuel. With methane concentrations exceeding 90%, Bio-CNG has a high calorific value, rendering it a highly efficient fuel for both transportation and industrial applications. Its energy profile ensures reliable performance and economic utilization in accordance with operational requirements.
22. In view of the foregoing, Bio-CNG constitutes a scientifically validated, environmentally sustainable, and economically viable alternative to conventional fossil fuels. The establishment and operation of the 250 TPD Bio-CNG Plant at Vellalore shall not only provide a sustainable solution for municipal solid waste management but also generate a renewable, eco-friendly fuel. Such implementation aligns with India's national objectives for clean energy, reduction of greenhouse gas emissions, and promotion of sustainable development, thereby contributing significantly to environmental protection and public welfare.
23. The Vellalore site has historically accumulated significant quantities of municipal solid waste (MSW), creating environmental and public health concerns. The proposed Bio-CNG project offers a sustainable and scientifically proven solution to the solid waste problem. Municipal solid waste will be processed through anaerobic digestion to produce renewable Bio-CNG, thereby diverting biodegradable waste from landfills. This approach minimizes methane emissions from uncontrolled decomposition, reduces dependency on fossil fuels, and generates a clean energy source that aligns with India's renewable energy targets. Additionally, by producing energy from waste, the project contributes to a circular economy and supports climate action objectives. The project will utilize the anaerobic digestion process, wherein biodegradable organic waste is decomposed by microorganisms in the absence of oxygen. This process produces biogas rich in methane, which is subsequently upgraded to Bio-CNG. Anaerobic digestion also generates nutrient-rich digestate, which can be safely utilized as a soil conditioner or compost, thereby reducing the environmental footprint of residual waste. The process is

engineered to ensure optimal retention time, controlled temperature, and pH levels, ensuring maximum biogas yield and operational efficiency. All design, construction, and operational activities will adhere to the relevant technical and environmental standards prescribed by the Central Pollution Control Board (CPCB), Tamil Nadu Pollution Control Board (TNPCB), and Indian Standards (IS codes). This includes compliance with standards for gas purity, emissions, wastewater treatment, solid residue handling, and occupational health and safety. Regular audits, monitoring, and reporting will ensure sustained compliance, thereby guaranteeing that the facility operates safely, efficiently, and with minimal environmental impact. Through controlled anaerobic digestion, stringent emission and safety measures, and adherence to statutory standards, the project ensures sustainable waste management, energy recovery, and environmental protection, in alignment with national policies and regulatory frameworks.

24. It is humbly submitted that the establishment of the Bio-CNG plant will generate significant employment opportunities for local communities, reduce open dumping and fire hazards, and improve public health by minimizing leachate generation and air pollution. The project directly supports India's national commitments under Swachh Bharat Mission 2.0, thereby contributing to sustainable development. It is humbly submitted that remediation of past legacy waste at Vellalore through bio mining is already ongoing. The proposed Bio-CNG plant is corrective in nature and does not perpetuate illegality; rather, it ensures scientific processing of municipal solid waste and gradual phasing out of open dumping. Continuous monitoring and regulatory oversight will ensure that no environmental violation takes place.
25. Therefore it is most respectfully submitted that granting an injunction against the project would severely prejudice public interest, as it would lead to continued piling of waste, worsening pollution, and health hazards. Conversely, allowing the project will ensure compliance with environmental standards, promote remediation of existing waste, and generate renewable clean energy. The project squarely serves the directions of this Hon'ble Tribunal by enabling sustainable and scientific solid waste management.
26. In light of the foregoing, it is humbly reaffirmed that the Bio-CNG project is lawful, duly sanctioned, and in strict compliance with environmental norms. The project is beneficial both environmentally and socially, addressing waste management challenges while producing renewable energy. It is therefore prayed that the injunction application may be dismissed, permitting the project to proceed lawfully in the larger public interest.


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PRAYER

In view of the facts and submissions stated hereinabove, it is most humbly prayed that this Hon'ble Tribunal may be pleased to:

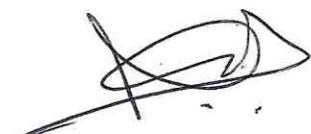
- a) Dismiss the injunction application filed against the Bio-CNG project at Vellalore;
- b) Uphold the lawfulness and validity of the project, being duly sanctioned and in strict compliance with CPCB, TNPCB and IS standards;
- c) Recognize the environmental and social benefits of the project in addressing the legacy waste problem, mitigating pollution, and producing renewable energy; and
- d) Pass such further or other orders as this Hon'ble Tribunal may deem fit and proper in the larger public interest and in the interest of justice.

I do hereby verify that the contents of this affidavit, including the status report and action plan, are true and correct to the best of my knowledge and belief and nothing material has been concealed therefrom.

Date: 25-10-2025

Place: Coimbatore


**COMMISSIONER
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Counsel for the Respondent

ANNEXURE I
**Detailed Feasibility Report on Establishment of
Municipal Solid Waste (MSW) based Bio-CNG plant in
Coimbatore Municipal Corporation (DPR)**

Detailed Feasibility Report on Establishment of Municipal Solid Waste (MSW) based Bio-CNG plant in Coimbatore Municipal Corporation

August 2023



Proposed By



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Annexure

- I Soil/Geotechnical Investigation Report
- II Quotation

Executive Summary

Executive Summary

<p>Project Background</p>	<p>India is the world's most populous country with a population of 1.43 billion accounting for 18% of the world's population. Around 55% of the population in the Country are living in urban areas, a proportion that is expected to increase to 68% by 2050. The annual rate of growth of urban population in India is 3.35% (Census of India, 2011).</p> <p>Rapid industrialization and population explosion in India has led to the migration of people from villages to cities, in turn led to a massive increase in the generation of Municipal Solid Waste (MSW). The country generates around 58.4 million tons of MSW annually (Source: MSW Annual Report 2020-21, Central Pollution Control Board (CPCB)). The country's MSW management system is inadequate and inefficient, leading to a range of environmental and health issues. Open dumping of MSW is a common practice in India, leading to the release of toxic gases, greenhouse gases, and leachate that contaminates the soil and water resources. It also causes air pollution, leading to respiratory problems and other health issues.</p> <p>To address this problem, Government of India has taken several initiatives to promote sustainable MSW management practices. The Government has launched the Swachh Bharat Abhiyan (Clean India Mission) in 2014, aiming to achieve 100% open-defecation-free India by 2019 and ensuring safe disposal of MSW. Under this program, the Government has emphasized the need for segregation of waste at the source, collection and transportation and processing and disposal.</p> <p>Tamil Nadu is one among the most urbanized states in India. There are 21 Municipal Corporations, 138 Municipalities and 490 Town Panchayats in the State (Source: Policy Note 2022-23, Municipal Administration and Water Supply Department). On an average, the total solid waste generated in the State is around 13,422 Metric Tons per day (Source - CPCB).</p> <p>Presently, the MSW is disposed at unregulated dumpsites within or outside the respective jurisdiction, causing civic issues and environmental hazards. The Urban Local Bodies (ULBs) find extremely challenging to treat this waste due to limited land availability and low technology penetration for scientific waste management.</p> <p>One of the most promising solutions for managing MSW is the establishment of biogas plants. The biogas produced can be used for cooking, heating,</p>
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	<p>electricity generation and transport fuel, while the organic fertilizer can be used for agricultural purposes, promoting sustainable farming practices.</p> <p>In this context, during the 4th State High Powered Committee (on Solid Waste Management) held on 09.11.2022, it was announced by the Committee that Municipal Administration Department will establish Bio-CNG plants in bigger corporations viz, Tambaram, Coimbatore, Madurai, Salem, Tiruchirappalli, Tirunelveli, Tiruppur, Thanjavur and Nagercoil.</p> <p>In this regard, Directorate of Municipal Administration has appointed ITCOT Limited, Chennai for preparation of Detailed Feasibility Report (DFR) on the project. Accordingly, ITCOT has prepared the report based on the guidelines of Tamil Nadu Infrastructure Development Board (TNIDB) and details provided by the Municipal Administration, site survey, demand assessment, estimates, collection of secondary information on market/internet, etc.</p>												
<p>Need Assessment</p>	<p>Coimbatore City Municipal Corporation (CCMC) is divided into five zones having 100 wards.</p> <p>The primary waste collection (i.e.,) door-to-door collection of wet waste and dry waste is managed by MC. As per Solid Waste Management Rules 2016, Bulk waste generators (BWG) are responsible for collection and management of their own waste includes Apartments, Hotels, Restaurants, Hospitals, Schools, College, Mandapam etc.</p> <p>The waste is collected through 572 vehicles (472 Small Commercial Vehicles and 100 Battery Operated Vehicles) which make 2 trips a day. The average load carried by these waste collection vehicles varies between 1.60 to 1.80 TPD.</p> <p>Capacity Determination</p> <p>The capacity of Bio-CNG plant determined based on the per capita waste generated is as given below:</p> <table border="1" data-bbox="416 1697 1513 2018"> <thead> <tr> <th>Particulars</th> <th>As per GOI norms</th> <th>As per market survey</th> </tr> </thead> <tbody> <tr> <td>Per capita waste generated per day (kg)</td> <td>0.550</td> <td>0.509</td> </tr> <tr> <td>Projected population for the year 2026</td> <td>30,05,116</td> <td>30,05,116</td> </tr> <tr> <td>Total waste generated for the year 2026 (in TPD)</td> <td>1548</td> <td>1433</td> </tr> </tbody> </table>	Particulars	As per GOI norms	As per market survey	Per capita waste generated per day (kg)	0.550	0.509	Projected population for the year 2026	30,05,116	30,05,116	Total waste generated for the year 2026 (in TPD)	1548	1433
Particulars	As per GOI norms	As per market survey											
Per capita waste generated per day (kg)	0.550	0.509											
Projected population for the year 2026	30,05,116	30,05,116											
Total waste generated for the year 2026 (in TPD)	1548	1433											

	Less: Waste managed by BWG	136	126
	Total Waste available for the year 2026 (in TPD)	1412	1307
	Per capita wet waste generated per day for the year 2026 (in kg)	0.30	0.20
	Total wet waste generated (in TPD)	776	507
	Less: Waste not suitable for Biogas production @ 5% (in TPD)	39	25
	Less: Waste processed at MCCs (in TPD)	43	43
	Less: Waste Processed at VCC (in TPD)	65	65
	Less: Waste Processed at Bio-CNG (in TPD)	4	4
	Wet waste available for processing (in TPD)	626	370
	Capacity of Bio-CNG Plant (@75% of projected quantity)	469	278
	<p><i>Note: 1.3% increase in per capita waste generation as per CPHEEO manual and NEERI study.</i></p> <p>Based on the discussions with the promoters of Bio-CNG plants elsewhere, factor of 0.75 of the projected quantity is considered for determining the installed capacity. Accordingly, by considering the projected waste generation the capacity of the Bio-CNG plant is fixed at 250 TPD.</p>		
Project Scoping	<p>The project involves establishment of Bio-CNG plant of capacity 250 TPD. The project is proposed to be implemented on Design, Finance, Build, Own, Operate and Transfer (DFBOOT) model under Public Private Partnership (PPP) mode.</p> <p>It is envisaged that the land will be provided by the Municipal Administration and the selected Private Player will be responsible for establishment, operation & maintenance of the facility.</p>		
Service Standard - Output and Services	<p>The proposed for a bio-CNG plant of processing capacity 250 MT per day that would significantly address the identified service gaps and achieve the overall objectives of the Project.</p> <p>By addressing environmental concerns through the conversion of organic waste into renewable natural gas, the plant contributes to mitigating climate change and promoting sustainable waste management practices. Also, the project can stimulate economic development, create job opportunities, and foster local entrepreneurship.</p> <p>Overall, the bio CNG plant represents a promising solution with multiple benefits, spanning environmental, energy, and socio-economic aspects.</p>		

Location	The project is proposed at Vellalore dump yard, Vellalore town, Coimbatore South Taluk, Coimbatore District.																		
Land	<p>At present, an extent of 654.54 acres of land at Vellalore Village, Madukarai Taluk, Coimbatore District has been used for solid waste disposal.</p> <p>Of the total area, it is proposed to earmark about 10 acres of land at SF No. 580, 581 Pt, 588 Pt, 589 Pt, 590 Pt, 591 Pt, 595 Pt for establishment of Bio-CNG plant.</p> <p>Bio-mining process has been completed at the identified site and the proposed land could be utilised for establishment of Bio-CNG plant.</p>																		
Installed Capacity	It is proposed to install a 250 TPD capacity Bio-CNG plant. Considering 365 working days per annum, the installed capacity at 100% capacity utilization is 91,250 MT per year.																		
Power	The total connected load required for the operation of the Bio-CNG plant is estimated at 2,464 KVA, which would be met from TNEB grid supply. Further, a standby generator of capacity 1,700 KVA has been proposed to cater to the anticipated peak demand.																		
Manpower	<p>The manpower required for the proposed facility is envisaged as under:</p> <table border="1" data-bbox="678 1086 1252 1512"> <thead> <tr> <th>Description</th> <th>Nos.</th> </tr> </thead> <tbody> <tr> <td>Plant Head</td> <td>1</td> </tr> <tr> <td>Maintenance Engineers</td> <td>2</td> </tr> <tr> <td>Supervisors</td> <td>2</td> </tr> <tr> <td>Technicians</td> <td>10</td> </tr> <tr> <td>Helpers</td> <td>52</td> </tr> <tr> <td>Accounts and Admin Staffs</td> <td>5</td> </tr> <tr> <td>Security</td> <td>4</td> </tr> <tr> <td>Total</td> <td>76</td> </tr> </tbody> </table>	Description	Nos.	Plant Head	1	Maintenance Engineers	2	Supervisors	2	Technicians	10	Helpers	52	Accounts and Admin Staffs	5	Security	4	Total	76
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Total	76																		
Water	<p>For every kg of waste processed 1 litre of water is required. Accordingly, the total water requirement for operation of the plant is estimated at 250 KLD. Further, the domestic water requirement as per IS 1172, Code of Basic Requirements for Water Supply, Drainage and Sanitation is estimated at 3 KLD. Accordingly, the total water requirement works out to 253 KLD.</p> <p>Out of the total water required for operation of the plant, about 95% could be recovered and reused. Accordingly, the total freshwater requirement is estimated at 19 KLD</p>																		
Statutory Approval	The statutory approvals and clearances that are to be obtained are as follows:																		

	S. No.	Permission	Authority
	1.	Approval of layout and building plan	District Town & Country Planning (DTCP)
	2.	Consent to Establish & Consent to Operate (CTE & CTO)	Tamil Nadu Pollution Control Board (TNPCB)
	3.	Explosive substance license - CTE & CTO	Petroleum and Explosives Safety Organization (PESO)
	4.	Factory License	Chief Inspector of Factories
	5.	Labour License	Department of Labour
	6.	NOC from Fire Department	State Fire and Emergency Services
	7.	Certificate of Manufacture of Organic manure	Department of Agriculture
Schedule of Implementation	The project is envisaged to be implemented in 18 months' time from the date of award of contract		
Proposed PPP model	The project is proposed to be implemented on Design, Build, Finance, Own, Operate, Transfer (DBFOOT) model under Public Private Partnership (PPP) mode		
Concession Period	The concession shall be for a period of 20 years from the date of commencement of commercial operation		
Bid Variable	The bidder who quotes the Highest Royalty per MT of waste shall be awarded the Contract.		
Qualification Criteria for selection of Private Player	<p>The criteria for selection of the Private Player shall be as below:</p> <ol style="list-style-type: none"> 1. The bidder should be a registered company in India and should be in existence for the past three years as on 31st March 2023. 2. The bidder should have experience in setting up, operating and maintaining a Bio-CNG plant of capacity of at least 150 TPD, or should be technically supported by original equipment manufacturer/ technology provider who has successfully completed implementation of at least 150 TPD Bio-CNG plant. 3. The bidder should have reported an Average Annual Turnover of at least ₹50 Crores in the last three consecutive financial years i.e., 2020-21, 2021-22 and 2022-23. 		

	<p>4. The bidder should have reported a positive net worth of at least ₹25.00 crores as on 31st March 2023.</p> <p>5. The bidder should not have been blacklisted by Union Government, any State Government, a Statutory Body, any Public Sector Undertaking, Banks or Financial Institutions or declared as NPA by Banks or Financial Institutions as on the date of tender opening.</p>																														
Project cost	<p>The total project cost works out to ₹69.20 crores as shown below:</p> <table border="1"> <thead> <tr> <th>S.No.</th> <th>Components</th> <th>Cost (₹ in crores)</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>Civil works</td> <td>16.71</td> </tr> <tr> <td>2.</td> <td>Mechanical and Electrical Equipment</td> <td>43.15</td> </tr> <tr> <td>3.</td> <td>Miscellaneous Fixed Assets</td> <td>1.41</td> </tr> <tr> <td>4.</td> <td>Laboratory Equipment</td> <td>0.06</td> </tr> <tr> <td></td> <td style="text-align: right;">Sub Total</td> <td>61.32</td> </tr> <tr> <td>5.</td> <td>Contingencies (5%)</td> <td>3.07</td> </tr> <tr> <td>6.</td> <td>Preoperative expenses (1%)</td> <td>0.61</td> </tr> <tr> <td>7.</td> <td>Interest During Construction</td> <td>4.19</td> </tr> <tr> <td></td> <td style="text-align: right;">Total</td> <td>69.20</td> </tr> </tbody> </table>	S.No.	Components	Cost (₹ in crores)	1.	Civil works	16.71	2.	Mechanical and Electrical Equipment	43.15	3.	Miscellaneous Fixed Assets	1.41	4.	Laboratory Equipment	0.06		Sub Total	61.32	5.	Contingencies (5%)	3.07	6.	Preoperative expenses (1%)	0.61	7.	Interest During Construction	4.19		Total	69.20
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Proposed Means of Finance for Private Player	<p>The project is proposed to be financed as under:</p> <table border="1"> <thead> <tr> <th>Particulars</th> <th>₹ in Crores</th> </tr> </thead> <tbody> <tr> <td>Equity</td> <td>17.30</td> </tr> <tr> <td>Central Financial Assistance (CFA) under WTE scheme, MNRE</td> <td>5.07</td> </tr> <tr> <td>Term loan</td> <td>46.83</td> </tr> <tr> <td style="text-align: right;">Total</td> <td>69.20</td> </tr> </tbody> </table>	Particulars	₹ in Crores	Equity	17.30	Central Financial Assistance (CFA) under WTE scheme, MNRE	5.07	Term loan	46.83	Total	69.20																				
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Financial Indicators for Private Player	<p>DSCR : 1.45</p> <p>BEP (3rd year) : 79%</p> <p>NPV : ₹15.27</p> <p>IRR : 14.28%</p> <p>Equity IRR : 20.79%</p>																														

Detailed Chapters

PART A: Feasibility Assessment

1 Project Background

India is the world's most populous country with a population of 1.43 billion accounting for 18% of the world's population. Around 55% of the population in the Country are living in urban areas, a proportion that is expected to increase to 68% by 2050. The annual rate of growth of urban population in India is 3.35% (Census of India, 2011).

Rapid industrialization and population explosion in India has led to the migration of people from villages to cities, in turn led to a massive increase in the generation of Municipal Solid Waste (MSW). The country generates around 58.4 million tons of MSW annually (Source: MSW Annual Report 2020-21, Central Pollution Control Board). The country's MSW management system is inadequate and inefficient, leading to a range of environmental and health issue Open dumping of MSW is a common practice in India, leading to the release of toxic gases, greenhouse gases, and leachate that contaminates the soil and water resources. It also causes air pollution, leading to respiratory problems and other health issues.

To address this problem, Government of India has taken several initiatives to promote sustainable MSW management practices. The Government has launched the Swachh Bharat Abhiyan (Clean India Mission) in 2014, aiming to achieve 100% open-defecation-free India by 2019 and ensuring safe disposal of MSW. Under this program, the Government has emphasized the need for segregation of waste at the source, collection and transportation and processing and disposal.

Tamil Nadu is one among the most urbanized states in India. There are 21 Municipal Corporations, 138 Municipalities and 490 Town Panchayats in the State (**Source: Policy Note 2022-23, Municipal Administration and Water Supply Department**). On an average, the total solid waste generated in the State is around 13,422 Metric Tons per day.

Presently, the MSW is disposed at unregulated dump sites within or outside the respective jurisdiction, causing civic issues and environmental hazards. The Urban Local Bodies (ULBs) find extremely challenging to treat this waste due to limited land availability and low technology penetration for scientific waste management.

One of the most promising solutions for managing MSW is the establishment of biogas plants. The biogas produced can be used for cooking, heating, and electricity

generation, while the organic fertilizer can be used for agricultural purposes, promoting sustainable farming practices.

In this context, during the 4th State High Powered Committee (on Solid Waste Management) held on 09.11.2022, it was announced by the Committee that Municipal Administration Department will establish Bio-CNG plants in bigger corporations viz, Tambaram, **Coimbatore**, Madurai, Salem, Tiruchirappalli, Tirunelveli, Tiruppur, Thanjavur and Nagercoil.

In this regard, Directorate of Municipal Administration has appointed ITCOT Limited, Chennai for preparation of Detailed Feasibility Report (DFR) on the project. Accordingly, ITCOT has prepared the report based on the guidelines of Tamil Nadu Infrastructure Development Board (TNIDB) and details provided by the Municipal Administration, site survey, demand assessment, estimates, collection of secondary information on market/internet, etc.

2 Strategic Need Assessment, Demand Assessment and Project scoping

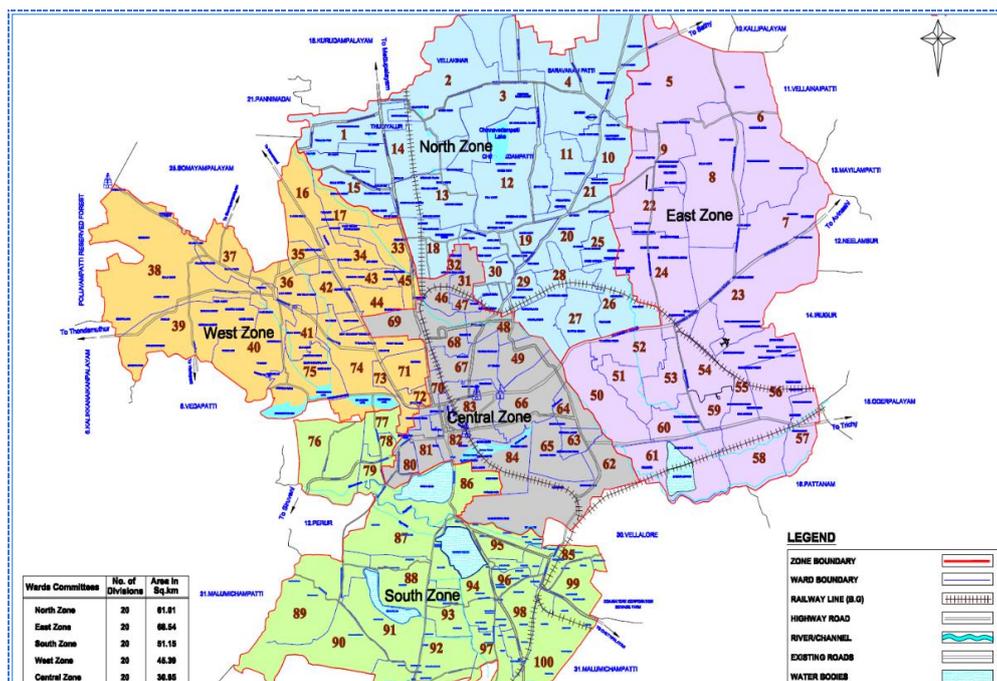
This section analyses the existing solid waste management system and system deficiencies, to focus on further planning, implementation, and monitoring processes. Local conditions are considered for assessing the inadequacy of existing system and for future plans with due consideration of local demography, physical location, growth objectives of the Urban Local Bodies (ULB), as well as social and environmental conditions.

2.1 Existing condition of Solid Waste Management in CCMC

Coimbatore City Municipal Corporation (CCMC) is divided into five zones having 100 wards. The City has an estimated population of 21,52,680 for the year 2022, that grows at an annual rate of 2.75% and the details are as given hereunder:

S.No.	Zone No.	Ward Count	Households	Commercials
1	East	20	89615	4905
2	West	20	89617	4418
3	North	20	88945	6727
4	South	20	84683	3925
5	Central	20	84339	15895
Total		100	437199	35870

The map below depicts the five zones of Coimbatore Corporation:



Coimbatore Corporation - Zonal Map

2.1.1 Solid waste from bulk waste generators

The primary waste collection (i.e.,) door-to-door collection of wet waste and dry waste is managed by MC. As per Solid Waste Management Rules 2016, Bulk waste generators (BWG) are responsible for collection and management of their own waste includes Apartments, Hotels, Restaurants, Hospitals, Schools, College, Mandapam etc.

2.1.2 Waste collection and transportation

The waste is collected through 572 vehicles (472 Small Commercial Vehicles and 100 Battery Operated Vehicles) which make 2 trips a day. The average load carried by these waste collection vehicles varies between 1.60 to 1.80 TPD.

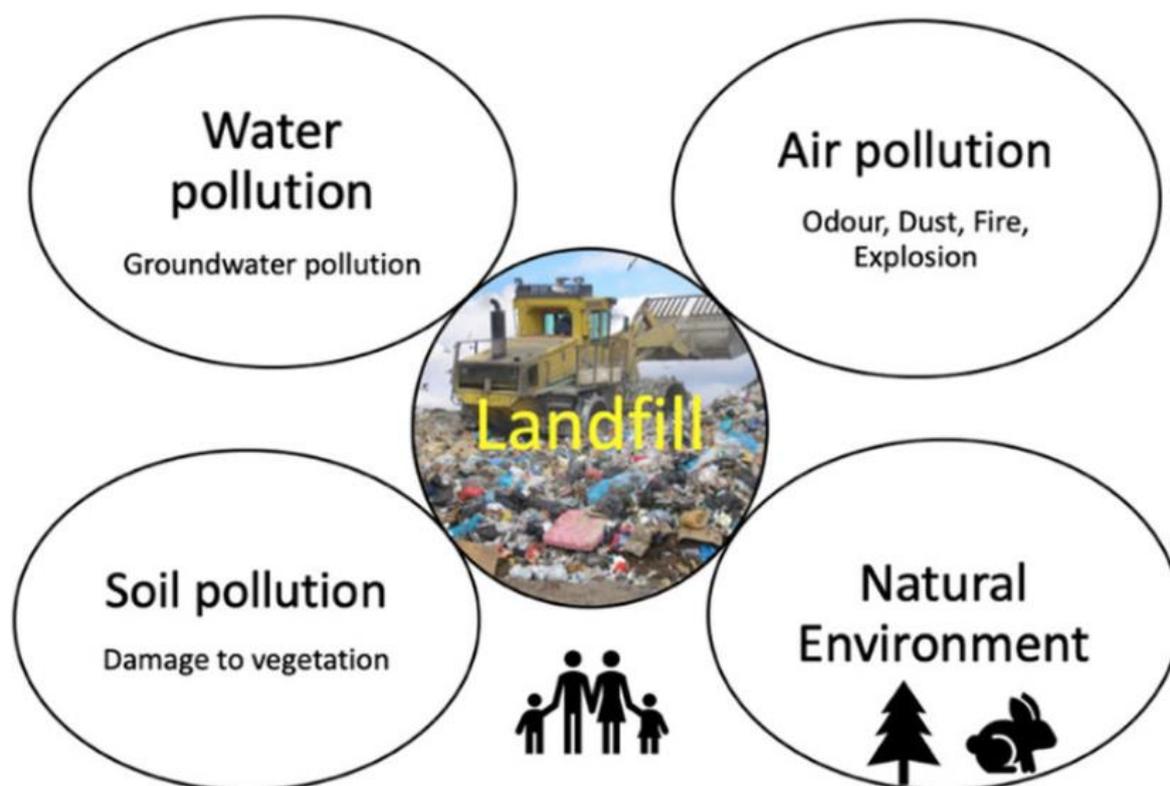
2.2 Existing Service Gaps

Solid garbage that is spread out in open dumps clogs drains and sewers, causing flooding and unhygienic conditions. Moreover, landfills contaminate groundwater, while incinerators pollute the air and degrade the quality of the soil, which negatively impacting the environment and human health.

The other problems faced due to dumping of waste are foul odour, reducing the quality of life in the nearby areas and the local communities, threatening the health

of humans and animals as well as polluting the environment. Open dumping, composting and sanitary land filling are three methods being adopted for MSW disposal.

Also, segregation is mostly done by unorganized sector (scavengers and rag pickers) and is rarely done by bulk waste generators. Hence, the efficiency of segregation is quite low, as the unorganized sector tends to segregate only those waste materials, which fetch money in the recycling market. Due to which, substantial amount of waste is dumped into low-lying areas, canals, rivers etc.



The degradation of wastes in the landfill results in the production of leachate and gases. These emissions cause potential threats to human health and to the quality of the environment. Furthermore, it usually contains a large number of other gases at low concentrations, some of which are toxic. Leachate migrate to groundwater/ surface water through the flaws in the liners thereby possessing serious problem to the environment.

i) Segregation & Collection

Housing Societies, being Bulk Waste Generators, play a major role in managing the waste. Responsible segregation of waste can greatly reduce the burden on urban waste management infrastructure. The major challenges faced are as follows:

- Government is unable to segregate and process 100% of the collected waste
- Segregation is done under unsafe and hazardous conditions, posing health hazards and injuries to waste collectors
- Mixed waste is dumped in landfills

Proper solid-waste collection is important for the protection of public health, safety, and environmental quality. The collection of waste from door to door is the prime process for Municipal Solid Waste Management (MSWM). As there is no organized and scientifically planned source segregation at individual household level, there are several challenges being faced. The main reasons for lack of segregation at source are:

- i) Lack of awareness about segregation and waste management rules
- ii) Habit of open dumping
- iii) Source segregation without source reduction - Residents simply segregate without minimising the amount of waste generated.

ii) Storage & transportation

Generated solid waste mostly stored in the community bins and individual bins. The residents often utilise the single bin for mixed waste, often found unmanaged, filled with leachate, especially during the rainy session. The scarcity of land for waste dumping is even a more challenging issue. The collected waste is stored in a wrong manner and improper technique is used as mentioned below:

- Hazardous waste are not sealed - Wrap hazardous waste securely, double bag it with a label and seal it tightly.
- Excessive use of garbage liners/bags - Dry and wet waste are separated in two garbage bags, doubling the volume of plastic waste.
- Incorrect disposal of e-waste - Waste such as tube lights are not segregated from other type of waste; broken tube lights are major source of mercury poisoning.

iii) Treatment & disposal

Collected waste is currently dumped at Vellalore disposal site. Ineffective disposal causes air pollution, water and soil contamination. Unscientific disposal of waste, mostly in open and unsanitary landfills, contributes to contamination of drinking water and can cause infection and transmit diseases. Also, other type of waste such as sanitary, battery, E-waste and other hazardous waste are not segregated and disposed of scientifically.

The overall objective of the project is to hold great promise for efficient municipal Solid Waste Management and to tackle the problem of polluted urban air due to Carbon Emissions.

Biogas helps to mitigate methane emissions that would have otherwise escaped from landfills or manure lagoons. The project has high importance for planning the collection, transport, recycling and treatment systems.

2.3 Demand Assessment

ITCOT conducted primary market survey from 21.04.2023 to 30.04.2023 and 29.07.2023 to 02.08.2023 in the Coimbatore Corporation to analyse the demand for the proposed Bio-CNG project and the findings are as under:

a) Assessment of waste in Fruits and Vegetable market Zone wise:

S.No.	Zone	Fruits and Vegetable Waste generated (MT per day)	Current mode of disposal
1.	Central	8.50	Corporation Vehicle
2.	East	6.50	Corporation Vehicle
3.	North	2.25	Corporation Vehicle
4.	West	4.25	Corporation Vehicle
5.	South	5.50	Corporation Vehicle





b) Assessment of waste in Hotels and Restaurants

S.No	Zone	Food Waste generated (MT per day)	Current mode of disposal
1.	Central	93.00	Corporation Vehicle
2.	East	5.05	Corporation Vehicle
3.	North	24.75	Corporation Vehicle
4.	West	7.9	Corporation Vehicle
5.	South	11.00	Corporation Vehicle

c) Assessment of waste in Commercial/Mall

S.No	Zone	Wet Waste Collection (MT per day)	Current mode of disposal
1.	Central	12.75	Corporation Vehicle
2.	East	1.00	Corporation Vehicle
3.	North	4.25	Corporation Vehicle
4.	West	1.45	Corporation Vehicle
5.	South	3.25	Corporation Vehicle

d) Assessment of waste in Hospitals/ Clinics

S.No	Zone	Wet Waste Collection (MT per day)	Current mode of disposal
1.	Central	17.25	Corporation Vehicle
2.	East	1.65	Corporation Vehicle
3.	North	4.25	Corporation Vehicle
4.	West	2.95	Corporation Vehicle
5.	South	0	Corporation Vehicle

e) Assessment of waste in Marriage Halls

S.No	Zone	Wet Waste Collection (MT per day)	Current mode of disposal
1.	Central	77.75	Corporation Vehicle
2.	East	5.40	Corporation Vehicle
3.	North	6.75	Corporation Vehicle
4.	West	2.425	Corporation Vehicle
5.	South	151.00	Corporation Vehicle

f) Assessment of waste in Household

S.No	Zone	Wet Waste Collection (MT per day)	Current mode of disposal
1.	Central	63.75	Corporation Vehicle
2.	East	10.65	Corporation Vehicle
3.	North	63.75	Corporation Vehicle
4.	West	8.02	Corporation Vehicle
5.	South	4.25	Corporation Vehicle

BWG includes Apartments, Hotels, Restaurants, Hospitals, Schools, College, Mandapam etc. According to data provided by the ULB, this collective group

generates about 109 MT of waste per day and are managed by the respective BWGs. Of the total w generated from BWGs wet waste constitutes to about 65 MT.

2.3.1. Existing Municipal Solid Waste Processing Centres

There are 42 municipal solid waste processing centres that include 21 Micro Composting Centres (MCC), 10 Resource Recovery Centres (RRC), 6 Material Recovery Facilities (MRF), 1 E-waste processing centre, 1 Vermi-Composting Centre, 1 Garden and 3 existing Bio-Gas facilities as shown under:



a) *Micro Composting Centres (MCC)*

There are totally 21 MCCs of capacity 5 MT each. Of the total MCCs, 18 Nos. are functional, 2 Nos. are non-functional and 3 Nos. are under construction. The total capacity of functional MCCs is 90 MT per day and the average waste processed at all the functional MCCs is 70 MT per day.

The List of MCCs in CCMC is as follows:

S.No	Name and location of MCC	Capacity of MCC (TPD)	Actual wet waste processed (TPD)	Operating status	Photos
1.	OSR Layout Vilankurichi (Near Burial Ground)	5	4	Functional	 <p>Coimbatore, Tamil Nadu, India 342, K S Layout Rd, Peelnamedu, Karpupana Layout, Coimbatore, Tamil Nadu 641006, India Lat 11.036667° Long 77.005746° 16/05/23 09:19 AM GMT +05:30</p>
2.	Fire station Ramasamy Nagar	5	4	Functional	 <p>May 16, 2023 11:16:49</p>
3.	Thudiyalur	5	4	Functional	 <p>May 16, 2023 12:10:02 11.081588333333332N 76.94275333333333E தூடியலூர் தமிழ்நாடு</p>

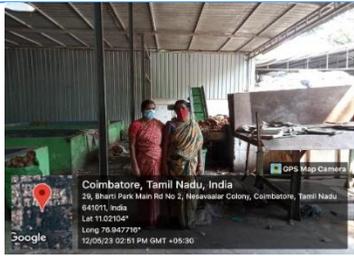
S.No	Name and location of MCC	Capacity of MCC (TPD)	Actual wet waste processed (TPD)	Operating status	Photos
4.	Ondipudur STP Premises (West Side)	5	5	Functional	 <p>Coimbatore, Tamil Nadu, India 1, Singai Nagar, Coimbatore, Tamil Nadu 641016, India Lat: 10.993173° Long 77.051976° 27/04/23 05:50 PM GMT +05:30</p>
5.	Ondipudur STP Premises (East Side)	10	10	Functional	 <p>Coimbatore, Tamil Nadu, India 1, Singai Nagar, Coimbatore, Tamil Nadu 641016, India Lat: 10.99307° Long 77.051996° 27/04/23 05:51 PM GMT +05:30</p>
6.	Valakkai Mandi Premises in R.S.Puram	5	-	Non-Functional	 <p>Coimbatore, Tamil Nadu, India Boys School Building, Arokkasmy Rd W, R.S. Puram, Coimbatore, Tamil Nadu 641002, India Lat: 11.004708° Long 76.947671° 12/05/23 10:48 AM GMT +05:30</p>

S.No	Name and location of MCC	Capacity of MCC (TPD)	Actual wet waste processed (TPD)	Operating status	Photos
7.	Music College Premises in R.S.Puram	5	3	Functional	 <p>Coimbatore, Tamil Nadu, India No 11, Fisher Bancy St, R.S. Puram, Coimbatore, Tamil Nadu 641002, India Lat: 11.008415° Long: 76.945289° 27/04/23 10:14 AM GMT +05:30</p>
8.	South side of Old Kavundampalayam	5	-	Non-Functional	 <p>Coimbatore, Tamil Nadu, India 10/8/A, Jeeva Rd, Jeeva Nagar, Kavundam Palayam, Coimbatore, Tamil Nadu 641030, India Lat: 11.034775° Long: 76.947372° 12/05/23 12:43 PM GMT +05:30</p>
9.	North side of Old Kavundampalayam	5	3	Functional	 <p>Peppanickalpalayam, Tamil Nadu, India 2/162, Kavundam, Peppanickalpalayam, Tamil Nadu 641030, India Lat: 11.038224° Long: 76.946166° 12/05/23 12:38 PM GMT +05:30</p>

S.No	Name and location of MCC	Capacity of MCC (TPD)	Actual wet waste processed (TPD)	Operating status	Photos
10.	MGR Market	5	-	Non-Functional	 <p>Coimbatore, Tamil Nadu, India 19, Arunachalam Grounds St, KK Pudur, Coimbatore, Tamil Nadu 641038, India Lat 11.030681° Long 76.849382° 12/05/23 12:58 PM GMT +05:30</p>
11.	MGR Market, K.A.Ramasamy Street	5	3	Functional	 <p>Coimbatore, Tamil Nadu, India 45, KS Ramasamy St, Saibaba Colony, Coimbatore, Tamil Nadu 641011, India Lat 11.030762° Long 76.849191° 12/05/23 12:56 PM GMT +05:30</p>
12.	Onapalayam	5	3	Functional	 <p>Coimbatore, Tamil Nadu, India Global Greens, Tamil Nadu 641007, India Lat 11.016089° Long 76.873955° 12/05/23 11:26 AM GMT +05:30</p>

S.No	Name and location of MCC	Capacity of MCC (TPD)	Actual wet waste processed (TPD)	Operating status	Photos
13.	Uzhavar Santhai, R.S.Puram	5	3	Functional	 <p>Coimbatore, Tamil Nadu, India Uzhavar Santhai, 2/NP/PPG, Vincent Colony, R.S. Puram, Coimbatore, Tamil Nadu 641008, India Lat: 11.014271° Long: 76.944292° 27/04/23 12:58 PM GMT +05:30</p>
14.	Ukkadam Sewage Farm Premises	5	3	Functional	 <p>Kurichi Pirivu, Tamil Nadu, India XXJC+X3M, 5th St, Anbu Nagar, Kurichi Pirivu, Tamil Nadu 641024, India Lat: 10.982652° Long: 76.971531° 19/05/23 11:05 AM GMT +05:30</p>
15.	Q Block Kovaipudur	5	3	Functional	 <p>Kovaipudur, Tamil Nadu, India WWXJ+X29, R - Block, Kovaipudur, Tamil Nadu 641042, India Lat: 10.95019° Long: 76.929935° 19/05/23 01:02 PM GMT +05:30</p>

S.No	Name and location of MCC	Capacity of MCC (TPD)	Actual wet waste processed (TPD)	Operating status	Photos
16.	Tharun Residency	5	3	Functional	 <p>Eachanari, Tamil Nadu, India Unnamed Road, Eachanari, Tirukva Nagar, Eachanari, Tamil Nadu 641021, India Lat 10.645529° Long 76.900984° 19/05/23 12:17 PM GMT +05:30</p>
17.	Chokkamputhur	5	3	Functional	 <p>Ponnaiyah Raja Puram, Tamil Nadu, India 29/22+09, Shanthi Nagar, Selvasaram North, Ponnaiyah Raja Puram, Tamil Nadu 641001, India Lat 11.00121° Long 76.938428° 19/05/23 02:24 PM GMT +05:30</p>
18.	Shasthri Nagar (Semmozhi Poonga)	5	3	Functional	 <p>Coimbatore, Tamil Nadu, India No 112, Old No 158, Sri Abhirami, First Fly, Dr Radhakrishna Road, Nr Karnataka As, Coimbatore, Tamil Nadu 641012, India Lat 11.022431° Long 76.867472° 15/05/23 01:22 PM GMT +05:30</p>

S.No	Name and location of MCC	Capacity of MCC (TPD)	Actual wet waste processed (TPD)	Operating status	Photos
19.	Valliyammal Street	5	2	Functional	 <p>Coimbatore, Tamil Nadu, India No 3, Angalamman Koi Complex, 80 Feet Road, Putamal Koi St, Olymbus, Bharathi Nagar, Coimbatore, Tamil Nadu 641046, India Lat: 10.995277° Long: 76.964031° 10/05/23 02:38 PM GMT +05:30</p>
20.	Bharathi Park	5	3	Functional	 <p>Coimbatore, Tamil Nadu, India 29, Bharathi Park Main Rd No 2, Nelsavalar Colony, Coimbatore, Tamil Nadu 641011, India Lat: 11.022564° Long: 76.947716° 12/05/23 02:51 PM GMT +05:30</p>
21.	Variety Hall road	5	4	Functional	 <p>Coimbatore, Tamil Nadu, India Shiva Star Complex, Mill Rd, Town Hall, Coimbatore, Tamil Nadu 641001, India Lat: 11.000834° Long: 76.961958° 16/05/23 09:28 AM GMT +05:30</p>

From the above table, it is inferred that the average quantity of waste processed at each MCCs is around 40% of the capacity. Subsequently, data was gathered over a span of three months (i.e.,) May, June and July 2023 indicating that the average daily waste processed at all MCCs is around 43 TPD.

b) Vermi Composting Centres (VCC)

S.No	Name and location of VCC	Capacity of VCC (TPD)	Actual wet waste processed (TPD)
1.	Vellalore	100	65

c) Existing Bio-Gas plants

S.No	Name and location of plant	Capacity (TPD)	Actual wet waste processed (TPD)
1.	Bharathi Park	1.5	1.20
2.	Amma Unavagam	1.5	1.20
3.	Vellalore	2	1.6

d) Existing RRC

S.No.	Zone	Ward No.	Location
1.	Central	48	Shasthri Nagar
2.	Central	68	Shasthri Nagar (Anna Nagar)
3.	Central	48	Shasthri Nagar (C.K.Colony)
4.	Central	32	Sanganoor Narayanasamy Street
5.	East	57	Ondipudur STP Premises (West Side)
6.	East	52	Chandragandhi nagar
7.	North	28	Vilanguruchi Road (inside TS)
8.	North	28	Transfer Station Peelamedu
9.	South	99	Vellalore Dump Yard
10.	South	99	Vellalore Dump Yard
11.	South	77	Chokkamputhur
12.	South	86	Ukkadam Sewage Farm Premises
13.	South	99	Vellalore Dump Yard
14.	West	72	Valakkai Mandi Premises in R.S.Puram
15.	West	43	Venkitapuram Crimitorium
16.	West	34	South side of Old Kuvundampalayam
17.	West	45	MGR Market

S.No.	Zone	Ward No.	Location
18.	West	75	Panaimarathur
19.	West	71	Sir Shanmugam Road in R.S.Puram
20.	West	73	Subramaniam Scheme Road

2.4 Estimation of wet waste available for processing

2.4.1 Estimation of waste generated per day

Since the quantity and quality of MSW plays a significant role in selection of technology and operation of the any facility, ITCOT carried out physical characterization, quantification and chemical analysis of the MSW as per the methodology given in the CPHEEO Manual.

a) Physical Characterization

The physical characterization of waste focuses on three distinct groups: high-income, low-income, and rural wards. The average waste quantities received in the designated ward are given in the table hereunder:

Particulars	Details		
	High level group	Mid-level group	Rural Ward
Type of Ward	High level group	Mid-level group	Rural Ward
Name of Zone	West	South	West
No of Ward Covered	71	86	38
Total Population	20,575	42,000	29,000
Wet Waste Collection per day at selected ward	8320	495	2055

The physical assessment of waste indicates that wet waste constitutes leftover food, used tea leaves and teabags, egg shells, coconut shells, used flowers and leaves, rotten vegetables and fruits, etc.

b) Quantification of solid waste

At Dumpsite:

Quantification of solid waste is done for three consecutive days during which the recorded data includes the weights of waste that is being deposited at the landfill site. Details of the same is given in the table below:

S. No	Date	Total Waste (TPD)
1	30.07.2023	97
2	31.07.2023	448
3	01.08.2023	447

Based on market survey, it is estimated that the average quantity of waste received at dump site is around 401 TPD. Subsequently, data was gathered over a for the month of July 2023 indicating that the average daily waste is around 422TPD.

Accordingly, the average quantity of waste received at the dumpsite is considered at around **422 TPD**. Of the total waste received, it is estimated that wet waste constitutes 40%.

From BWG:

As discussed under the section 2.3, **109 MT** of waste from BWG is managed internally.

At MCC:

As discussed under the section 2.3.1, the average daily waste processed at all MCCs is around **43 TPD**.

At Bio- CNG:

As discussed under the section 2.3.1, the average daily waste processed at Bio-CNG plant is around **4 TPD**.

At VCC:

As discussed under the section 2.3.1, the average daily waste processed at VCC is around **65 TPD**.

At RRC:

There are 20 RRCs, each with a processing capacity 5 TPD and the average daily waste processed is **57 TPD**.

At Coimbatore Integrated Waste Management Company Private Ltd.(CIWMCP)

Coimbatore Integrated Waste Management Company Private Ltd. is a Special Purpose Vehicle (SPV) - formed by BEIL-UPL (consortium) in 2007-08 for management of waste generated in CCMC on PPP mode under DBOOT basis for a period of 20 years.

At present average daily waste processed at CIWMCP is 540 MT. Of which 30% i.e. 162 MT of is wet waste. The 20 years concession period ends by 2027. Accordingly, the waste currently processed by CIWMCP is also taken into consideration for capacity determination of Bio-CNG plant.

Overall, the total waste generation in CCMC is estimated at **1240 TPD**.

2.4.2 Projection of Population

It is estimated that the Bio-CNG plant will become fully operational during the year 2026. Accordingly, the projected population of CCMC during the year 2026 is estimated based on the following assumptions:

- Population data for the year 2011 and 2021 has been taken in accordance with the G.O. No. 152 by the Municipal Corporation & Water Supply Department.
- Geometrical Increase Method is considered for population projection among various methods which includes National Average Decadal Growth Rate, Arithmetic Increase Method, and Exponential Method.
- Based on the discussion with ULB, floating population is taken as 10% of the total residential population of MC.

Particulars		Floating population	Total Population
Population during the year 2011	16,04,925		
Population during the year 2021	22,88,042		
CAGR	3.61%		
Projected population for the year 2022	23,70,636	2,37,063.62	26,07,700
Projected population for the year 2023	24,56,212	2,45,621.20	27,01,833
Projected population for the year 2024	25,44,877	2,54,487.68	27,99,365
Projected population for the year 2025	26,36,742	2,63,674.23	29,00,417
Projected population for the year 2026	27,31,924	2,73,192.40	30,05,116

Accordingly, the **current per capita waste generated** is estimated as given below:

S.No	Particulars	Quantity
1.	Waste received per day at dumpsite (A)	422 MT
2.	Waste received per day at MCC (B)	43 MT
3.	Waste received per day at VCC (C)	65 MT
4.	Wet waste received per day at Bio-CNG (D)	4 MT
5.	Waste collected and managed by BWG (E)	109 MT
6.	Waste collected and managed by CIWMCPL (F)	540 MT
7.	Waste collected per day at RCC(G)	57 MT
8.	Total Waste generated per day (H=A+B+C+D+E+F+G)	1240 MT
9.	Total wet waste generated per day (H=(40% of A) + (48% of B) +(65% of C)+ (80% of D)+(60% of E)+(30% of F)	508 MT
10.	Population - 2023	23,70,636
11.	Floating population - 2023	2,37,063.62
12.	Total Population - 2023	26,07,700
13.	Per capita waste generated per day for the year 2023	0.460 kg
14.	Per capita wet waste generated per day 2023	0.20 kg

Note: Per capita waste generation by floating Population is assumed as 30% of per capita waste generation by residential population.

As per Gol norms, it is estimated that the per capita waste generated per day is estimated as below:

S.No.	Particulars	Quantity
1.	Per capita waste generated per day	0.55 kg
2.	Per capita wet waste generated per day (i.e.) 55% of total waste generated	0.30 kg

2.4.3 Capacity Determination

The capacity of Bio-CNG plant determined based on the per capita waste generated is as given below:

Particulars	As per GOI norms	As per market survey
Per capita waste generated per day (kg)	0.550	0.509
Projected population for the year 2026	30,05,116	30,05,116

Particulars	As per GOI norms	As per market survey
Total waste generated for the year 2026 (in TPD)	1548	1433
Less: Waste managed by BWG	136	126
Total Waste available for the year 2026 (in TPD)	1412	1307
Per capita wet waste generated per day for the year 2026 (in kg)	0.30	0.20
Total wet waste generated (in TPD)	776	507
Less: Waste not suitable for Biogas production @ 5% (in TPD)	39	25
Less: Waste processed at MCCs (in TPD)	43	43
Less: Waste Processed at VCC (in TPD)	65	65
Less: Waste Processed at Bio-CNG (in TPD)	4	4
Wet waste available for processing (in TPD)	626	370
Capacity of Bio-CNG Plant (@75% of projected quantity)	469	278

Note: 1.3% increase in per capita waste generation as per CPHEEO manual and NEERI study.

Based on the discussions with the promoters of Bio-CNG plants elsewhere, a factor of 0.75 of the projected quantity is considered for determining the installed capacity. Accordingly, by considering the projected waste generation the capacity of the Bio-CNG plant is fixed at 250 TPD.

2.5 Project Scoping

Upon processing of wet waste in MCCs, the remaining wet waste is transferred to dump yard, exacerbating environmental concerns and putting a strain on existing waste management systems.

Recognizing the urgency to address this challenge, the proposed initiative focuses on the implementation of a state-of-the-art Bio-CNG plant. By leveraging advanced technologies and sustainable practices, this facility will be designed to efficiently convert the organic waste generated into renewable energy in the form of Compressed Natural Gas (CNG).

The project involves establishment of Bio-CNG plant of capacity 100 TPD. The project is proposed to be implemented on Design, Finance, Build, Own, Operate and Transfer (DFBOOT) model under Public Private Partnership (PPP) mode.

It is envisaged that the land will be provided by the Municipal Administration and the selected Private Player will be responsible for establishment, operation & maintenance of the facility. The details are provided in the ensuing chapters.

3 Service Standard - Output and Services

The chapter encompasses the following key parameters:

- | | |
|---|---|
| <ul style="list-style-type: none"> • Impact of the proposed project on the needs and the gaps identified • Outputs expected from the proposed Project | <ul style="list-style-type: none"> • Service Standards and specifications • Relevance of the project to Contracting Authority |
|---|---|

3.1 Impact of the proposed project on the needs and gap identified

The presence of MCCs signifies a positive step towards waste management and renewable energy generation. Despite the existing plants, there exists a gap between the wet waste generated and processing capacity of the current facilities and the same is discussed in the Chapter 2.2.

Hence, a bio-CNG plant of processing capacity 250 MT per day is proposed that would significantly address the identified service gaps and achieve the overall objectives of the Project.

By addressing environmental concerns through the conversion of organic waste into renewable natural gas, the plant contributes to mitigating climate change and promoting sustainable waste management practices. Also, the project can stimulate economic development, create job opportunities, and foster local entrepreneurship.

Overall, the bio CNG plant represents a promising solution with multiple benefits, spanning environmental, energy, and socio-economic aspects.

3.2 Outputs expected from the proposed project

Need and identified gap	Output from the proposed project
~ The unprocessed wet waste is dumped along with mixed waste without any segregation at the landfill site at Vellalore resulting in significant GHG emissions/ existing including bulk organic waste	Establishment of Bio-CNG plant with processing capacity of 250 TPD MSW would reduce GHG emissions, which would have resulted from dumping of this waste in landfill.

3.3 Service Standards and specifications of Bio-CNG

Bio-CNG supplied from the proposed facility shall meet IS 16087:2016 standards of BIS as mentioned below:

S.No.	Composition	Biogas	BioCNG
1	Methane	55% - 65%	>90%
2	Carbondioxide	30% - 40%	<4%
3	Hydrogen sulfide	0.1 - 4%	<16 ppm
4	Ammonia Z	0.1%	~0%
5	Nitrogen	3%	<0.5%
6	Oxygen	0.1 - 2%	<0.5%
7	Moisture	1 - 2%	~0%

In addition to the IS 16087:2016 standards, Bio-CNG should also meet the following specifications:

- Bio-CNG should be compressed at 250 Bar and supplied through Cascades
- Bio-CNG shall be free from liquid over the entire range of temperature and pressure encountered in storage and dispensing system
- Bio-CNG shall be free from particulate matter such as dirt, dust, etc
- Bio-CNG delivered shall be odourized similar to a level found in local distribution

3.4 Relevance of the project to long term strategic goals

The Directorate of Municipal Administration is the nodal department responsible for development of urban areas in the state. Various infrastructure developments viz., Underground Sewerage System, Storm Water Drains, Improvement of Roads, Bus stands, Water supply, slum upgradation and Housing for Urban Poor etc., have been taken up by the Department.

The management of municipal solid waste is one of the main functions of the Department. It includes recycling, recovery, composting, incineration and land filling and open dumping. The department is responsible for the establishment, operation and control of waste disposal sites, bulk waste transfer facilities and waste disposal facilities.

The establishment of a bio-CNG plant can have several relevant aspects and benefits for a contracting authority's long-term strategic goals and overall national development plan.

Environmental Sustainability

By utilizing the MSW, a bio-CNG plant helps in reducing greenhouse gas emissions, mitigates climate change, etc. This aligns with national development plans focused on environmental sustainability and climate action.

Waste Management and Circular Economy

Establishing a bio-CNG plant provides an efficient solution for managing MSW that would otherwise end up in landfills or contribute to pollution. By converting these waste materials into bio-CNG, the plant promotes a circular economy approach, where waste is transformed into a valuable resource, thus supporting sustainable waste management practices.

Rural Development and Job Creation

The proposed project can stimulate rural development by creating employment opportunities, particularly in the agriculture and waste management sectors. It supports the contracting authority's goal of fostering economic growth and reducing regional disparities.

Energy Independence and Economic Resilience

By producing bio-CNG domestically, the contracting authority reduces dependence on external energy sources, thereby enhancing energy independence and increasing economic resilience. This aligns with long-term strategic goals of enhancing national self-sufficiency and reducing vulnerability to energy price fluctuations.

Health and Air Quality Improvement

The use of bio-CNG as a clean fuel in transportation contributes to improving air quality and public health. Bio-CNG has lower emissions of pollutants such as particulate matter, nitrous oxides, and sulphur compounds than conventional fossil fuels. This aligns with the contracting authority's goals of promoting sustainable transport solutions and ensuring a healthier environment for its citizens.

4 Market Assessment

4.1 Description of the industry: Oil & Gas sector

India is the third largest energy consumer in the world after China and USA. It is also the fastest growing energy consumer with a share of 5.7% of the total world's primary energy consumption. India's energy requirement is fulfilled primarily by Coal, Crude Oil, Natural Gas and Renewable Energy.

Growing economy and population growth are the main drivers for oil & gas demand increasing every year. Government of India is determined to promote usage of natural gas, as a fuel across the country, and to increase its share in primary energy mix from around 6.7% to 15% by 2030. Amongst commodity exports, share of oil and gas sector alone accounts for 21.4% in 2020-21 out of the country's overall imports standing at ₹29,09,937 crores. India imports up to 85% of its crude and around 50% of its natural gas requirements, with a significant chunk of the demand coming from transportation sector.

In 2021, World Natural Gas Consumption accounted for 4.04 Trillion Cubic metre (TCM) which is 5.5% higher than the 2020 (3.82 TCM). Also, United States is leading in natural gas consumption with share of 21% (868.33 BCM) of total world natural gas consumption followed by Russia (12%) i.e. 498.67 BCM and China (9%) i.e. 362.84 BCM. India stood at 13th position in natural gas consumption during 2021-22 with contribution of 2% total world consumption.

While it reconfigures its energy policies with a conscience to realize the 2070 net-zero goal, India will require adopting multiple pathways in de-carbonising its energy future. Currently, Electric Vehicles (EVs) represent the face of decarbonised transport, but bio-CNG as a fuel is a formidable option less spoken about. Bio-CNG plants can add synergy to the mission through organic waste treatment, generating renewable fuel and bio-manure.

As per Central Pollution Control Board (Annual Report 2020-21), India generates around 58.4 Million Tonnes of MSW per annum.). This translates to 13% of the total waste generated globally and 83% of the waste generated in South Asia. According to the Ministry of Housing and Urban Affairs, only 70% of the waste generated gets treated, whereas the remaining waste generated (i.e., around 84 Million Tonnes per

annum) gets dumped in landfills and unauthorized disposal sites. Also, it was stated that an estimated 1.5 million Tonnes per annum (MTPA) of Bio-CNG to fuel automobile can be produced by treating MSW produced in India.

About Bio-CNG

The purity levels prescribed by statutory bodies for usage of Bio-CNG as a fuel to power combustion engines instead of conventional motor spirit and CNG is listed below:

S No.	Elements	Composition
1.	Methane	>90%
2.	Carbon-dioxide	<4%
3.	Hydrogen sulphide	<16 ppm
4.	Ammonia	~0%
5.	Nitrogen	<0.5%
6.	Oxygen	<0.5%
7.	Moisture	~0%

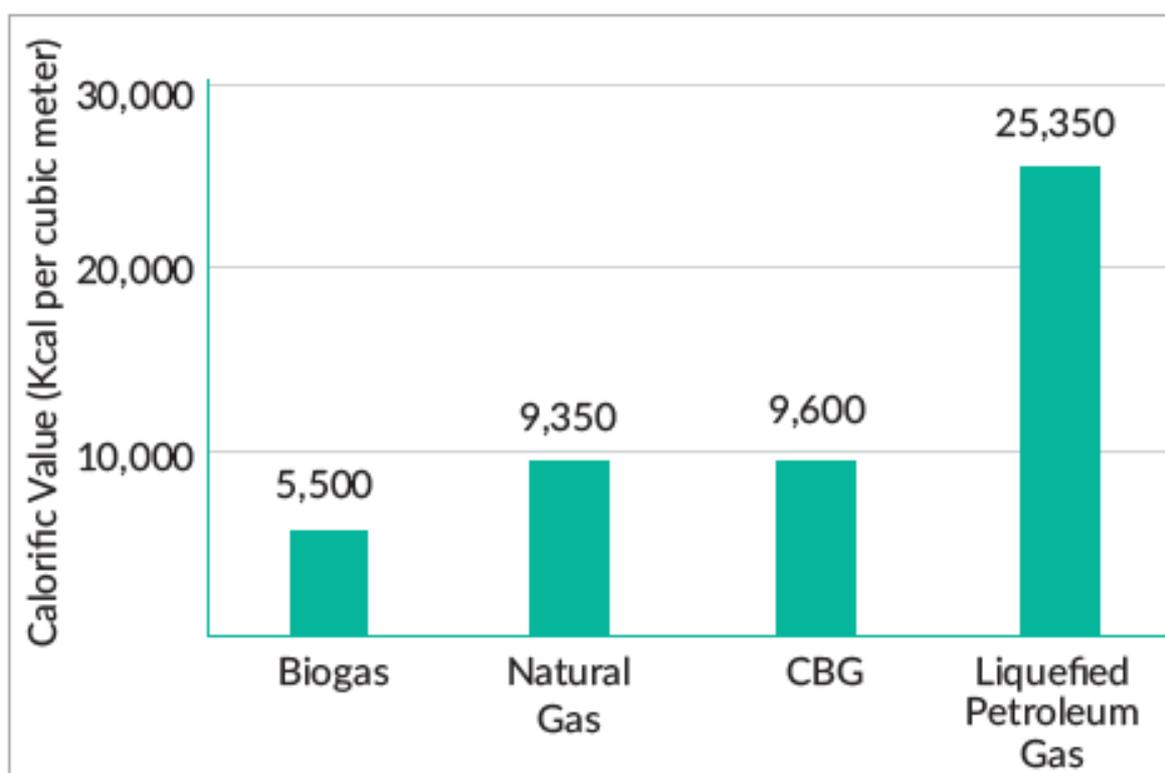
Based on IS 16087:2016 standards

The advantages of Bio-CNG over normal biogas are listed below:

1. **Energy Density:** Bio-CNG has a higher energy density compared to normal biogas, which means it contains more energy per unit volume. This makes Bio-CNG more efficient as a fuel for transportation, as it can provide more mileage per unit of fuel.
2. **Storage and Transportation:** Bio-CNG can be compressed to a higher pressure than normal biogas, which makes it easier to store and transport. Bio-CNG can be stored in high-pressure tanks, which take up less space and can be transported more easily than large, uncompressed biogas storage tanks.
3. **Lower Emissions:** Bio-CNG has lower emissions of greenhouse gases and pollutants compared to normal biogas. This is because Bio-CNG is purified to remove impurities such as carbon dioxide and hydrogen sulphide, which can contribute to greenhouse gas emissions and air pollution. The comparison of emission levels for different fuel types are listed below:

Emissions (g/Km)	Diesel	CNG	Biogas	Bio-CNG
CO	0.2	0.4	0.06	0.02
Hydrocarbons	0.4	0.6	0.35	0.12
NOx	9.73	1.11	5.44	0.48
Suspended particles	0.1	0.22	0.5	0.1

4. Compatibility: Bio-CNG is compatible with the existing natural gas infrastructure, which means it can be used in vehicles that run on natural gas without any modification. This makes Bio-CNG a more practical and cost-effective alternative to traditional fossil fuels.
5. Caloric value: The presence of methane at higher concentration level makes it a suitable alternative to natural gas as a vehicle fuel. The Calorific values of different fuels is shown below:



4.2 Current market analysis

The list of major Bio-CNG producing companies in India along with its details on the type of feedstock, technology and end use market segment are listed below:

1. Green Elephant Pune



Green Elephant is a Pune based firm producing Bio-CNG as well as technology provider. It has built India's largest biogas plant (Satara Plant) in a phased manner during the year 2010 (Phase 1) and 2015 (Phase 2) utilising up to 1,000 Tonnes of organic waste producing up to 28,000 m³ of biogas per day.

The plant is located in Satara is based on CSTR (continuous stirred tank reactor technology) and is promoted by Elephant Equity, Maduas Capital and other European investors and financed by the Indian Renewable Energy Development Agency (IREDA) under the assistance of KfW Bank, Germany.

With its project partners, Green Elephant is planning to expand its activities further and is seeking cooperation partners providing organic waste.

Technology ideated - Green Box

Green Elephant has developed a unique technology and build several pre-fabricated and re-locatable biogas plants for customers in India, Far-East and Europe. Customers using this zero discharge solution are Volkswagen, TATA, Royal Family of Abu Dhabi..

The offered anaerobic digestion plant has a capacity of 0.5 - 3 Tons organic waste per day. Green Elephant offers the following models: GB500, GB1000, GB2000, GB 3000. The models can utilise different volumes and waste streams.

2. Spectrum Renewable Energy Limited (SREL) Pune



SREL, a Haryana based firm is dedicated to the development of innovative biogas projects in rural markets that capture renewable energy from organic waste products, while increasing agricultural profitability and sustainability through environmentally responsible practices.

The company has set up a large scale bio-CNG production plant at Kolhapur with a capacity of 100 TPD using press mud from the Warana sugar factory. The plant uses

CSTR based technology and produces 3,900 kg of bio-CNG per day. The Bio-CNG produced from this facility is being consumed for industrial purposes.

3. Carbon Masters Bangalore



Carbon Masters, a Bangalore based firm is a carbon management company that spun out of the University of Edinburgh, Scotland and has offices in UK, India and Ecuador. The company has installed its own bio-CNG plant of capacity 40 TPD using wet waste such as food waste, cow dung and poultry litter. The bio-CNG produced is supplied to the restaurants. In addition, the company offers complete end-to-end solutions for waste management for bulk waste generators such as hotels, IT parks, commercial kitchens, apartment complexes etc. As part of this solution, the company offers bio-CNG technology - Carbonlites-In-A-Box - a containerized bio-CNG technology solution for IT parks, apartment blocks, temples, colleges and large manufacturing sites which generate food waste in large quantities.

Technology ideated - Carbonlites-In-A-Box

It is a fully functioning biogas plant housed inside refurbished shipping containers. It is completely customizable and can process organic waste streams from 500kgs to 5 tons and produce up to 250kgs of bio-CNG per day. It could also produce 10,000 litres of liquid fertilizer. It does all this in just a one-third of the space occupied by a conventional biogas plant.

4. Primove Engineering Pune



Incorporated in 2008, Primove Engineering Pvt. Ltd. (PEPL) is a nationally recognized EPC Company in the domain of gaseous fuels and energy. Their initiatives in the field of renewable energy have led to the development of novel technologies for the conversion of agro-residue and waste into Bio-CNG for transportation and industrial applications. Primove is a subsidiary of VJ Coresoft Pvt. Ltd.

The company has also set up its own bio-CNG plant at Pune of capacity 100 kg/day using rice straw and Bajra. The bio-CNG produced is sold to customers as automotive

fuel through its own dispensing station. Branded under the name AgroGaz, the bio-CNG is produced by extracting biogas from agricultural, factory, and farm waste products like Bagasse, Rice Straw, Maize Straw, Wheat Straw, and Soyabean Thrash through a patented process. The biogas is further purified to meet the standard IS 16087:2016 and compressed and stored under high pressure in cylinder cascades for use in transportation and industrial applications.

5. Mahindra World city Chennai



Mahindra World City, Chennai has set up a bio-CNG plant at its campus as a joint CSR initiative between Mahindra Research Valley (MRV) and Mahindra World City Developers Limited (MWCDL). It was also named as the India's first food-waste-free-city by creating a carbon-neutral ecosystem.

Salient features of the project:

The plant was developed to power the Mahindra Group's vehicles and meet the electrification needs of the city. The project was built at a cost of \$16.9 billion in January 2016 spread over an area of 1000 m². The plant has a capacity to convert 100% of the ten tons of food and kitchen waste generated daily in the city into 1000 m³ of raw biogas. This raw biogas is enriched to yield 400 kg/day of purified CNG grade fuel which is equivalent to a 200 kW power plant. As a by-product, four tons of organic fertilizer is produced each day.

Utilization:

Automobile such as free shuttle services for buses and tractors involved in the waste collection process are powered by the Bio-CNG produced at the plant. These vehicles cumulatively cover an average distance of 5,400 Km per month. The green energy (Bio-CNG) is effectively used to replace LPG for cooking purposes, as well as to power streetlights at Mahindra World City, Chennai. The organic fertilizer is used by farmers to enhance soil fertility.

6. Bharat Biogas Energy Limited Gujarat



The company is a Gujarat based firm involved in the production of bio-CNG and other organic products for agronomic applications. The company has set up a Bio-CNG

plant using 153 TPD urban and 38 TPD industrial wastes to produce 6,538 kg/day of Bio-CNG. The Bio-CNG produced in the plant is supplied to Amul Dairy Company. The revision of CNG price used in transportation sector is listed in the table below:

Historical price hike of CNG	Price (₹ per Kg)
October 5, 2022	₹86
August 3, 2022	₹86
July 13, 2022	₹80
April 30, 2022	₹76
April 12, 2022	₹72
April 5, 2022	₹67
January 8, 2022	₹66
December 17, 2021	₹63.50
November 27, 2021	₹61.50
October 7, 2021	₹57.54
July 13, 2021	₹51.98
February 8, 2021	₹49.40

Breakup of CNG Price reduction	Price (₹ per Kg)
August 17, 2022 (by ₹6/Kg)	₹80
April 1, 2022 (by ₹6/Kg)	₹60

4.3 Competition

There are several potential competitors to Bio-CNG, which are both renewable and environmentally friendly alternatives and are as discussed hereunder:

1. **Electric Vehicles (EVs):** Electric vehicles powered by batteries or hydrogen fuel cells are gaining popularity as a clean transportation option. EVs offer zero **tailpipe** emissions and can be charged using renewable energy sources. As EV charging infrastructure continues to expand, they pose a significant competition to Bio-CNG in the transportation sector.
2. **Hydrogen Fuel:** Hydrogen fuel is another alternative to Bio-CNG. It can be produced through various methods, such as electrolysis of water using renewable energy or by reforming natural gas with carbon capture and storage. Hydrogen fuel can power fuel cell vehicles, which produce only water vapour as a

byproduct. As hydrogen infrastructure develops, it could potentially compete with Bio-CNG.

3. **Bioethanol and Biodiesel:** Bioethanol and biodiesel are biofuels derived from renewable sources such as corn, sugarcane, or soybeans. These fuels can be used in vehicles with minor modifications or blended with conventional gasoline or diesel. While they are not directly competing with Bio-CNG, they serve as alternatives for transportation fuel and could affect its market share.
4. **Synthetic Fuels:** Synthetic fuels, also known as e-fuels or power-to-liquids (PtL), are produced by converting renewable electricity into synthetic hydrocarbon fuels. These fuels can be used in existing combustion engines without significant modifications. While synthetic fuels are still in the early stages of development and face cost and scalability challenges, they have the potential to compete with Bio-CNG in the long term.

Other non-renewable sources of alternatives to Bio-CNG are listed below:

- LPG
- Gasoline (Petrol)
- Diesel

The comparison of Bio-CNG vs other non-renewable sources of alternatives is detailed hereunder:

1. Source and Environmental Impact:

- **Bio-CNG:** Bio-CNG is produced from organic waste materials through processes like anaerobic digestion. It is considered a renewable and low-carbon fuel as it utilizes waste streams and reduces greenhouse gas emissions.
- **LPG:** LPG is primarily derived from fossil fuel sources, such as natural gas or petroleum. While it burns cleaner than diesel and petrol, it is not considered a renewable fuel.
- **Diesel and Petrol:** Diesel and petrol are derived from crude oil, a non-renewable fossil fuel. They contribute to greenhouse gas emissions and air pollution.

2. Emissions and Air Quality:

- **Bio-CNG:** Bio-CNG has lower emissions of greenhouse gases, particulate matter, and Sulphur dioxide compared to diesel and petrol. It offers better air quality benefits and helps reduce pollution.
- **LPG:** LPG also produces lower emissions of pollutants compared to diesel and petrol, including lower levels of particulate matter and nitrogen oxide. However, its emissions are higher than those of Bio-CNG.
- **Diesel and Petrol:** Diesel and petrol engines emit higher levels of greenhouse gases, particulate matter, nitrogen oxide, and other pollutants, contributing to air pollution and climate change.

3. Energy Content and Efficiency:

- **Bio-CNG:** Bio-CNG has a lower energy content compared to diesel and petrol. It means that vehicles running on Bio-CNG may have slightly reduced power and fuel efficiency compared to diesel and petrol vehicles.
- **LPG:** LPG has higher energy content per unit volume compared to Bio-CNG but slightly lower compared to diesel and petrol.
- **Diesel and Petrol:** Diesel and petrol have higher energy content per unit volume, resulting in better fuel efficiency and longer driving range compared to both Bio-CNG and LPG.

4. Infrastructure and Vehicle Compatibility:

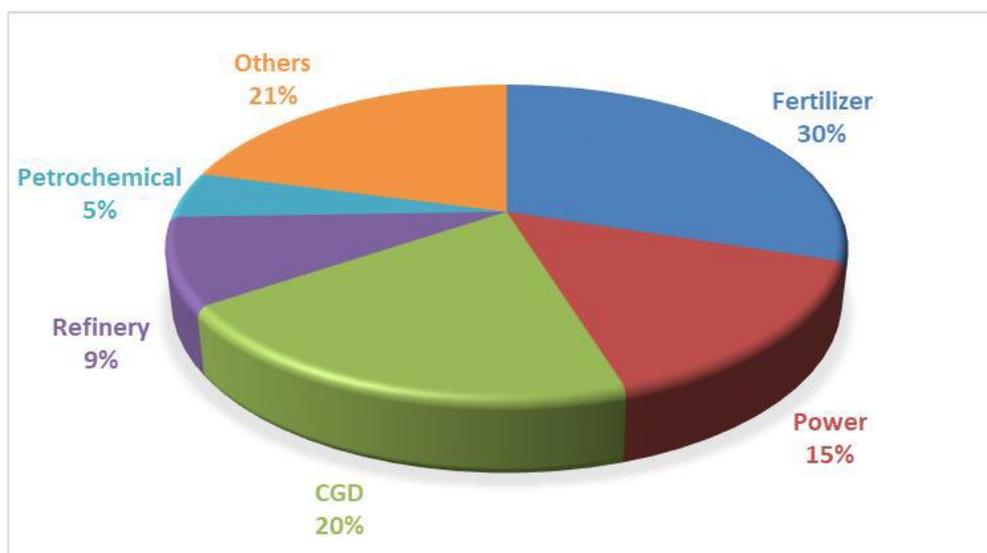
- **Bio-CNG:** Bio-CNG requires specific infrastructure for biogas production, purification, and compression. However, it can be used in vehicles designed for CNG with minor modifications.
- **LPG:** LPG has an established distribution network and infrastructure for storage, transportation, and refuelling. LPG-compatible vehicles are widely available.
- **Diesel and Petrol:** Diesel and petrol have well-established infrastructure and are compatible with conventional internal combustion engines found in most vehicles.

5. Availability and Market:

- **Bio-CNG:** Bio-CNG availability may vary depending on the local production of organic waste and the development of biogas facilities. It is primarily used in the transportation sector, particularly in public transportation and waste management.
- **LPG:** LPG is widely available and commonly used in residential, commercial, and industrial sectors for heating, cooking, and as an automotive fuel.
- **Diesel and Petrol:** Diesel and petrol are the most commonly used transportation fuels globally and have widespread availability.

4.4 Anticipated future market potential

As per the Industry POL & NG Consumption Report by PPAC, the sector wise consumption of natural gas for the period of Apr 2021 - Feb 2022 was Fertilizer (30%), Power (15%), City Gas Distribution - CGD (20%), refinery (9%), Petrochemicals (5%) and others (21%).



Globally, India comprises a sizable chunk of the CNG market and the demand for natural gas has increased substantially over the past decade. Maharashtra, Gujarat, Uttar Pradesh, Haryana, and Delhi accounts for nearly 85 percent of the CNG passenger car vehicle (PV) offered in India. In the recent times, it was noted that Tier-II cities are also showing a rising inclination towards CNG-powered vehicles, primarily due to the reduced total cost of ownership they offer. The rising absorption

of CNG is expected to follow due to the proliferation of CNG pipeline network planned by the Government of India.

The comparison trend in segment-wise sale of automobiles during FY2021-22 and FY2022-23 is given below:

Vehicle segment	FY 2021-22	FY 2022-23
Passenger vehicle	30,69,523	38,90,114
Commercial vehicle	7,16,566	9,62,468
Three-wheeler	2,61,385	4,88,768

Source: SIAM

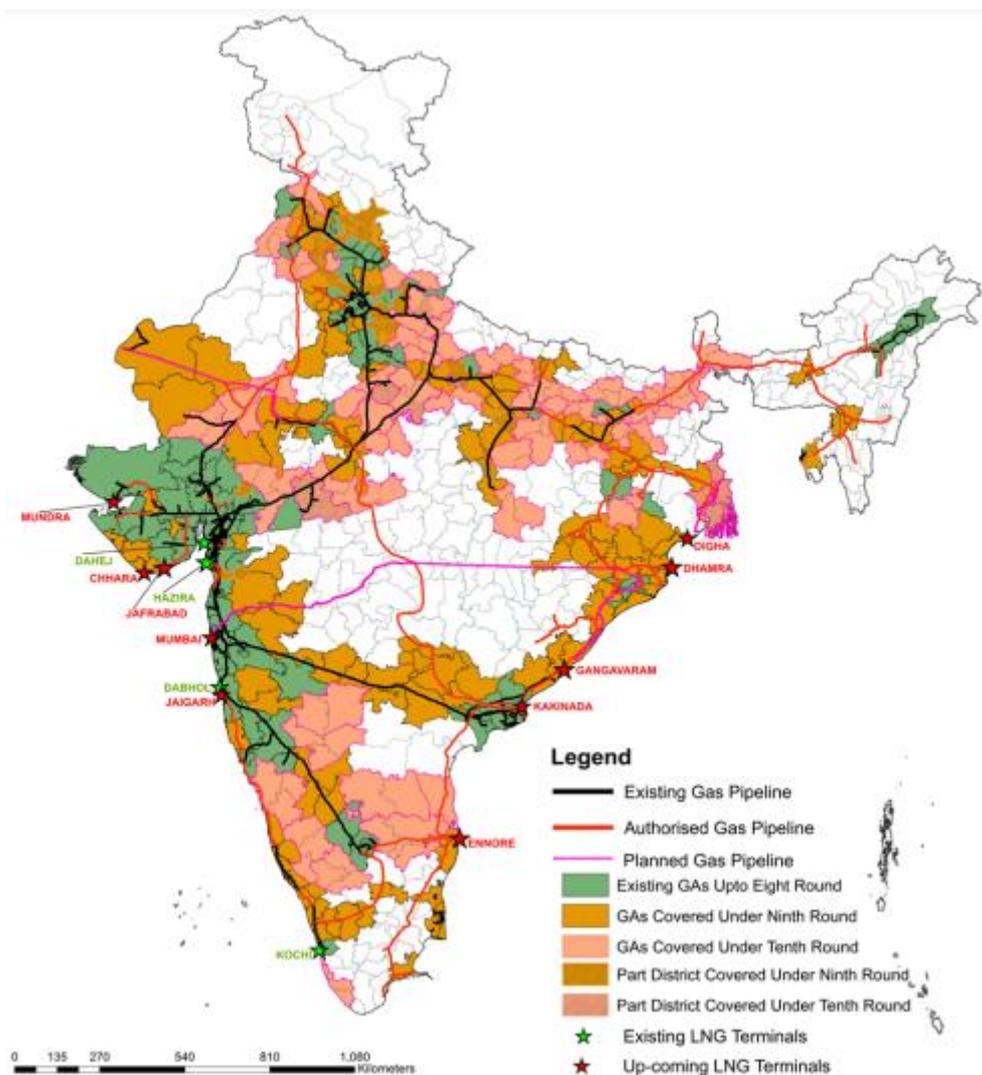
Further, there has been a significant increase in sales of CNG vehicles in India. The fuel-wise sales percentage is as follows:

Transition towards CNGs/EVs	FY 2020-21				FY 2021-22			
	EVs	CNG	Conventional	Total	EVs	CNG	Conventional	Total
Passenger cars (in %)	0.03	7.79	92.19	100	0.36	12.09	87.55	100
Utility vehicles (in %)	0.52	1.56	97.92	100	1.11	4.12	94.77	100
Vans (in %)	0.00	17.86	82.14	100	0.00	23.47	76.53	100

Source: SIAM

City Gas Distribution (CGD) network

Under the Petroleum and Natural Gas Regulatory Board (PNGRB) Act 2006, PNGRB controls and grants the authorization to OMCs to supply and distribute petroleum products including Compressed Natural Gas in India. The business is done through PSU's or Public Sector Undertakings along with the private sector in the Public Private Partnership (PPP) model. Companies like GAIL (India) Ltd, Brahmaputra Crackers Polymer Limited, Indraprastha Gas Limited also known as Mahanagar Gas Limited, Bharat Petroleum, Indian Oil and other City Gas Distribution Entities forms part of the Distribution and business chain all over India. Private entities such as Adani Gas and Torrent Gas are also gaining a significant presence in the sector. The Gas infrastructure map of India is represented below:



The list of Geographical area (GA) covered in Tamil Nadu for establishment of CGD under 9th CGD bidding round is given below:

S. No	Geographical Area (GA)	Authorised entity	Existing infrastructure		
			CNG stations	PNG connections	Steel Pipe (inch-Km)
1.	Karaikal & Nagapattinam	Torrent Gas Private Limited	27	1,66,644	495
2.	Kanchipuram	Consortium of AG&P LNG Marketing PTE limited & Atlantic Gulf and Pacific	111	11,51,111	668
3.	Chennai & Tiruvallur	Torrent Gas Private Limited	222	33,00,000	6,666

S. No	Geographical Area (GA)	Authorised entity	Existing infrastructure		
			CNG stations	PNG connections	Steel Pipe (inch-Km)
4.	Coimbatore	IOCL	273	9,12,783	2,500
5.	Cuddalore, Nagapattinam & Thiruvarur	Adani Gas Limited	40	3,00,089	839
6.	Ramanathapuram	AGP CGD India Private Limited	11	41,311	251
7.	Salem	IOCL	158	3,37,062	1,368
8.	Tiruppur	Adani Gas Limited	75	3,75,005	829

Source: Petroleum and Natural Gas Regulatory Board

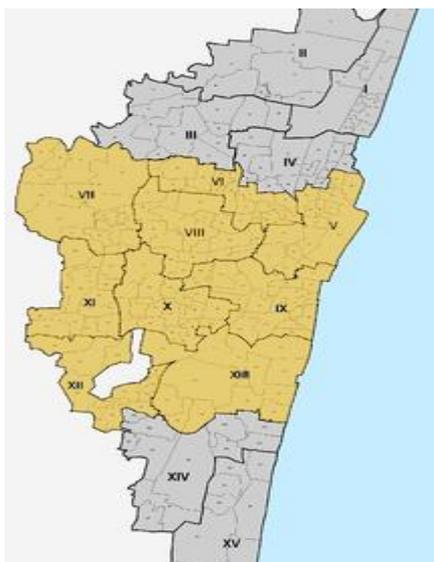
4.5 Similar Bio-CNG Plants

4.5.1 Chetpet Bio-CNG Facility

The site visit of SWMS Bio-CNG plant was conducted on 20th April, 2023 by officials from ITCOT and DMA. The plant is located at Gengu Reddy Road, Chetpet, Chennai spread across an area of 3 acres. The plant was established under PPP model wherein, M/s. Srinivas Waste Management Services Private Limited (SWMS) is a “**Private Partner**” and Greater Chennai Corporation (GCC) being a “**Public Partner**”.

The plant commenced its operation during September, 2021 and currently, the total manpower employed for conducting regular operations is 60 pax. The total processing capacity of the plant is 100-120 MT per day by collecting municipal solid waste (MSW) (i.e., food waste) from Zone V -XIII of the Chennai district.

The colour coded zonal map showing the waste collection zones is given below:



Zone V	- Royapuram
Zone VI	- Thiru-vi-ka Nagar
Zone VII	- Ambattur
Zone VIII	- Anna Nagar
Zone IX	- Teynampet
Zone X	- Kodambakkam
Zone XI	- Valasarawakkam
Zone XII	- Alandur
Zone XIII	- Adayar

The list of important components in the plant is listed below:

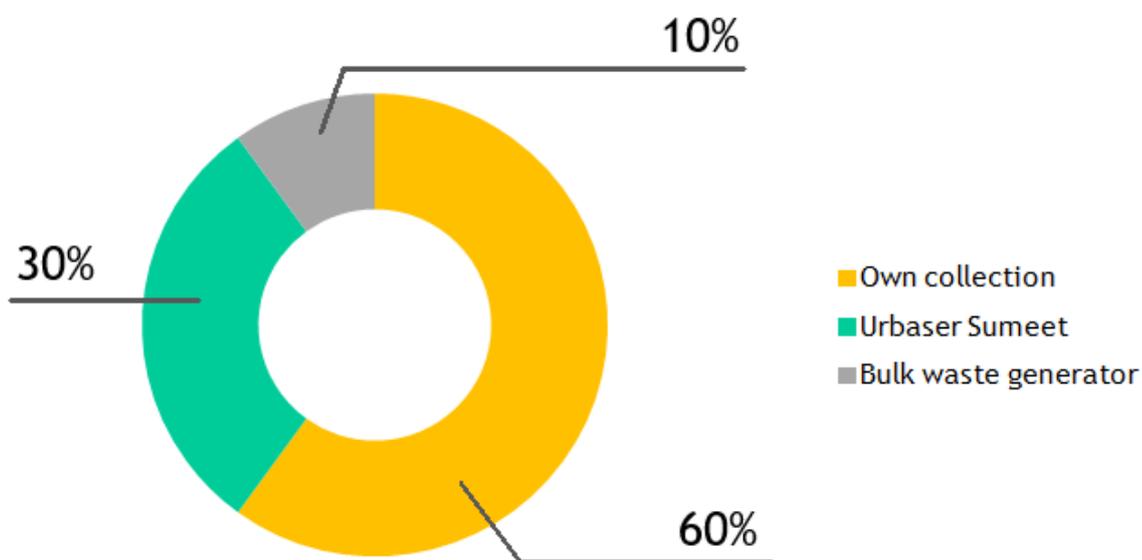
- Hopper - 1 No.
- Grinder - 1 No.
- Digester - 2 Nos.
- 5-stage Compressor - 1 No.
- Storage Balloon - 1 No.
- Agitator - 8 Nos
- H₂S separator - 1 No.

S No.	Name of the component	Quantity (In Nos.)	Specification	Capacity
1.	Hopper	1	-	-
2.	Grinder	1	-	7MT/hr
3.	Digester	2	RCC structure Height - 9m Diameter - 20 m	600 m ³
4.	5-stage compressor	1	250 bar	300 m ³
5.	Storage Balloon	1	Material: PVC coated Fabric Thickness: 1300 GSM	500 m ³
6.	Agitator	8	-	-
7.	H ₂ S separator	1	-	2000 ppm/hr

Observation

1. Supply chain management cycle

Based on the discussion with the SWMS it is inferred that the SWMS manages its feedstock supply by three modes viz. Own vehicles, Urbaser Sumeet and through Bulk waste generator (BWG). The composition of feedstock supply from all three modes on a day-to-day basis is represented in a chart given below:



2. Pattern of waste collection

In order to provide continuous supply of feedstock and maintain the operation of the plant, SWMS has formulated and prescribed a specific timeline for deposit of waste by Urbaser Sumeet and BWG through seamless communication. It was also communicated by SWMS; during unprecedented circumstances the waste collected by *Urbaser Sumeet* will be stored at their strategic store points up to 24 hrs in order to enable uninterrupted flow of feedstock supply. The waste collection pattern is explained in the table below:

Own collection



Municipal waste from local households

Food waste generated by hotels in the nearby location

Urbaser Sumeet



24 hrs supply by holding it in the nearby strategic store points

Bulk waste generator (BWG)



Accumulated deposit of waste

3. Mode of collecting the waste

The feedstock consumed by the plant is supplied by three modes viz. Battery operated vehicle (BOV), Small Commercial Vehicle and Compactor. The different modes by which SWMS procure feedstock for its plant is given below:

Battery operated vehicles (BOV)



Capacity
300 Kg

No. of trips per day
150

Tata Ace



Capacity
1.8 to 2 Tonnes

No. of trips per day
10 Trips

Compactor



Capacity
8 to 9 Tonnes

No. of trips per day
7 Trips

4. Composition of waste consumed for processing

Based on the discussions with the SWMS it was inferred that the majority of the waste deposited in the plant consists of food waste followed by organic waste. Cow dung is procured from nearby cattle farmers in order to act as a catalyst in digestion of feedstock.



5. Business model

The plant has a capacity to produce about 8 Tonnes of Bio-CNG per day. The Bio-CNG produced is being sold commercially as a cooking gas for hotels and also as green fuel for vehicles. The model of selling and cost per Kg of Bio-CNG sold is given below:

To commercial hotels:

The Bio-CNG is stored in cascades having 4 cylinder connected in series with a cumulative storage capacity of 25 Kgs and the cost of Bio-CNG sold per Kg to commercial hotels is ₹80-85.

To vehicle CNG fuel dispensing station:

The cascades are series connected and mounted on to vehicle for ease of transportation. The Bio-CNG is sold to private gas suppliers at a cost of ₹65/Kg.

4.5.2 Madhavaram Bio-CNG plant

Technical details

Capacity: 140 MT

Number of Digesters: 2

Membrane type used on top of Digester: Double membrane

Capacity of each Digester: 70 Lakh Litres

Dimension of each Digester: Diameter - 30 meters; Height - 9.5 meters

Membrane holding capacity: 3,500 to 4,000 M3 of Raw Biogas for each membrane

Number of Agitators in Each Digester: 5

Number of Scum breakers in Each Digester: 2

Estimated Life Span of Digester and Membrane: 15 - 20 years

Marketing and distribution of Bio-gas



Mode of delivery	Cascade
Cascade capacity	475 - 500 Kg
No. of cascades	2 units
Number of Cylinders in each Cascade	40
Capacity per cylinder	12.5 kg
Time taken for biogas to be compressed at 250 bars to one cascade	3.5 hrs

Compressed biogas is proposed to be supplied directly through Gas Pipelines to Torrent Gas Pvt Ltd at a later stage. GAIL shall buy Bio CNG at a slightly higher price and supply it to torrent at a lower price. Supply from Mahashakthi to Torrent is yet to start.

Bio Manure

At present the liquid fertilizer is being recycled into the Digester. An estimated yield of 15 to 20 TPD of solid bio-fertiliser is envisaged from digester processing 120-140 TPD of MSW.

4.6 Market Player for Organic Manure

UTPANN fertilizer is a renowned brand in the agricultural industry that specializes in manufacturing and supplying high-quality fertilizers from organic waste products while increasing agricultural profitability and to sustain ability through environmentally responsible practices.

UTPANN fertilizer offers a wide range of fertilizers tailored to meet the specific nutritional requirements of different crops. They produce both organic and inorganic fertilizers, including nitrogenous, phosphatic, and potassic fertilizers.

UTPANN is committed to environmental sustainability and offers eco-friendly fertilizer options. They emphasize the use of organic and bio-based fertilizers, which minimize the negative impact on soil health, water resources, and biodiversity.

4.7 Demand for Bio-CNG

The procurement price of the Bio-CNG appears to be cost competitive with comparable fuel in the market. The table shown below presents the comparison of

calorific value, fuel cost and cost of energy comparison of various fossil based liquid and gaseous fuels with Bio-CNG.

S. No.	Fuel	Calorific value	Fuel cost	Cost of energy
1.	Bio-CNG	47.0 MJ/Kg	₹75/Kg	₹1.6/MJ
2.	Compressed Natural Gas (CNG)	47.1 MJ/Kg	₹83/Kg	₹1.8/MJ
3.	LPG - Domestic (Subsidied by Govt.)	46.6 MJ/Kg	₹78/Kg	₹1.7/MJ
4.	LPG - Commercial (No subsidy)	46.6 MJ/Kg	₹170/Kg	₹3.65/MJ
5.	Diesel	36.9 MJ/litre	₹90/litre	₹2.4/MJ
6.	Gasoline/Petrol	33.7 MJ/litre	₹102/litre	₹3.0/MJ

Bio-CNG has the potential to reduce net carbon emissions, replace CNG and LPG in domestic, commercial and industrial applications. This in turn will save foreign exchange reserves due to less dependence on import of petroleum products.

Oil Marketing Companies are the agencies deputized by Government of India to procure Bio-CNG. Bio-CNG will be compressed on site and transported in gas cascades to gas stations designated by Oil Marketing Companies. Each gas cascade has a capacity of 250 kg of Bio-CNG. For gas stations within 75 km of the site, all transportation costs has to be borne by the plant operators. For stations beyond 75 km, additional costs will be paid by Oil Marketing Companies. Bio-CNG supplied to gas stations will be sold as vehicle fuel, as an alternative to fossil fuel-derived CNG. Also, the plant operators have the choice of selling Bio-CNG to city gas distribution pipeline networks which will supply natural gas to residential areas, industrial facilities and commercial entities such as restaurants. These networks are expected to be established in the coming years in all the regions where the proposed project site is located. This would require new infrastructure for interconnection of digesters with pipeline gas networks.

Further, the Gol has mandated that 10% of all pipeline gas carried by city gas distribution networks be sourced from Bio-CNG. This creates a table market for plant operators who require high value, long-term agreements with end users for their facilities to remain economically viable.

Therefore, growth in Bio-CNG has the potential to meet national targets, global commitments, energy security and environmental sustainability.

Nearby CNG Filling Station



Nearby CNG filling stations around the site

The above map shows that the proximity to 20 CNG filling stations in the vicinity of the site identified for establishment of Bio-CNG plant. Hence, there exists tremendous potential for a biogas plant in this area. The abundance of CNG infrastructure creates a strong foundation for the successful implementation and operation of a biogas facility, making it a promising investment opportunity.

5 Support Scheme/Incentives for Bio-CNG Plant

5.1 Schemes/Programmes to promote Bio-CNG

The Ministry of New and Renewable Energy (MNRE) in India has launched several biogas schemes at both the central and state levels to promote the use of bio-CNG as a clean alternative to fossil fuels. Some of the major bio-CNG schemes are:

5.1.1 Bio-Gas Programme

Introduction

India is endowed with abundant renewable energy resources and their use should be encouraged in every possible way. Rural India generates enormous quantities of bio-waste including animal waste, kitchen leftovers, crop residue, market waste and faecal sludge. Biogas is an environment friendly fuel and its utilization contributes to reduction of carbon emissions and pollution.

Over a period of time, MNRE has fine-tuned the Biogas programme and rationalized the subsidy scheme, strengthened the institutional framework at State and district level, supported new & innovative biogas plant models, supported women empowerment through usage of biogas plants & organic farming and created employment opportunities.

Objectives

The objectives of the Biogas Programme are as follows:

- i) Setting up of biogas plants for clean cooking fuel, lighting, meeting thermal and small power needs of users which results in GHG reduction, improved sanitation, women empowerment, and creation of rural employment.
- ii) Organic enriched Bio-manure: The digested slurry from biogas plants, a rich source of manure, shall benefit farmers in supplementing/reducing of use of chemical fertilizers.

The following two implementation models under the Biogas Programme shall be eligible for Central Finance Assistance (CFA)/Incentive.

- i) Implementation through State Programme Implementing Agency (PIA)s: The biogas programme will be implemented by the designated PIA of the State/ Union Territory / Khadi Village and Industry Commission (KVIC), Mumbai, National Dairy Development Board (NDDB) Anand/Biogas Development and Training Centres (BDTC).
- ii) Implementation through Financial Institutions: Financing Organizations/ Institutions/Banks/Indian Renewable Energy Development Agency (IREDA), National Bank for Agriculture and Rural Development (NABARD)/ Reserve Bank of India (RBI) approved Financial Institutions may also implement the Biogas Programme in consultation with PIAs.

Proposal submission under biogas programme

For Medium Size Biogas Plants (above 25 m³ to 2500 m³): The proposals for such projects shall be submitted by the PIAs to MNRE round the year through MNRE Biogas web-portal.

Project completion and commissioning

For medium size biogas plants (above 25 m³ to 2500 m³) the commissioning of projects in all respects should be completed within 12 months from the date of Sanction of project and in any case not more than 24 months from the date of the issue of MNRE's Administrative Sanction/in-principle approval of the project.

Further, Bank loans under Priority Sector Lending (PSL) Loans to entrepreneurs for setting up Compressed Biogas (CBG) plants have been included under PSL (2020) as per master directions issued by RBI on September 04, 2020

5.1.2 Waste to Energy Programme

Objective

The objective of the programme is to support the setting up of Waste to Energy projects for generation of Biogas/ Bio-CNG/ Power/ producer of syngas from urban, industrial and agricultural wastes/residues.

The programme provides Central Financial Assistance (CFA) to project developers and service charges to implementing/inspection agencies in respect of successful commissioning of Waste to Energy plants for generation of Biogas, Bio-CNG/enriched Biogas/Compressed Biogas, Power/ generation of producer or syngas.

Funding Pattern

Standard CFA pattern: Standard pattern of CFA for grant of ‘In-principal Approval’ to Waste to Energy projects under the programme is as follows:

Type of project	Standard CFA rate @ installed capacity of the plant
Bio-CNG/Enriched Biogas / Compressed Biogas	-₹4.0 Cr per 4,800 kg/day (for Bio-CNG generation from new biogas plant) -Maximum CFA of ₹10.0 Cr/project.

5.1.3 Sustainable Alternative Towards Affordable Transportation (SATAT) scheme

SATAT scheme on Compressed Biogas (CBG) was launched on 1.10.2018. The SATAT initiative has potential to boost availability of more affordable transport fuels, better use of agricultural residue, cattle dung and municipal solid waste, as well as provide additional revenue source to farmers. It will also benefit vehicle-users as well as farmers and entrepreneurs.

Objectives

- The eventual objective is to make 5000 CBG facilities by 2025. These units will produce about 15 million tons of compressed biogas annually.
- Reducing reliance on fuel imports.
- Increases the nation’s growth in job rate.
- Lowering hazardous pollutants from burning agricultural waste and vehicle emissions.

SATAT Implementation:

- The principal means of implementing the plan is through proposals to construct compressed biogas facilities. The CBG created at these facilities will be shipped in cylinders to gas stations around the nation.

- To increase the Return on Investment (ROI), business owners might market the additional by-products produced by these plants separately, such as carbon dioxide and bio-manure.

The SATAT scheme details of operation are provided below:

- Independent business owners will construct Compressed Biogas facilities under SATAT.
- Firms will be allowed to transport the compressed biogas produced at their facilities to the networks of fuel stations owned by oil marketing corporations using cylinders. This gasoline will be used to replace renewable fuel.
- There is already a network of 1500 CNG stations that support about 32 lakh gas-powered automobiles.
- Additionally, business owners will promote and sell additional plant by-products, including carbon dioxide and bio-manure. As a result, they can increase their return on investment.

An Expression of Interest (EOI) to procure CBG by Indian Oil was released under the SATAT scheme on 1st October 2018. As per the EOI, the price offered for CBG by Oil & gas companies is as follows:

S No	Lower Retail Selling Price of CBG in Slab (inclusive of tax) in Rs/kg	Higher Retail Selling Price of CBG in Slab (inclusive of tax) in Rs/kg	Procurement Price of CBG (without GST) in Rs/kg	Procurement Price of CBG (with GST) in Rs/kg
1	Retail Selling Price of CBG up to Rs 70		54.00	56.70
2	70.01	75	55.25	58.01
3	75.01	80	59.06	62.01
4	80.01	85	62.86	66.01
5	85.01	90	66.67	70.01
6	90.01	95	70.48	74.01
7	95.01	100	74.29	78.01

Note: The above table is applicable strictly for supply of CBG at a one-way distance of 75 km from the CBG Plant. For distance beyond 75 km, the price will be defined as per the notification on CBG Procurement Price Revision.

Facilitation by Oil & Marketing companies (OMCs) through LOI

- ✚ Oil & gas companies shall facilitate Plant owners in design, erecting, construction, commissioning of the CBG Plants.
- ✚ It will off-take and market the CBG produced.
- ✚ It will also facilitate marketing of Bio-manure produced from the CBG Plants. For facilitating the same, Indian Oil has entered into MoU with National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED).
- ✚ Oil & gas companies are entering into MoU with State Governments for facilitating CBG plants. Indian Oil has entered into MoU with Government of Punjab and Government of Haryana for facilitating setting up of CBG Plants. Execution of similar MoU share also being explored with State Governments of Chhattisgarh, Uttar Pradesh and Andhra Pradesh.
- ✚ Policy guideline has been issued for synchronization of CBG produced by plants under SATAT scheme in the City Gas Distribution (CGD network) are as follows:
 - The scheme of co-mingling of Compressed Biogas (CBG) generated progressively under the SATAT scheme meeting the technical standards with the natural gas in CGD network will be operationalized.
 - GAIL will finalize operational modalities for supply of CBG co-mingled with domestic gas at uniform base price across all CGD entities for CNG (T) and PNG (D) segment of CGD network.
 - The scheme envisages the share of co-mingled CBG in the total domestic gas supplied to CNG (T) and PNG (D) segment of CGD sector reach up to 10%.
 - The scheme will be reviewed after a period of three years or as and when the percentage of CBG in the overall mix of CNG(T)/PNG(D) in the CGD sector reaches 10% whichever is earlier.

The following guidelines for operationalisation of supply of Biogas under CBG-CGD synchronisation are as below:

- GAIL to pay total composite sale price of CBG-to-CBG producer inclusive of compression charges and charge the Biogas compression charge to the CGD entity along with the Biogas price, at the Weighted Average Price (WAP) for the pooled quantity of Biogas/CBG and APM/NAPM gas Biogas/CBG and APM/NAPM gases.

- Revision of the Basic Price of Biogas with methane content of ~96%, to be paid to Biogas/CBG producers, upward from Rs. 730/MMBTU to Rs. 770/MMBTU.
- A Pipeline Compression Charge of Rs. 2/Kg may be paid to the Biogas producer for injecting in the MDPE/Steel pipeline of CGD entity and for transporting the same in cascades for injecting into CGD pipeline through decompression units.
- Biogas/CBG quantities, received directly and physically by the CGD entity from nearby CBG producers under CBG-CGD synchronization scheme, would be over and above its APM/NAPM domestic allocation quantity and would not attract any natural gas pipeline transmission charges. However, such Biogas/CBG quantities would only be for use in CNG (T) & PNG (D) segments and would be reported by CGD entity to PPAC on a periodic basis as per the applicable formats and MOP&NG guidelines.

5.2 Schemes/Loan/Subsidy to promote Biomass

a) *IREDA Financing Scheme - "Manufacturing of Biomass Pellets / Briquettes/Torrefied Pellets/ Refuse Derived Fuels (RDF)"*

The scheme aims to provide financial assistance for the establishment of Biomass Pellets / Briquette / RDF manufacturing facilities to promote the economic processing of agricultural crop residues/MSW and support sustainable environmental practices.

Projects Eligible for Assistance:

All commercially viable Biomass pellets / Torrefied Pellets / Briquette / RDF manufacturing plants are eligible for the scheme.

Minimum Loan:

The minimum loan amount eligible from IREDA is Rs. 50 Lakh.

Promoter Contribution and Quantum of Loan:

The loan amount from IREDA is linked to the project cost. The percentage of loan amount based on the project cost is as follows:

- Up to 70% of the project cost for projects up to Rs.5 Crore

- Up to 60% of the project cost for projects more than Rs. 5 Crore and up to Rs. 10 Crore
- Up to 50% of the project cost for projects more than Rs. 10 Crore

The minimum promoter contribution required is 30% of the project cost.

Interest Rate:

The applicable interest rate varies based on the project grade, as per IREDA Credit Risk Rating system (CRRS) applicable to Biomass Power projects. The interest rates are revised periodically through IREDA's internal process.

Repayment Period & Moratorium:

The maximum repayment period is 6 years, based on the project cash flows and Debt Service Coverage Ratio (DSCR). The moratorium period is up to 12 months from the Commercial Operation Date (COD) of the project.

Securities:

- The borrower is required to provide securities, including an exclusive charge or Pari-passu charge in case of co-financing, through equitable mortgage and hypothecation of movable assets.
- Pledge of shares (minimum 51%) of the applicant company is also required.
- Additional securities such as mortgage of collateral security, corporate and/or personal guarantees, 3rd party guarantee, deposit of Post-Dated Cheques (PDCs), Demand Promissory Note, BG/FDR (Bank Guarantee/Fixed Deposit Receipt) for not less than 10% of the loan may be requested.

b) Organic fertilizer standards as per FCO, 1985, amended in July 2021

Organic fertilisers and biofertilizers are regulated by the Fertiliser (Inorganic, Organic or Mixed) (Control) Order (FCO), 1985, under the Union Ministry of Agriculture and Farmers' Welfare

- Clause 7 and 8 of the FCO 1985 allows State Governments, by notification in the Official Gazette, to exempt from the requirement of registration or grant of authorization letter for any person selling fertiliser to farmers in such areas and subject to such conditions as may be specified in that notification. Dealers/retailers marketing Organic fertiliser in small packaging, not

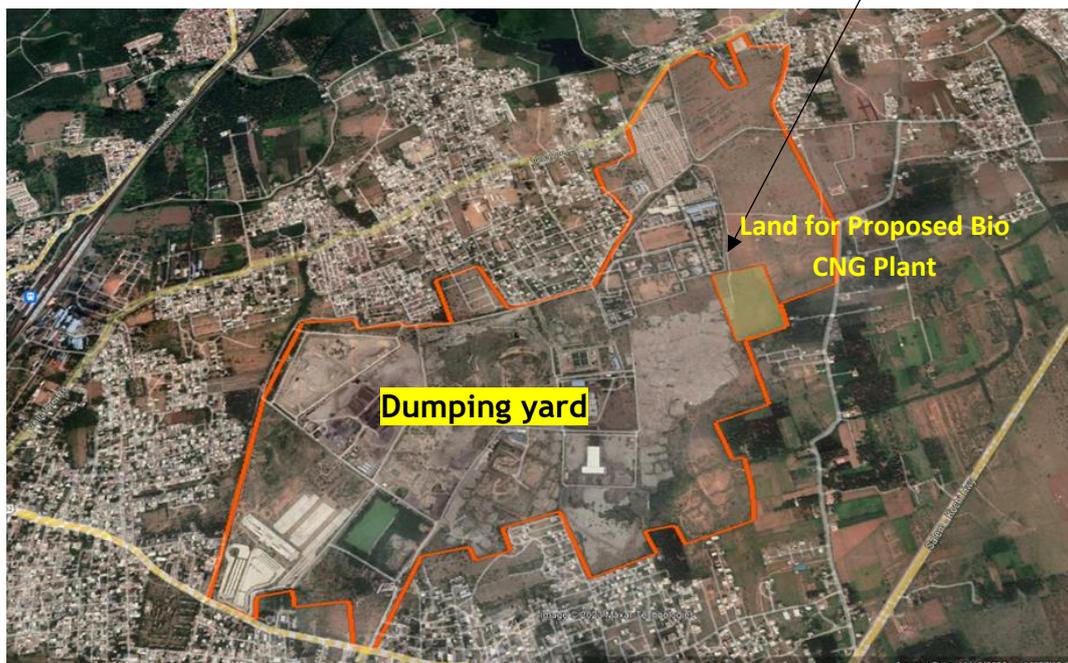
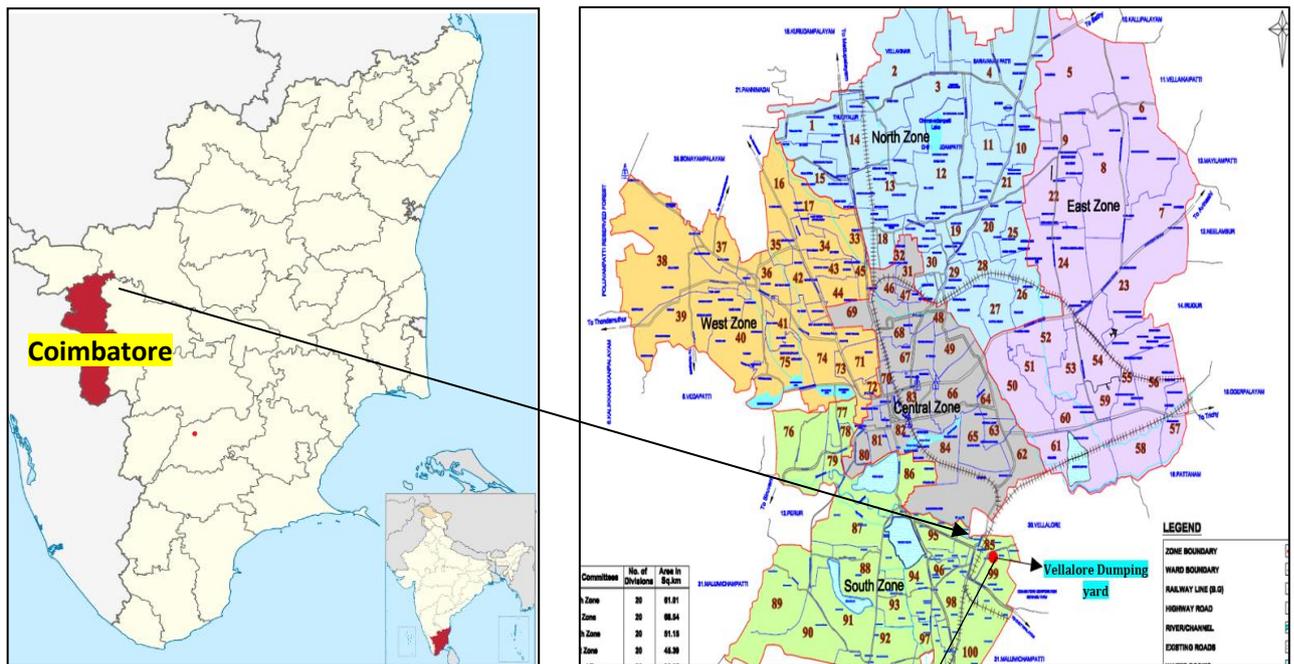
weighing more than 5 kg (net) and dealers/retailers having stock of Organic Fertiliser up to 50 ton at a given time be exempted from obtaining a certificate of registration or authorization letter under Fertiliser Control Order (FCO) 1985 by State Government

- Incentive/ Policy Intervention to encourage production and consumption of organic fertilisers as under:
 - Mandatory 10-20% off-take of bio-fertiliser/organic manure/fertiliser by fertiliser companies. Example: mandatory off-take of 2 bags of bio-fertiliser or one bag of enriched Organic-fertiliser (Phosphate Rich Organic Manure (PROM) etc.) with one bag of urea.

6 Technical Feasibility

6.1 Location

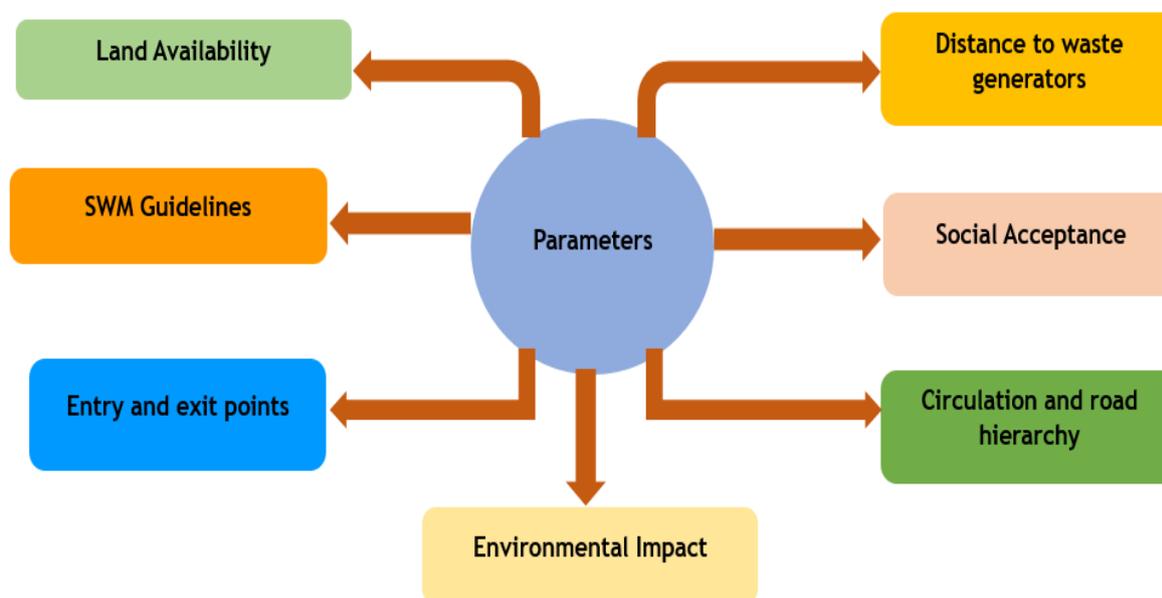
The project site is located at Vellalore dump yard, Vellalore town, Coimbatore South Taluk, Coimbatore District as shown below:



Location of proposed Bio-CNG plant

6.2 Site plan

The following key parameters are considered in selection of the land for the proposed Bio-CNG plant:



6.3 Land

At present, an extent of 654.54 acres of land at Vellalore Village, Madukarai Taluk, Coimbatore District has been used for solid waste disposal.

Of the total area, it is proposed to earmark about 10 acres of land at SF No. 580, 581 Pt, 588 Pt, 589 Pt, 590 Pt, 591 Pt, 595 Pt for establishment of Bio-CNG plant.





Visuals of land earmarked for Bio-CNG plant

Bio-mining process has been completed at the identified site and the proposed land could be utilised for establishment of Bio-CNG plant.

The Geotechnical study also suggests that the site is well suited for the proposed project and recommends the following:

- The engineering properties of soil and SPT N values are to be considered for foundation recommendation. The safe bearing capacity based on settlement criterion governs the design.
- For the above conditions, open foundation in the form of Isolated / Combined footing is recommended for the proposed structure. The recommendation is given below:

Location	Depth, m	Foundation stratum	Safe Bearing capacity (SBC)
BH 01	2.5 m	Poorly Graded Gravel (GP)	280 kN/m ² or 28 t/m ²
BH 02	2.5 m	Poorly Graded Gravel (GP)	
BH 03	2.5 m	Poorly Graded Gravel (GP)	
BH 04	2.5 m	Poorly Graded Gravel (GP)	
BH 05	2.5 m	Poorly Graded Gravel (GP)	

- If prescribed foundation depth is not able to reach during the time of excavation and the hard strata found before 2.5 m, then the foundation may be rested on the hard strata at that particular level itself.

The detailed Geotechnical study report is enclosed as Annexure - I.

6.4 Site topography

The site is located 411 metre above the Mean Sea Level. The land earmarked for Bio-CNG plant is currently vacant and is found to be plain without any undulations and hence, site levelling is not required.

6.5 Road connectivity

The dump yard is abutting State Highway (SH) - 162. CCMC has already developed a 7 m wide internal road within the site and about 450 meters of new pathway has to be developed for accessing the location. The same is as depicted in the map below:



Road connectivity to the site

For the proposed capacity of the plant, approximately 130 trips per day with combination of Heavy Commercial vehicle (HCV), Light Commercial Vehicle (LCV) and Tata Ace Vehicles for transportation of waste is required. The existing road could handle the movement of vehicles without any traffic hindrance.

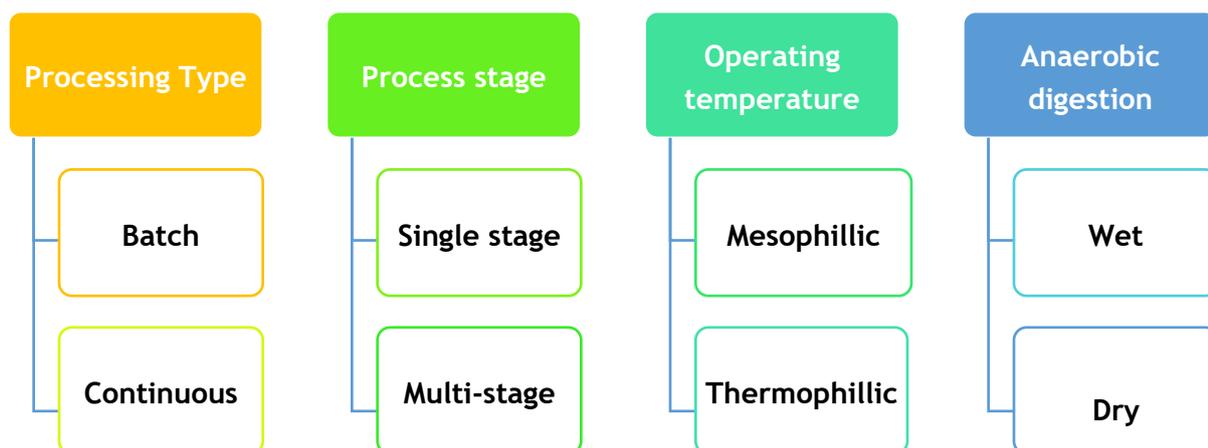
6.6 Installed capacity

As discussed in the section 2.4.3, it is proposed to install a 250 TPD capacity Bio-CNG plant. Considering 365 working days per annum, the installed capacity at 100% capacity utilization is 91,250 MT per year.

6.7 Technology

Biomethanation is the natural process of Anaerobic digestion which breaks down organic matter in the absence of oxygen to release biogas, leaving an organic residue called digestate. Biogas is a mixture of methane, carbon dioxide and water and can be used to produce electricity and heat or used as a natural gas substitute. It will help to reduce the use of fossil fuels and thus reduce CO₂ emission. The organic waste must be of high quality and source segregated with a low degree of impurities in order for the Biomethanation technology to work appropriately. Digestate is a nutrient rich by-product of Anaerobic digestion and can be used as a fertilizer and soil improver. The following key parameters are to be considered in designing a Bio-CNG plant:

- Type of Process
- No. of stages in the process
- Operating Temperature and
- Type of Anaerobic digestion



a. Processing Type:

Batch digesters, also known as discontinuous digesters, operate in a batch mode, where the feedstock is added in discrete batches, i.e., the charging of the biogas

plant occurs at intervals of 50-60 days. Once the plant is charged, it takes approximately 8-10 days to begin supplying gas, and this supply continues for around 40-50 days until the digestion process is complete.

Whereas in continuous digesters, they operate in a continuous mode, with a constant feed of waste material. The digestion process occurs in a continuous manner without the need for intermittent loading and emptying.

In conclusion, for biogas production, continuous digestion is better suited over batch digestion for its consistent gas production, eliminates the need for manual loading and unloading of waste at regular intervals, and are generally better suited for larger-scale operations and operational convenience.

b. Process Stage:

In a single-stage biogas plant, the entire anaerobic digestion process occurs in a single reactor or tank. The organic waste, such as animal manure, agricultural residues, or food waste, is mixed and added to the digester, where it undergoes anaerobic digestion to produce biogas. Single-stage bio gas plants are relatively simple in design and operation. They are commonly used in small to medium-scale applications, such as on-farm digesters or community-level biogas plants. However, they may have limitations in terms of efficiency and process control, especially for challenging waste materials or when a high purity of biogas is required.

In a multi-stage bio gas plant, the anaerobic digestion process is divided into multiple stages or reactors, each optimized for specific purposes. The waste material undergoes sequential digestion, usually with different environmental conditions or microbial populations in each stage such as:

- **Pre-treatment:** In the first stage, the organic waste is typically subjected to pre-treatment processes, such as size reduction, solid-liquid separation, or pH adjustment. This step prepares the feedstock for efficient digestion in subsequent stages.
- **Primary Digestion:** The pre-treated waste enters the primary digester, where the initial phase of anaerobic digestion occurs. This stage typically focuses on breaking down complex organic compounds and converting them into simpler substances.
- **Secondary Digestion:** The partially digested material from the primary digester is then transferred to a secondary digester, often referred to as a

methane digester. This stage allows for further breakdown of the organic matter, primarily focusing on methane production.

- Tertiary Digestion (Optional): In some cases, a tertiary digester may be incorporated for additional treatment or to optimize specific digestion parameters. This stage can help maximize biogas production or enhance the removal of certain pollutants.
- Biogas Collection: Similar to single-stage plants, the biogas generated during the multi-stage digestion process is collected and stored for energy utilization.

Multi-stage biogas plants offer several advantages over single-stage systems. They allow far better control of digestion parameters, improved biogas yield, and increased process stability. They are suitable for large-scale applications, such as centralized biogas plants, where diverse waste streams are processed or when specific treatment requirements need to be met.

Hence, for biogas production, multi-stage digestion is favoured over single-stage digestion due to its improved process control, higher biogas yield, and enhanced digestion efficiency.

c. Operating Temperature

Anaerobic digesters typically operate in one of two distinct temperature ranges.

1. Mesophilic : 35 - 40.5 degrees C
2. Thermophilic: 60 - 62.5 degrees C

Thermophilic digestion is a process used in anaerobic digestion systems where microorganisms break down organic waste materials at higher temperatures, typically ranging from 60°C to 62.5°C, compared to mesophilic digestion, which operates at temperatures around 35°C to 40.5°C.

Thermophilic digestion generally results in faster rates of microbial growth and waste degradation compared to mesophilic digestion. The higher temperatures provide an environment that favours the growth and activity of specific heat-loving microorganisms, such as thermophilic bacteria and archaea. These organisms have faster metabolic rates, allowing for more rapid decomposition of organic matter and increased biogas production.

Another benefit of thermophilic digestion is the potential for increased pathogen reduction. The higher temperatures in the process help in killing or inhibiting the growth of certain pathogenic microorganisms present in the waste, reducing the risk of disease transmission.

However, there are some challenges associated with thermophilic digestion. One significant challenge is the production of an odourous digestate. The higher temperatures can lead to the generation of unpleasant odours during the digestion process, which may require additional measures to control and mitigate.

Furthermore, thermophilic digestion typically requires more heat energy compared to mesophilic digestion. The elevated temperatures demand additional energy for heating the system and maintaining the desired operating conditions. This increased energy requirement can have cost implications and may impact the overall efficiency of the digestion process.

Thermophilic digesters have a greater pathogen reducing effect (elimination of more pathogens) than mesophilic digesters. However, as much as 95-98% of common pathogens are eliminated in mesophilic (~ 38 degrees C) digesters, which means that the digestate is virtually free of pathogens. This might be enough especially when the trade-off (higher energy requirement) is considered.

The microbial species used in the thermophilic range are more prone to instability by small temperature fluctuations compared to those used in the mesophilic range, risking digester upsets. Hence, mesophilic range is preferred over thermophilic range.

d. Anaerobic digestion

Wet Digestion

Wet anaerobic digestion systems are a class of digesters designed to treat wet organic waste i.e. organic waste with moisture content greater than 85% (or) total solids concentration (TS) lesser than 15%. Most anaerobic digesters are built based on wet-type anaerobic digestion, wherein biomass (usually organic food waste or animal dung) and water are mixed in equal amounts to form a slurry in which the content of total solids (TS) is about 10-15%. Digester technologies within this class are relatively more mature and widespread compared to dry digestion technologies.

Dry digestion

Dry anaerobic digestion systems, also known as high solids anaerobic digestion systems, solid-state digesters or “dry fermentation” systems, are a class of digesters designed to treat relatively drier organic waste. These waste streams are typically “stackable” and generally have total solids concentration (TS) greater than 25%. Also, these waste streams are difficult to pump and mix, two mechanisms that play

an important role in most wet digestion systems. Dry digestion involves stacking the waste in a container that can be sealed to collect the biogas being produced.

Some waste streams that can be treated by dry anaerobic digestion systems are drier animal manures, food scraps, yard debris, crop residues and the organic fraction of municipal solid wastes. Dry digestion technologies are newer and therefore relatively unproven compared to the wet digestion technologies, which have widespread adoption.

Considering the characteristics of the solid waste generated in the catchment areas, it could be concluded that wet digestion technology is better suited than dry digestion technologies in treating these waste streams.

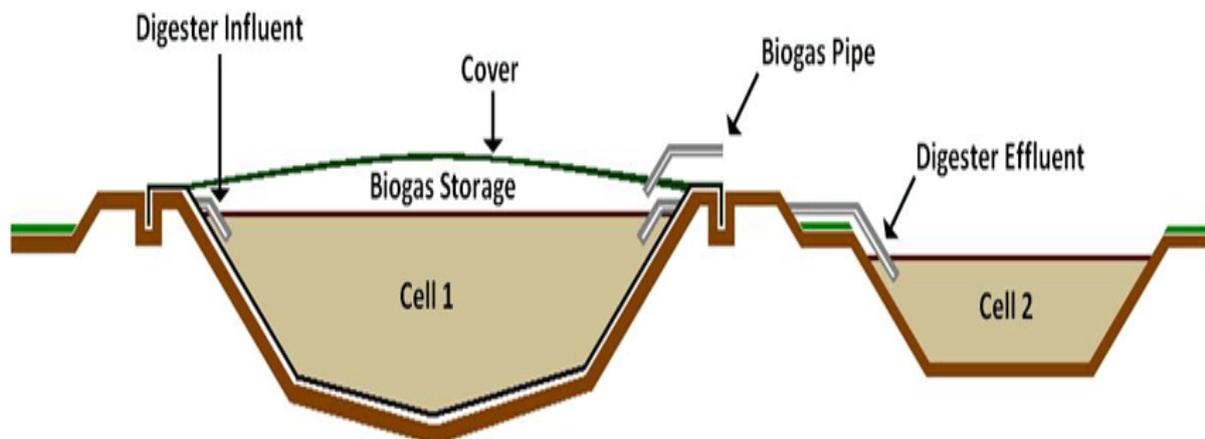
Based on the above, it is considered that Bio-methanation with continuous multi-stage, mesophilic, wet anaerobic digester system is the most suitable technology. However, it shall be up to the Private Player to choose the technology most suited for processing the waste handed over by the ULB.

6.7.1 Wet Digester Technologies

The wet digester, also known as wet anaerobic digestion or Wet AD, are a group of technologies used for the treatment of organic waste and the production of biogas. Some common types of wet digestion technologies are as below:

a) Covered anaerobic lagoon digester

Covered anaerobic lagoons are huge ponds which are covered with impermeable covers, made of woven geotextile fabrics, creating an anaerobic environment. The waste is stored in these ponds and left to degrade. The biogas that is generated is captured under the lagoon cover and then piped to the combustion device.



Source: AgSTAR Project Development Handbook

They are utilized when the waste feedstock has total solids concentration (TS) of less than three to five percent. This feedstock is mostly in liquid form.

Generally, large lagoon volumes are required, preferably with depths greater than 12 feet. The hydraulic retention time (HRT) is at least 60 days. The organic loading rate (OLR) is an important design parameter for covered anaerobic lagoons.

This system is fairly simple, passive and low maintenance, unlike the other wet digester technologies which are more complex. There is no mixing of the digester contents. It generally doesn't require added heating (of its feedstock). The temperature of the covered lagoon depends on the ambient temperature, which follows seasonal patterns. A covered lagoon located in the tropics will produce gas year-round, but the rate of anaerobic degradation is quite low, especially compared to other wet digester technologies.

Biogas production drops when lagoon temperatures dip below 20 degrees C. While the temperature of lagoons built in Tamil Nadu are unlikely to dip below 20 degrees C, during the colder months, less anaerobic degradation will occur and in turn, less biogas is produced. Thus, biogas production is inefficient compared to other wet digester technologies, which have relatively more controlled environments. Also, it is very costly to heat covered lagoons for optimal biogas production.

Solids accumulate in the lagoon bottom and require removal on an infrequent basis depending on the amount of inert material in the waste and the temperature.

It is the most inexpensive technology for anaerobic digestion but it is quite inefficient. These systems are typically used in large farms practicing animal husbandry, where there is enough space to build these huge ponds and for whom it

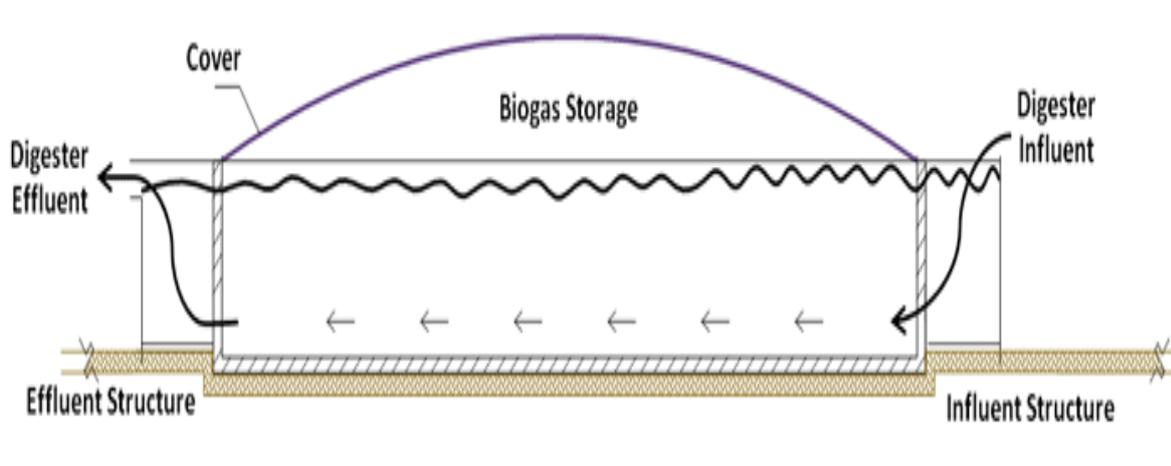
is an inexpensive way to dispose of the animal manure generated in the farm in order to control odour and reduce water pollution. They are also used by waste water treatment plants to pretreat raw water.

Considering the low rate of waste degradation, the inefficiency in biogas production, and the large land area requirements (which is a prohibitive demand in urban areas), we find that this technology is not feasible for the proposed project despite its low cost.

b) Plug flow digester

A plug flow digester consists of a long, narrow, covered trough/tank, made of reinforced concrete, steel or fiberglass, filled with waste. As waste feedstock is added at one end of the digester, the digester's contents moves through the digester, as a plug, in a unidirectional manner. This results in the displacement of an equal amount of digestate at the other end. The biogas generated is collected under an expandable gas-tight cover, made of geo-membrane material. The captured gas is then drawn off and fed to the combustion device.

Generally, plug flow digesters have roughly 1:5 ratio of width or height to length dimensions. Some plug flow digesters are U-shaped, while allows for easier capacity addition to process additional waste. This means that both the input and output ends are located on the same side. Capacity addition is achieved by expanding the looped end of a U-shaped digester.



Source: AgSTAR Project Development Handbook

They are utilized when the waste feedstock has TS of 10-15 %. At these concentrations, the waste feedstock is of semi-solid nature.

The solids in the waste need to be in suspension for the process to be stable, as plug flow style digesters are prone to the buildup of solids at the bottom. This also means that low TS feedstock content (<12%) is not suited for these digesters, as they are not thick enough to keep solids from settling at the bottom. These digesters are also prone to crusting of solids at the top.

Some solids do accumulate, which eventually needs to be cleaned out, as settling reduces the effective volume of the digester. This will necessitate some downtime. Also, the cost of cleaning accumulated solids can be considerable.

Plug flow digesters normally do not include mixing of digester contents. However, plug flow digesters can include modifications such as horizontal or vertical mixing. Such digesters are known as modified / mixed plug flow digesters. Mixing reduces formation of crusts at the top and settling of solids at the bottom. They improve the rate of waste degradation, and in turn the rate of biogas production.

Plug-flow digesters are typically heated. It can be installed both above and below ground (buried). Installing them below ground helps with heat insulation, especially in colder climates. These digesters can operate in both mesophilic (35 - 40.5 degrees C) and thermophilic (60 - 62.5 degrees C) temperature ranges. Since they are heated using external heat/power sources, they can operate in all climatic conditions and are not subject to seasonal weather fluctuations. These digesters are not suited for digesting feedstock consisting of waste from diverse sources.

HRT of a plug flow digester is around 20 - 25 days. The solids retention time (SRT) is the same as HRT for a plug flow digester. Maintaining a consistent OLR for a plug flow digester translates to maintaining a constant SRT and HRT.

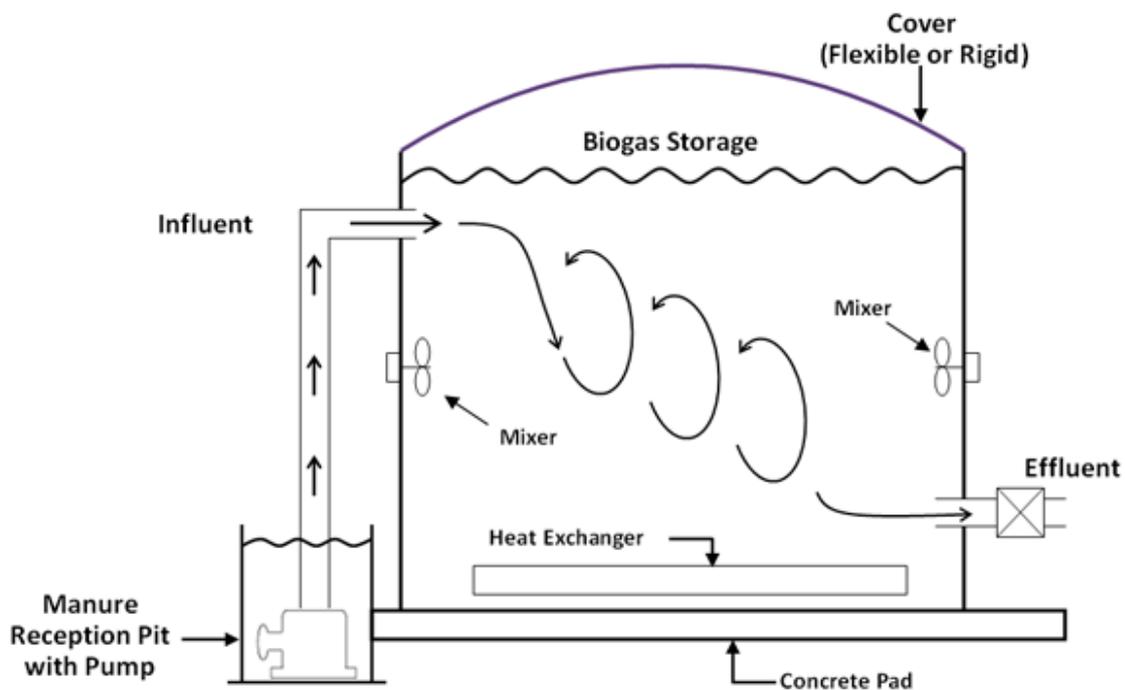
Plug flow digesters are more expensive to build and operate, compared to covered lagoons. But they still have lower capital and maintenance requirements than completely mixed digesters.

c) Completely mixed digester

Completely mixed digesters, also known as continuously stirred tank reactors (CSTR), are generally cylindrical containers made of fiberglass, steel, or reinforced concrete and may be built above ground or partially below ground (buried). The waste is fed to the tank where anaerobic degradation takes place. As waste feedstock is added to the digester, an equal amount of digested waste gets displaced out of the tank. The gas is collected under an impermeable cover at the top of the

tank, which is then piped to the combustion device. The cover can be either flexible or rigid (fixed). Flexible covers are more expensive than rigid covers.

They can be constructed with a height much greater than the diameter or with a diameter greater than the height. Most digesters in Europe have tanks with heights much greater than the diameter which enhances mixing while eliminating much of the stratification (crusting and settling of solids).



Source: AgSTAR Project Development Handbook

These systems are utilized to treat waste feedstocks having TS of 3-10%. Completely mixed digesters include continuous mixing of its contents, mechanically or hydraulically or both. This reduces crusting and settling of solids. In addition to the effective volume reduction of the digester due to settling, crusting can keep the biogas from escaping the surface of the slurry in the digester, hindering collection.

Thus, it improves the rate of waste degradation and hence the rate of biogas production. The mixing is achieved with the help of mixers and agitators (mechanically) or pumps (hydraulically). Most digesters for treating municipal solid waste are intensely mixed. The intense mixing is required to keep sand and silt in suspension, but there is evidence that intense mixing may inhibit the microbial population that is responsible for anaerobic degradation.

These digesters can operate in both the mesophilic (35 - 40.5 degrees C) and thermophilic (60 - 62.5 degrees C) temperature ranges. Since they are heated using

external heat/power sources, they can operate in all climatic conditions and are not subject to seasonal weather fluctuations.

Completely mixed digesters are better suited for co-digestion of feedstocks of various sources of waste, compared to plug flow digesters, because of its flexibility to digest various consistencies of manure and food waste.

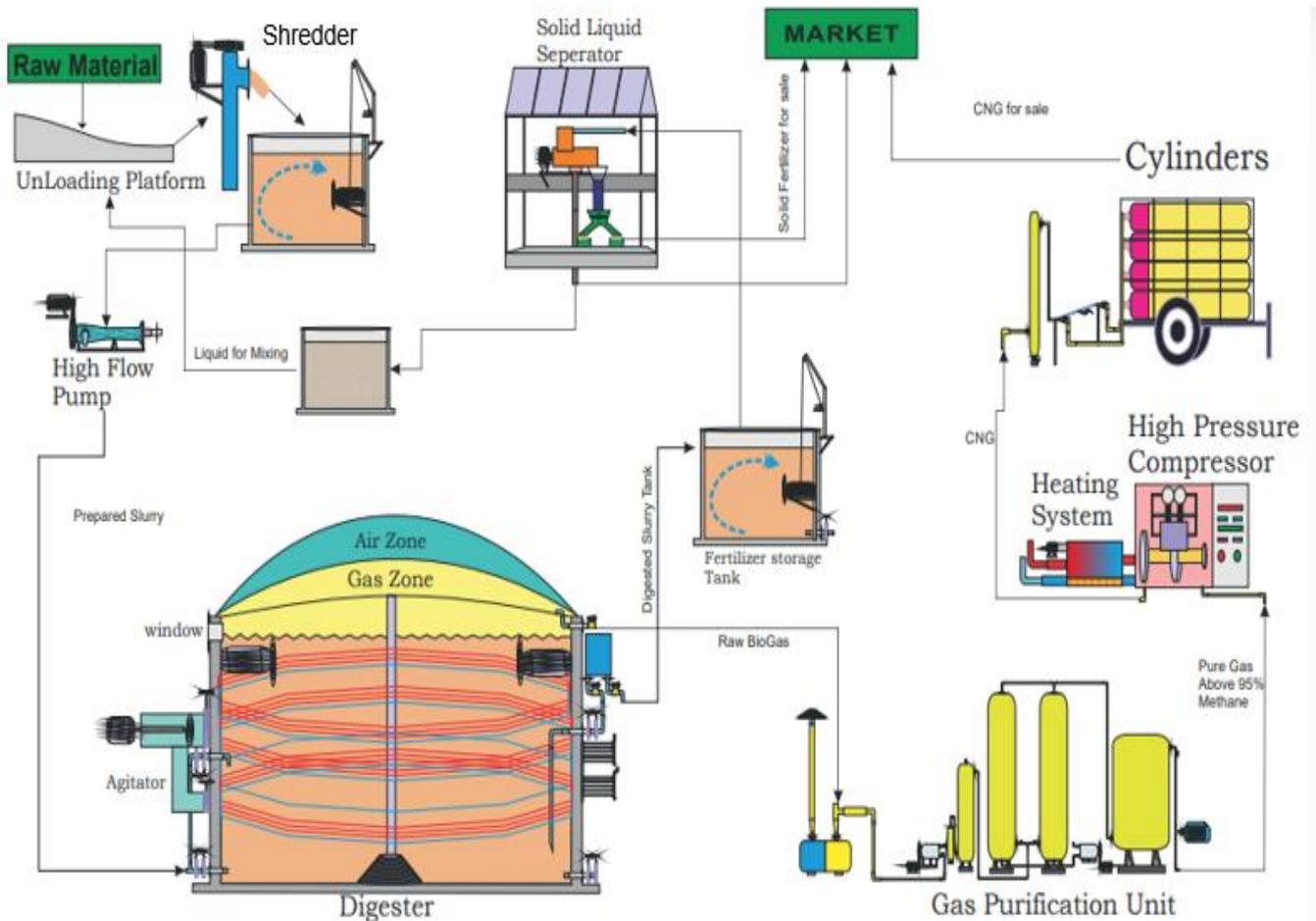
HRT of a completely mixed digester is around 15 - 25 days. As in plug flow digesters, the SRT is the same as HRT. Maintaining a consistent OLR for a completely mixed digester translates to maintaining a constant SRT and HRT.

While completely mixed digesters are proven to achieve higher rates of conversion of waste to biogas (as compared to plug flow digesters), they are more expensive to install. The operational costs are also higher, because mixers requires significant amount of energy to work.

Considering the higher rates of waste degradation and biogas production, the small land area requirements (which is an important factor in urban areas), the ability to treat waste feedstocks of varying solid concentrations from diverse sources (as long as TS concentration of the combined feedstock is 3-10%), we find that completely mixed digesters are best suited for the proposed project.

6.8 Process

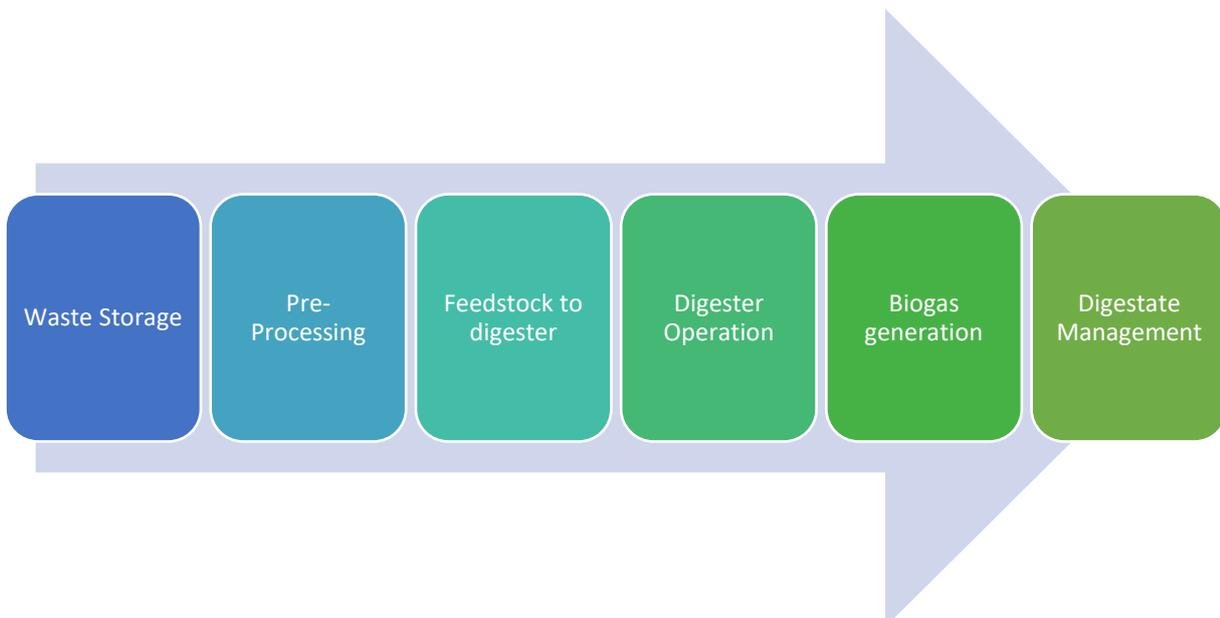
The process flow of the plant is depicted hereunder:



Biomethanation process flow

Process description

The overall process is divided into six stages and the same is described as under:



6.8.1. Storage of waste

The collected waste loading / unloading station be located indoors to protect the waste feedstock from contamination from outside elements. Organic waste attracts pests like flies, birds and rodents. Therefore, locating this facility indoors can enable easier pest control and reduce contamination. Also, an indoor facility enables usage of an odour control system, which will prevent the odour emanating from the waste feedstock from escaping and causing a nuisance to nearby communities.

To provide consistent loading and a uniform feeding rate, most anaerobic digester facilities accumulate waste feedstock in a short-term storage tank. This can act as a buffer against fluctuations in delivery of waste feedstock to the digester facility and help ensure flow equalization by allowing for a continuous, consistent input of feedstock. The amount of waste accumulated in short term storage is dependent on the capacity of the digester.

6.8.2. Pre-processing of waste feedstock

The type of feedstock used, the conveyance system, and the type of digester used dictate the amount and type of pre-processing. Typically, pre-processing includes

- Depackaging of food wastes
- Reduction in feedstock particle size
- Removal of grit and sand
- Homogenization of feedstock

The waste feedstock for the digesters are mixture of wastes from diverse sources, the different waste streams should ideally be in constant proportions and mixed, before being fed to the digester. Mixing helps maintain uniformity in the feedstock's physical and chemical characteristics, increasing stability of the microbial population and reducing fluctuations in biogas production. Mixing can be achieved through the use of mixers.

Maceration is the reduction of solids in waste feedstock into smaller pieces. This technique makes it easy to pump and mix the feedstock into the digester. Also, it improves feedstock-to-microbe contact and helps achieve greater degradation of waste and increased biogas yield from a given amount of waste. Maceration can be achieved through the use of a chopper pump.

The final mixed feedstock is temporarily stored before fed to the digester. Storage prior to digestion equilibrates and homogenizes the material and evens out fluctuations in the amount and other characteristics of the feedstock. Feedstock homogenization sometimes involves the use of a hydrolyser.

Preheating of waste feedstock before being introduced into the digester can improve the actual digestion process.

6.8.3. Feeding feedstock to Digester

The feedstock is fed to the digester in equal amounts at regular intervals to maintain a consistent organic loading rate (OLR). This is critical in maintaining a consistent and stable microbial ecosystem.

Any significant increase in the OLR due to new waste source is incorporated into the feedstock, must be gradual to allow for an increase in microbial populations.

Maintaining a consistent OLR translates to maintaining a constant solids retention time (SRT) and hydraulic retention time (HRT), which in turn will ensure consistent and maximum biogas production.

Inconsistent loading of feedstock might be caused due to factors such as:

- lack of storage space
- varying delivery times
- types of substrates and their varying rates of biodegradability.

These would result in disruption to the stability of the microbial communities and cause high fluctuations in biogas production. In extreme cases, it results in death of methanogens. Unbalanced microbiological conditions can result in upset or stuck digesters, which must be emptied and restarted.

There are two modes of feedstock addition employed by digesters

- Continuous flow : In this mode, waste is added constantly over a 24- hour period i.e., there is a constant flow of waste into the digester.
- Semi-continuous flow digesters : In this mode, equal quantities of waste is added to the digester at equal time intervals, one or more times per day. This mode is more common among current digesters.

A pump is the equipment primarily responsible for moving waste feedstocks from storage into the digester, feeding it. The type of pump used depends on the feedstock or influent TS concentration and piping system pressure requirements for moving the material.

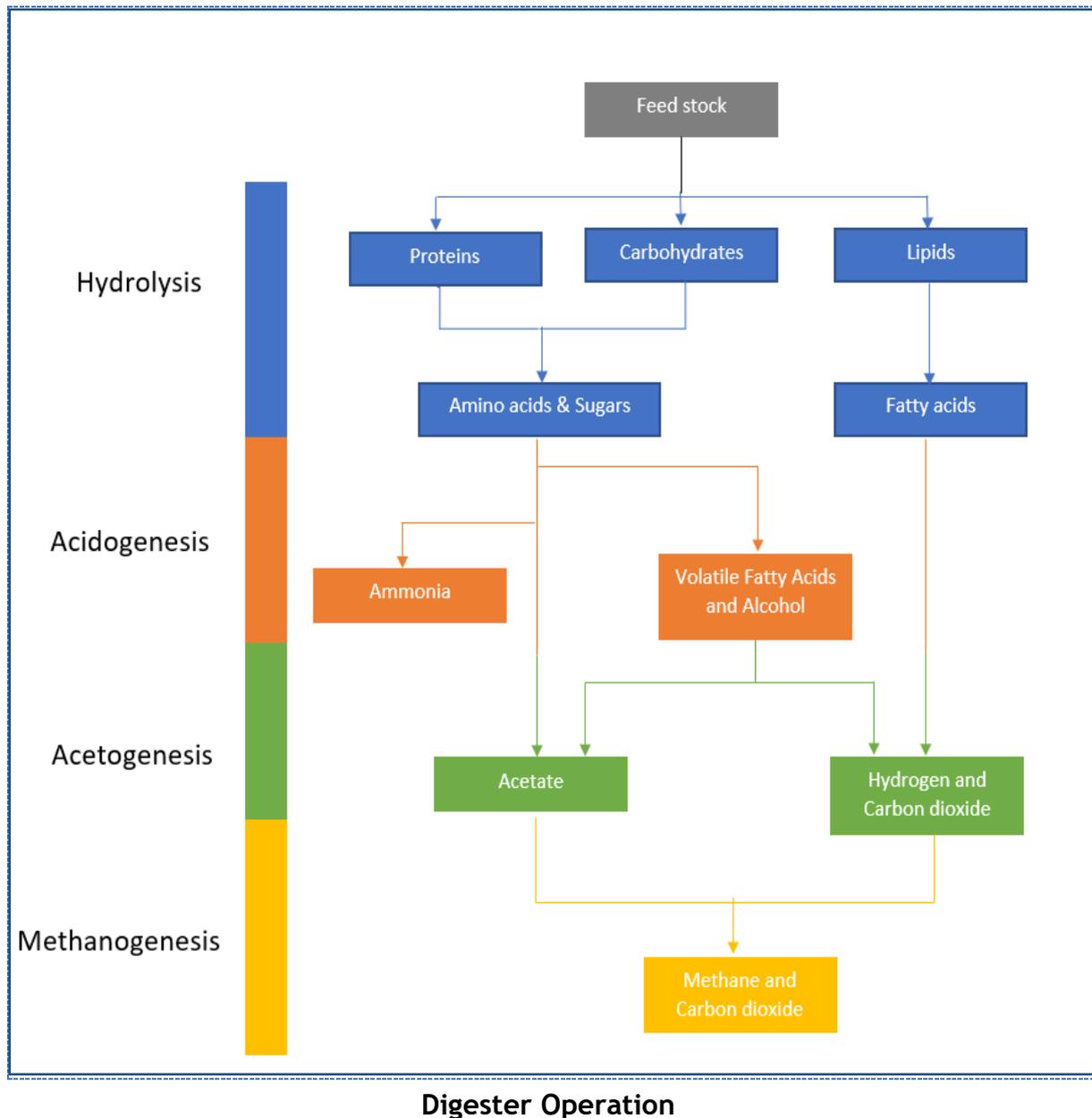
As such, it is recommended using chopper pumps to feed the feedstock into the digester. Chopper pumps are centrifugal pumps with a cutter on the pump inlet that grinds the solids in the feedstock a bit finer prior to pumping them. This type of pump allows for a uniform particle size, enabling improved waste degradation.

6.8.4. Digester operation

Completely mixed digester is operated to digest the waste, based on factors specific to the project. Also, it is recommended that the digester be operated in the mesophilic temperature range. This entails that the waste feedstock inside the digester is heated to temperatures in the mesophilic range (35 - 40.5 degrees C) as opposed to temperatures in the thermophilic range (60 - 62.5 degrees C). Operating in the mesophilic temperature range will require significantly less energy usage than operating in the thermophilic temperature range, while still providing a reasonable conversion of waste to biogas and other benefits.

Heat is supplied to the digester through external heat sources or by using heat exchangers. Heat exchangers transfer heat produced by combusting a part of the generated biogas in a combined heat and power (CHP) plant or a boiler. Unlike boilers, CHP plants provide electricity too, which can be used to power electric motors used for mixing and pumping materials through the AD/biogas system.

Temperature fluctuations is limited to ensure stable microbial communities. Typically, single-phase digesters are employed for anaerobic waste digestion, where all the four biochemical processes - hydrolysis, acidogenesis, acetogenesis and methanogenesis - happen concurrently. Theoretically, separating the various populations of microorganisms should provide for more precise process control and previous trials have shown increasing biogas yield per unit mass entering the digester, which results in an increased biogas yield. Two-stage digesters target microorganisms for the first three phases of digestion (hydrolysis, acidogenesis, and acetogenesis) in the first tank and the methane-forming microorganisms in a second, downstream tank.



6.8.5. Biogas generation and upgradation

The methane (CH_4) occurring in raw biogas generated from the digestion process comes from renewable sources. Raw biogas requires upgrading or conditioning to remove these impurities, resulting in CH_4 gas, also known as renewable natural gas (RNG) or biomethane. Because fossil-fuel derived natural gas contains a variety of other hydrocarbons, such as ethane, propane, and butane, it often has higher energy content than pure methane found in RNG. However, it is similar to natural gas and can be used in energy-consuming applications as natural gas. Most, it is blended into the natural gas pipeline or used as vehicle fuel substituting for fossil-fuel derived compressed natural gas (CNG).

Depending on the digester system and waste feedstock, the methane content of biogas is generally between 50 to 75 percent. The remaining amount is comprised of primarily CO₂, H₂S, water vapour (moisture), and other trace compounds. These impurities are removed or reduced to very low levels, as part of the conditioning/upgradation of biogas to RNG. In order to satisfy natural gas industry standards, which include maximum allowable concentrations of CO₂, H₂S, and water vapour.

Depending on the economics, biogas (after removal of H₂S and water vapour) can be burned in a CHP system (utilizing an internal combustion engine-generator set) or a boiler to provide heating for the digester (with the help of heat exchangers), as opposed to using external grid electricity or natural gas for heating. Additionally, burning biogas in a CHP system produces parasitic electricity, used to power the entire facility and its monitoring systems.

CO₂ can be removed using a pressure swing adsorption (PSA) process, membrane separation, chemical (amine) scrubbing, or a spray tower.

Water vapour is removed with a PSA system using a desiccant material. H₂S can be removed using amine scrubbing or a spray tower. Amine scrubbing is used only if H₂S levels in raw biogas are below 300 ppm. H₂S and water vapour can corrode biogas combustion equipment. Also, removal of water vapour from raw biogas optimizes the process of combustion of biogas, resulting in increased electrical energy generating capacity in CHP systems.

Siloxanes are another class of impurities to be removed. This is because when biogas containing siloxanes is combusted (in a CHP system/boiler/when used as vehicle fuel), the silicon in the siloxanes convert to silica. High silica concentrations can be corrosive and reduce the lifespan of combustion equipment, resulting in greater maintenance expenses.

Reciprocating or screw-type positive displacement compressors are frequently used to boost RNG to pipeline pressures or for transportation in gas cascades. These compressors generate a lot of heat during the compression process, which causes the discharge gas temperature to become very hot, and a discharge cooler may be required. Oil is used as a compressor lubricant, but it also functions as both a sealant and a coolant within the compressor. Compression units can be attached to raw biogas purification units.

Activated carbon is often used as a polishing step to remove any volatile organic compounds that were not removed during the previous biogas conditioning. The activated carbon adsorbs these contaminants.

6.8.6. Digestate management

Digestate is the degraded material recovered after the digestion process. The digestate is used as an organic fertilizer or a soil amendment. Typically, the digestate is stored in a storage pond or lagoon and is then processed using solid-liquid separators such as screw presses, roller presses and vibrating screens.

Screw presses are most commonly used for solid-liquid separation in anaerobic digesters. It is recommended that the storage ponds be covered, because ammonia, which is present in the digestate, can escape from uncovered ponds through volatilization. In the atmosphere, ammonia acts as a pollutant. The solid fraction is fibrous in nature. It can be composted and is typically used as a soil amendment or animal bedding.

The liquid fraction is typically land-applied as an excellent organic fertilizer. The nutrients nitrogen (N), phosphorus (P) and potassium (K) are present in relatively high concentrations (as compared to manure) in plant-available forms. The nitrogen present in the liquid fraction is in a slow-release form. This may increase plant nitrogen uptake. Thus, this increases the relative value of the fertilizer. The liquid fraction can be further processed for advanced nutrient recovery, which theoretically can further concentrate nutrients. But it requires significant capital and the operating costs are high. It is not economically feasible for the proposed digester to employ this process.

The solid fraction can be stored in sacks before further transportation; the liquid fraction is typically stored in ponds. The digestate is properly managed either it should be sold to farmers for its nutrient value or disposed of in an environmentally friendly way. Improper management of the digestate can result in eutrophication and reduction in the quality of local water sources.

6.9 Civil works and Plant & Machinery

The list of civil works, plant and machinery required for the project is as below:

Civil works

S. No.	Description	Type	Area	Unit
1.	Anaerobic Digester	RCC	5,500	Sq.m
2.	Waste segregation area	PEB	43000	Sq.ft.
3.	Pre-treatment process	PEB	8600	Sq.ft.
4.	Cascade Storage	PEB	16125	Sq.ft.
5.	Laboratory	RCC	150	Sq.ft.
6.	Office room	RCC	200	Sq.ft.
7.	Store room	RCC	200	Sq.ft.
8.	Control room	RCC	360	Sq.ft.
9.	Feed preparation tank	RCC	252000	Litres
10.	Digestate collection tank	RCC	486000	Litres
11.	Filtered water collection tank	RCC	252000	Litres

Plant and machinery

S. No.	List of Plant & Machineries	MOC	Capacity	Quantity
1.	Waste separation Belt conveyors (Raw vegetable waste)	MS	7.5 HP	2
2.	De-Packing Unit Belt conveyors	SS	7.5 HP	2
3.	De-Packing Unit		60 HP	1
4.	Primary Shredder Belt Conveyor	MS	7.5 HP	2
5.	Primary Waste Shredder	SS	60 HP	1
6.	Secondary Waste shredder	SS	40 HP	1
7.	Secondary Shredder Screw conveyor	SS	7.5 HP	1
8.	Digester feed pump	Rotor - SS , Nitrile/EPDM - Stator/CS housing	50 m ³ /hr	8

S. No.	List of Plant & Machineries	MOC	Capacity	Quantity
9.	Feed preparation tank Agitator	SS	3 HP	2
10.	Agitator	SS	12 KW	20 (4 Each)
11.	Digester Double Membrane Gas Holder	PVC Coated Fabric	800 m3	5
12.	External Double Membrane Gas Holder	PVC Coated Fabric	4000 m3	1
13.	Digestate collection tank Agitator	SS 304	3 HP	3
14.	Separator Feed Pump (screw type)	Rotor - SS , Nitrile/EPDM - Stator/CS housing	50 m3 /hr	1
15.	Solid Liquid Separator	screen - SS 304	7.5 HP	1
16.	Digestate outlet Pump (Wide Hopper)	Rotor - SS , Nitrile/EPDM - Stator/CS housing	30 m3 /hr	5
17.	Filtered Water - Centrifugal Pump	Rotor - SS , Nitrile/EPDM - Stator/CS housing	40 m3 / hr	1
18.	Gas Booster - Twin Lobe	CS	1250 m3/hr	2
19.	Gas flow meter (Digester Gas Outlet) - Ultrasonic	Housing SS 304/ Aluminum	40-600 m3/hr	5
20.	Slurry flowmeter - Electromagnetic	SS 304	5-60 m3/hr	4
21.	Gas flow meter - after Blower	SS304	1250m3/hr	2
22.	Gas flow meter - before LP compressor	SS304	2250 m3/hr	1
23.	Gas flow meter - after HP compressor	SS304	800 m3/hr	1
24.	Instrumentation (pressure Transmitter)	SS	0 to 50mbar	22
25.	Instrumentation (Electrical Valves)	SS	24VDC, NC	14
26.	H2S scrubber	SS316L	1250m3/hr	1
27.	Refrigerant Dryer	CS	1250m3/hr	1
28.	Dessicant Dryer	CS	2250 m3/hr	1
29.	Oil Filter and Micron Filter	MSEP	2250 m3/hr	1

S. No.	List of Plant & Machineries	MOC	Capacity	Quantity
30.	Heating System (S&T hx and Hot Water Generator)	SS Internals	2250 m ³ /hr	1
31.	Two Stage Membrane - CO ₂ Removal	Housing: Al-O ₂ Membrane: Polyimide Hollow Fibre	1250 m ³ /hr	1
32.	Raw Biogas Compressor	Cast Steel	2250 m ³ /hr	1
33.	Pure Biogas Compressor	Cast Steel	750 m ³ /hr	1No
34.	Odorant & Odorizing Unit	SS	200 Kg	1set
35.	Cylinder Manifold	SS/Copper	10 points	1set
36.	Cylinder Cascade for 2 days filling	Seamless Steel	75 L x 40 cylinders (3000L)	12 x 3 Nos
37.	Individual Cylinder	Seamless Steel	75 L	10Nos
38.	Inhouse Control panel Load	1.6mm Sheet metal	MCC Type	1
39.	Inline Biogas Analyzer	ABS/Polypropylene	CH ₄ , CO ₂ , H ₂ S, NH ₃ & O ₂	1
40.	Auto flare	Riser-MS & Burner- SS	1000 m ³ /hr	1
41.	Slurry pipelines	MDP/HDP	As Required	Lot
42.	Gas pipelines (Low & High Pressure lines)	MDP/HDP	As Required	Lot
43.	Inhouse Electrical Cables	PVC/Copper	Copper armoured	Lot
44.	Incoming Electrical Cable for Panel	PVC/Aluminium	Aluminium armoured	Lot
45.	Ball valves	SS 304	SS304	Lot
46.	Gate Valves	Carbon steel	Carbon steel	Lot
47.	Butterfly valves	Cast iron body & SS 304 disc	Cast iron body & SS 304 disc	Lot
48.	Submersible pump for Lagoon	40 m ³	7.5 HP	1
49.	Fire Extinguisher	Sheet Metal	6kg MAP	10
50.	Spare Pump (Wide Hopper)	Rotor - SS , Nitrile/EPDM - Stator/CS housing	50 m ³ /hr	1

S. No.	List of Plant & Machineries	MOC	Capacity	Quantity
51.	Plant Inoculation		Sewage Sludge digestate + cow dung + water	Lot
52.	Erection and Commissioning	-	-	Lot
53.	Miscellaneous electricals and accessories	-	-	LS
54.	SCADA System			1
55.	Portable pH Analyser	-	-	1
56.	Hot air Oven	-	-	1
57.	Muffle Furnace	-	-	1
58.	Refrigerator	-	-	1
59.	Small Scale digester	-	-	1
60.	Titration apparatus	-	-	Lot

6.10 Operating parameters for Bio Methanation

The following physical parameters shall be taken into consideration for effective production of Biomethane:

Parameters	Optimum	Description
Temperature	35° - 38° C	Anaerobic organisms are most active within mesophilic (20 - 45° C) and thermophilic (45-70° C) temperature ranges.
Carbon to Nitrogen (C-N) ratio	25-30 : 1	When the ratio of carbon to nitrogen is high, it indicates low nitrogen content that is not suitable for microbial growth. In such a situation, methanogens consume the available nitrogen for protein production, which ultimately results in carbon wastage and low biogas yield.
pH	6.5 to 7.2	The anaerobic digestion process is limited to a relatively narrow pH band from 6.0 pH to 8.5 pH approximately, especially that the methanogenic bacteria are very sensitive to pH (close to neutral pH around 7.0).
Loading rate	0.2 Kg/m ³ of digester capacity	The quantity of feed given to the digester daily is referred to as the loading rate.
Agitation	300 rpm, intermittent	Agitating the slurry aids in evenly distributing the feedstock and prevents it from settling along with ensuring consistent microbial activity.
Toxic substances	Non-biodegradable waste	Toxic substances such as ammonia, pesticides, detergents and heavy metals can hinder the fermentation rate since their presence is harmful to micro-organisms.
Retention Time	Mesophilic:10-40 days Thermophilic: 14 days	The time needed for the reactions to complete varies depending on the technology employed, process temperature and waste composition.
Solid concentration	TS <15%	When the solid concentrations are low, it becomes easier to mix the substrate, which, in turn, promotes the even distribution of nutrients and microorganisms within the digester.

6.11 Handling and distribution of Bio-CNG

Biogas, which has been refined or purified, is pressurized at a level of 250 bar, resulting in a type of fuel known as compressed biogas (CBG), which shares similar properties with Compressed Natural Gas (CNG). It is sent to a bottling unit where it is filled and sealed into cylinders. These cylinders are then placed into cascades and transported for storage and sale. CBG is stored at gas filling stations using two commonly used systems: buffer and cascade storage systems. In a buffer storage system, the pressure of CBG is maintained at a consistent level of 250 bar for all reservoir cylinders. In contrast, in the cascade storage system, the reservoir cylinders are kept at varying low, medium and high pressures. CBG can be distributed through pipelines at low (~40 bar), medium (~160 bar) and high (~250 bar) pressures.

6.12 Power

The estimated power requirement for the proposed Bio-CNG plant is as shown below:

S.No	Name of the Equipment	Total Capacity in kW
1	Weigh Bridge	6
2	Conveyer system	9
3	Shredder (wet waste)	9
4	Mixer (feedstock and recycled water)	6
5	High flow pump	150
6	Digestor Agitators	500
7	Heat Exchanger in Digestor	400
8	Scum Separator	50
9	Digestate pumps	300
10	Scrubber and purification	30
11	Filtration press	22.5
12	High pressure compressor (250 bar)	270
13	Chillers	300
14	Miscellaneous (Lab, Packing, PLC Automation, etc.)	165
		2217.5

The total connected load required for the operation of the Bio-CNG plant is estimated at 2,464 KVA, which would be met from TNEB grid supply. Further, a

standby generator of capacity 1,700 KVA has been proposed to cater to the anticipated peak demand.

6.13 Manpower

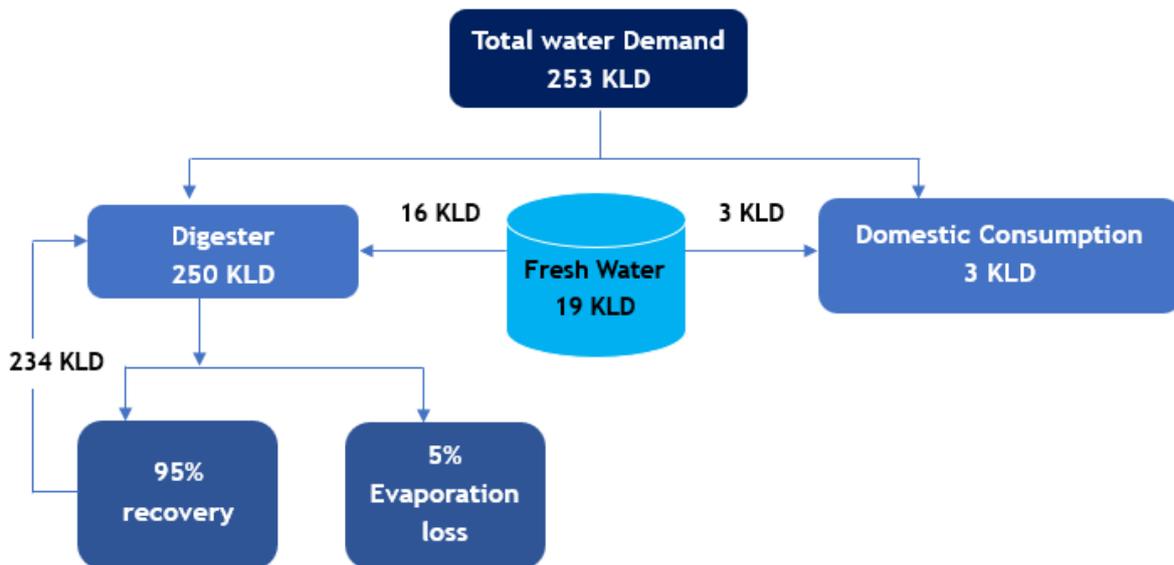
The manpower required for the proposed facility is envisaged as under:

Description	Nos.
Plant Head	1
Maintenance Engineers	2
Supervisors	2
Technicians	10
Helpers	52
Accounts and Admin Staffs	5
Security	4
Total	76

6.14 Water

For every kg of waste processed 1 litre of water is required. Accordingly, the total water requirement for operation of the plant is estimated at 250 KLD. Further, the domestic water requirement as per IS 1172, Code of Basic Requirements for Water Supply, Drainage and Sanitation is estimated at 3 KLD. Accordingly, the total water requirement works out to 253 KLD.

Out of the total water required for operation of the plant, about 95% could be recovered and reused. Accordingly, the total freshwater requirement is estimated at 19 KLD and the same is depicted below:



The freshwater requirement shall be met either from Borewell or from the Sewage Treatment Plant operated by CCMC located within the dump yard.

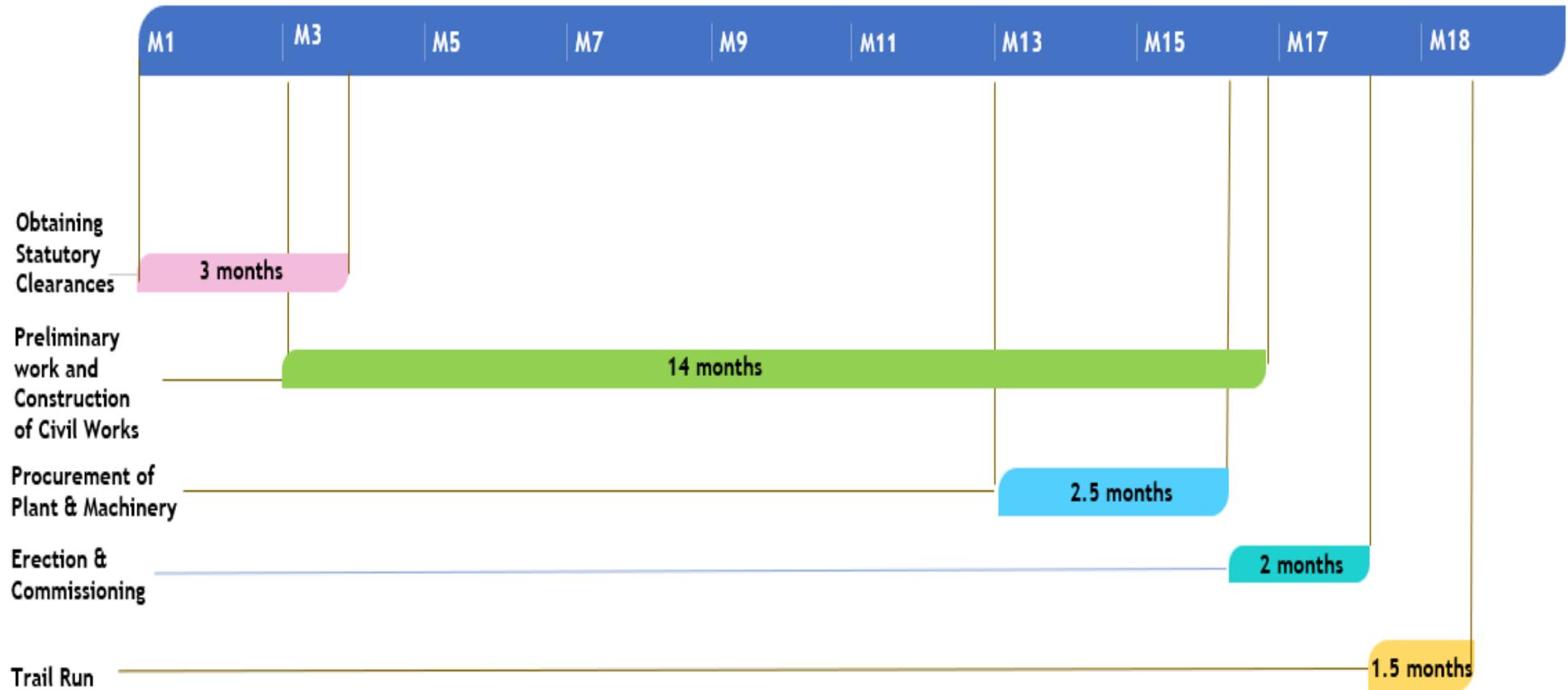
6.15 Statutory Approvals

The statutory approvals and clearances that are to be obtained are as follows:

S. No.	Permission	Authority
1.	Approval for layout and building	District Town & Country Planning (DTCP)
2.	Consent to Establish & Consent to Operate (CTE & CTO)	Tamil Nadu Pollution Control Board (TNPCB)
3.	Explosive substance license - CTE & CTO	Petroleum and Explosives Safety Organization (PESO)
4.	Factory License	Chief Inspector of Factories
5.	Labour License	Department of Labour
6.	NOC from Fire Department	State Fire and Emergency Services
7.	Certificate of Manufacture of Organic manure	Department of Agriculture

6.16 Schedule of implementation

The project shall be implemented in 18 months' time from the date of award of contract.



7 Financial Feasibility

7.1 Project Cost

The total project cost works out to ₹69.20 crores as shown below:

S.No.	Components	Cost (₹ in crores)
1.	Civil works	16.71
2.	Mechanical and Electrical Equipment	43.15
3.	Miscellaneous Fixed Assets	1.41
4.	Laboratory Equipment	0.06
	Sub Total	61.32
5.	Contingencies (5%)	3.07
6.	Preoperative expenses (1%)	0.61
7.	Interest During Construction	4.19
	Total	69.20

7.1.1 Civil works

The cost of the civil works is estimated at ₹16.71 crores. The details are given below:

S.No	Description	Qty	Unit	Rate per unit	Amount
Anaerobic digester foundation					
1	Excavation	555	cum	500.00	2,77,500
2	PCC M10 grade	550	cum	6,000.00	33,00,000
3	M30 grade concrete (including labour)	555	cum	8,500.00	47,17,500
4	Steel FE 500 or FE 550 (including labour)	67.5	Tonne	90,000.00	60,75,000
Anaerobic digester					
5	Steel work	475	Tonne	75,000.00	3,56,25,000
6	Labour for steel work	475	Tonne	6,500.00	30,87,500
7	Circular wall concrete	3036	cum	8,500.00	2,58,06,000
8	Shuttering labour	17344	sqm	700.00	1,21,40,800
Lagoon					

S.No	Description	Qty	Unit	Rate per unit	Amount
9	M30 grade concrete (including labour)	21500	sqft	200.00	43,00,000
Waste segregation					
10	M30 grade concrete (including labour)	43000	sqft	200.00	86,00,000
Pretreatment process (Roof)					
11	Truss -30ft height	8600	sqft	1100	94,60,000
Cascade storage					
12	Truss -15ft height	16125	sqft	900	1,45,12,500
Feed Preparation tank					
13	RCC structure (6x7x6)	252000	liter	4	10,08,000
Digestate collection tank					
14	RCC structure (9x9x6)	486000	liter	4	19,44,000
Filtered water collection tank					
15	RCC structure (6x7x6)	252000	liter	4	10,08,000
16	Road , Ramp for weight bridge (RCC)	9100	sqm	800	72,80,000
17	Compound wall	871	rmt	1100	9,58,100
18	Laboratory RCC	150	sqft	1700	2,55,000
19	Office room RCC	200	sqft	1700	3,40,000
20	Store room RCC	200	sqft	1700	3,40,000
21	Control room RCC and Shed	360	sqft	1700	6,12,000
Sub -Total					14,16,46,900
GST @18%					2,54,96,442
Total					16,71,43,342

7.1.2 Mechanical and Electrical Equipment

The cost of Mechanical & Electrical equipment is estimated at ₹43.15 crores and details are as under:

S.No	List of Plant Machineries	Qty	Total
1	Waste separation Belt conveyors (Raw vegetable waste)	2	11,40,000
2	De-Packing Unit Belt conveyors	2	11,40,000
3	De-Packing Unit	1	1,44,00,000
4	Primary Shredder Belt Conveyor	2	11,40,000

S.No	List of Plant Machineries	Qty	Total
5	Primary Waste Shredder	1	24,00,000
6	Secondary Waste shredder	1	19,20,000
7	Secondary Shredder Screw conveyor	1	9,30,000
8	Digester feed pump (Wide Hopper screw pump)	8	38,40,000
9	Feed preparation tank Agitator	2	8,40,000
10	Agitator	20 (4 Each)	1,68,00,000
11	Digester Double Membrane Gas Holder	5	2,04,00,000
12	External Double Membrane Gas Holder	1	84,00,000
13	Digestate collection tank Agitator	3	12,60,000
14	Separator Feed Pump (Wide Hopper screw pump)	1	7,80,000
15	Solid Liquid Separator	1	15,00,000
16	Digestate outlet Pump (Wide Hopper)	5	27,60,000
17	Filtered Water - Centrifugal Pump	1	2,16,000
18	Gas Booster - Twin Lobe	2	19,44,000
19	Gas flow meter (Digester Gas Outlet) - Ultrasonic	5	48,00,000
20	Slurry flowmeter - Electromagnetic	4	5,76,000
21	Gas flow meter - after Blowers	2	12,96,000
22	Gas flow meter - before LP compressor	1	8,10,000
23	Gas flow meter - after HP compressor	1	4,05,000
24	Instrumentation (pressure Transmitter)	22	13,20,000
25	Instrumentation (Electrical Valves)	14	33,60,000
26	H2S scrubber	1	1,21,50,000
27	Refrigerant Dryer	1	56,70,000
28	Dessicant Dryer	1	56,70,000
29	Oil Filter and Micron Filter	1	1,94,400
30	Heating System (S&T hx and Hot Water Generator)	1	14,58,000
31	Two Stage Membrane - CO2 Removal	1	2,52,00,000
32	Raw Biogas Compressor	1	4,00,00,000
33	Pure Biogas Compressor	1No	2,00,00,000
34	Odorant & Odorizing Unit	1set	24,00,000
35	Cylinder Manifold	1set	3,00,000
36	Cylinder Cascade for 3 days filling	12 x 3 Nos	9,50,40,000
37	Individual Cylinder	10Nos	2,40,000
38	Inhouse Control panel Load	1	30,00,000
39	Inline Biogas Analyzer	1	14,40,000
40	Auto flare	1	16,20,000
41	Slurry pipelines	Lot	21,60,000
42	Gas pipelines (Low & High Pressure lines)	Lot	34,80,000
43	Inhouse Electrical Cables	Lot	34,80,000
44	Incoming Electrical Cable for Panel	Lot	7,20,000
45	Ball valves	Lot	7,80,000

S.No	List of Plant Machineries	Qty	Total
46	Gate Valves	Lot	7,80,000
47	Butterfly valves	Lot	3,00,000
48	Submersible pump for Lagoon	1	2,64,000
49	Fire Extinguisher	20	3,60,000
50	Spare Pump (Wide Hopper)	1	7,80,000
51	Plant Inoculation	Lot	78,00,000
52	Erection and Commissioning	Lot	96,00,000
53	Miscellaneous electricals and accessories	LS	45,60,000
54	SCADA System	1	16,80,000
			34,55,03,400
Foundation for Plant & Machineries			
55	External Biogas storage balloon	-	65,70,000
56	Civil platform for machineries (Pretreatment process)	-	1,32,00,000
57	Auto flaring unit	-	
Sub Total			36,56,55,000
GST @ 18%			6,58,17,900
Total			43,14,72,900

7.1.3 Miscellaneous Fixed Assets

The cost of miscellaneous fixed assets (MFA) is estimated at ₹1.41 crores and the details are as below:

S.No	Description	Qty	Cost (₹)
1	Truck for handling CNG	3	65,14,800
2	Backhoe Loader	2	49,00,000
3	Weighbridge	1	5,00,000
Sub Total			1,19,14,800
GST @ 18%			21,44,664
Total			1,40,59,464

7.1.4 Laboratory Equipment

The cost of laboratory equipment is estimated at ₹0.06 crores as given below:

S.No.	Description	Qty	Cost (₹)
1	Portable pH Analyser	1	96,000

S.No.	Description	Qty	Cost (₹)
2	Hot air Oven	1	84,000
3	Muffle Furnace	1	84,000
4	Refrigerator	1	30,000
5	Small Scale digester	1	1,80,000
6	Titration apparatus	Lot	12,000
Sub-total			4,86,000
GST @18%			87,480
Total			5,73,480

7.1.5 Contingencies

The contingencies are considered at 5 percent on cost of civil works, mechanical & electrical equipment, laboratory equipment and MFA. The amount works out to ₹3.07 crores.

7.1.6 Preoperative Expenses

The preoperative expenses are considered at 1 percent on cost of civil works, mechanical & electrical equipment, laboratory equipment and MFA. The amount works out to ₹0.61 crores.

7.1.7 Interest During Construction

The interest during construction period works out to ₹4.19 Crores.

7.2 Means of Finance

The project is proposed to be financed as under:

Particulars	₹ in Crores
Equity	17.30
Central Financial Assistance (CFA) under WTE scheme, MNRE	5.07
Term loan	46.83
Total	69.20

7.2.1 Equity contribution

An amount of ₹17.30 crores (25% of the project cost) is proposed to be brought in by way of equity contribution.

7.2.2 CFA under WTE Programme

Ministry of New and Renewable Energy (MNRE) is implementing WTE programme under National Bioenergy Programme which provides Central Financial Assistance (CFA) of ₹4.0 Cr per 4,800 kg/day (for Bio-CNG generation from new biogas plant) subject to a maximum of ₹10.0 Cr/project.

Accordingly, the project is eligible for CFA to the tune of ₹5.07 crores.

7.2.3 Term Loan

An amount of ₹46.83 crores (68% of the project cost) is proposed to be met by way of Term Loan.

8 Financial Viability

8.1 Cost of Production and Profitability

The cost of production and profitability are given in the **Statement 3**. The assumptions for working the cost of production and profitability are given below:

Installed capacity per day	250	MT
No. of working days per annum	365	days
Capacity Utilization		
1	85%	
2	90%	
3 onwards	95%	
Output		
Bio Gas	65	Cum per MT of waste
Density of methane	0.657	kg/cum
Bio-CNG	60%	of Bio Gas
Organic manure	10%	of waste processed
Selling Price		
~CNG	₹ 54.00	per kg and 4% increase in every subsequent year
~Manure	₹ 4.00	per kg and 5% increase in every subsequent year
Consumables		
~Cow dung requirement	5%	of the waste processed
	12.5	TPD
~Cost of cow dung including transportation	₹ 400	per MT
	₹ 5,000	per day
	₹ 0.18	crores per annum and 5% increase in every subsequent year
Cost of transportation		
~CNG	₹ 1,500	per MT & 5% increase every subsequent year
~Manure	Transportation of manure from site shall be the responsibility of the purchaser	
Cost of TNEB power	₹ 6.90	per unit and 5% increase in every 3 years

Cost of Genset power	₹ 25	per unit and 5% increase in every subsequent year
Demand Charges	₹ 562	per KVA/month and 5% increase in every 3 years
Cost of manpower	₹ 1.98	crores per annum and 5% increase in every subsequent year
Repairs & Maintenance	0.20%	of cost of civil works and plant & machinery and 5% increase in every subsequent year
Royalty Charges payable to ULB	₹ 50	per MT of waste and 5% increase in every subsequent year
Interest on Term Loan	11.00%	per annum
Income Tax	IT rates applicable for Company have been considered.	
Depreciation		
Straight line depreciation is considered for profitability estimations and WDV depreciation is considered for IT purposes.		

8.2 Term Loan

The interest rate on Term Loan is considered at 11.00% per annum and the repayment period is considered as 120 months excluding moratorium of 18 months. The details are given in is given in Financial Statement-9.

8.3 Projected Cash Flow Statement

The projected cash flow statement is given in the Financial Statement 10.

8.4 Projected Balance Sheet

Projected balance sheet is given in the Financial Statement 11.

8.5 Debt Service Coverage Ratio (DSCR)

The weighted average DSCR for the project works out to 1.45 which indicates that the term loan serviceability of the Company is good. The details are given in Financial Statement-12.

8.6 Break-even Analysis

The break-even point is projected at 104%, 91% and 79% during first three years respectively. The details are given in the Financial Statement 13.

8.7 Internal Rate of Return (IRR) & Net Present Value (NPV)

The IRR & NPV of the project works out to 14.28% and ₹15.27 crores (at 11% discount rate) respectively, which may be considered good. The details are given in the Financial Statement 14.

8.8 Equity IRR

The equity IRR for the project works out to 20.79.%. The details are given in Financial Statement - 15.

9 Social and Environmental Feasibility

Biogas plants that use Municipal Solid Waste (MSW) have both positive social and environmental impacts.

9.1 Social Impact

The Bio-CNG Plant reduces the biological oxygen demand (BOD) and chemical oxygen demand (COD) of effluents and therefore decreases the potential dangers. The various benefits are as below:

1. Odour mitigation

Communities living around landfills face air quality issues, with bad odour being one of the major issue. The biological processes break down the odour producing compounds occurring in organic waste. This results in a reduction of bad odour. The reduction of odour is beneficial for better quality of life. However, for this benefit to be felt, the plant have to be properly operated and maintained.

2. Improved soil quality

The digestate, recovered from the plant of waste feedstock, can be processed further and used as organic fertilizer to increase crop yield. The potency of this fertilizer is comparable to that of mineral fertilizers, which are some of the most effective forms of fertilizer. The digestion process increases conversion of nitrogen and phosphorus present in organic waste, from organic forms into inorganic forms (for e.g., nitrogen into nitrate and ammonium). This results in an increase in amount of plant - available nutrients. It is an upgrade on compost, which only acts as a soil amendment.

3. Waste diversion from landfills

The plant for processing organic waste is an upgrade on the management of such waste through landfills. Landfills, while still necessary for proper disposal of solid waste, do decrease the quality of life of the people living nearby. They also depress economic activity and property values in the surrounding communities.

4. Improved water quality

Leaching of nutrients into groundwater is observed in landfills across Tamil Nadu. This results in contamination of local water resources, leading to further damage of ecosystems. The high levels of ammonia present in leachate from landfills results in eutrophication (enrichment with nutrients) in nearby water bodies. In turn, this increases the amount of plant and algae growth in the water bodies like rivers and estuaries resulting in harmful algal blooms, dead zones, and fish kills, according to the US EPA.

The digestate can be processed further and used as organic fertilizer. The increased plant availability of nutrients with the usage of digestate-derived fertilisers can decrease the runoff of nutrients, especially phosphorus, from agricultural fields into local water bodies, thus reducing eutrophication. This is a pertinent issue in India, with India ranking second in global phosphorus pollution by human activity. In addition, agriculture contributed to 38% of global phosphorus pollution.

5. Offsets in the use of fossil fuels

With these proposed plant, the waste will be treated to generate biogas, which will then be upgraded into renewable natural gas (RNG). RNG is of natural gas pipeline quality standards and can be blended with, substituted for, fossil fuel derived natural gas. It can also be used for vehicle fuel in the form of compressed natural gas (CNG). This displaces the use of fossil fuels like crude oil and natural gas in transportation, and is especially beneficial for India, as India is a net importer of oil and natural gas. Domestic generation of biogas allows India to reduce its dependence on imported natural gas and improve its energy security.

Also, the digestate, after post-processing, can act as a substitute to petrochemical fertilizers, which are derived from fossil fuels. This offsets heavy use of fossil fuels in fertilizer manufacturing.

6. Employment

Establishing and operating Biogas plant on former landfill sites can be beneficial for workers living in nearby communities, who might have otherwise worked in their local landfills also provide much safer and has better working conditions, compared to that in a landfill.

7. Income

MSW-based Biogas plants can provide an additional source of income for farmers and other small businesses that supply the feedstock for the plant.

8. Educational opportunities

Biogas plant are next-gen tools to manage organic waste responsibly and mitigate a host of issues affecting traditional methods of organic waste disposal. These plants can provide educational opportunities, both for students and teachers/researchers, to know about the benefits of waste-to-energy technology and sustainable waste management practices.

9. Economic benefits for sanitation agencies

Local sanitation agencies have traditionally been responsible for municipal waste management and thus far, they have only incurred costs in operating waste management facilities, be it by themselves or by contracting.

Biogas-based renewable energy and digestate-derived products - represent new sources of revenue for sanitation agencies, and, in turn, the local government. Waste products that are considered a liability are being turned into beneficial products.

9.2 Environmental Study and Impact

ITCOT conducted an Environmental Baseline Study from 14.05.2023 to 15.05.2023 for Monitoring, Sampling and Analysis for Ambient Air Quality, Surface Water quality and Ground Water Quality of the proposed site and the study results are detailed as below:

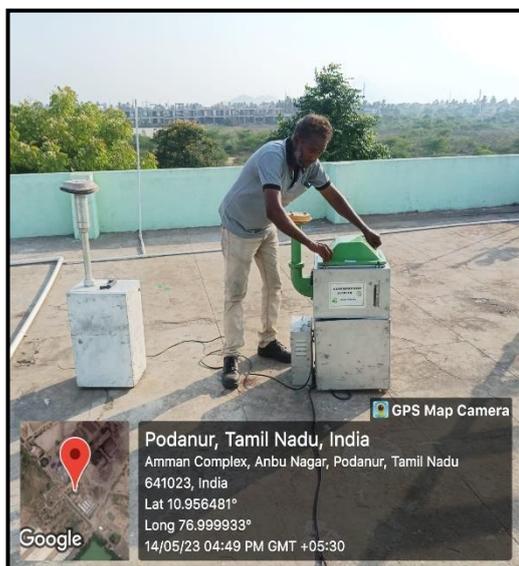
9.2.1 Ambient Air Quality Sampling dated 14.05.2023 to 15.05.2023

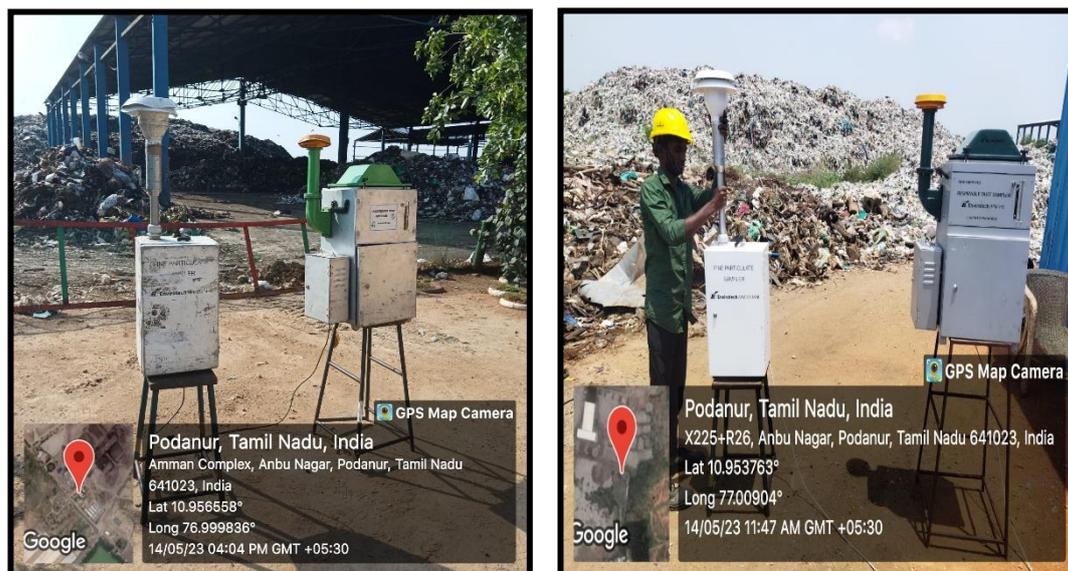
Sample Code	Name of the Monitoring Location	Latitude	Longitude
AAQ-1	On top of office and lab	10° 57' 23.33" N	76° 59' 59.75" E
AAQ-2	Near main gate	10° 57' 17.34" N	77° 0' 17.19" E
AAQ-3	Vermi Compost Plant	10° 57' 23.60" N	76° 59' 59.40" E
AAQ-4	Labour Shed	10° 57' 13.54" N	77° 0' 32.54" E



Google Earth Image Showing AAQ Monitoring Locations

a) Ambient Air Quality Sampling Photographs are as shown below:





b) Test Methods for Sampling and Analysis of Ambient Air Quality Parameters

S.No.	Pollutant	Test Method	Unit	NAAQ Standards
1	Sulphur Dioxide	CPCB Guidelines Volume 1: 2012	$\mu\text{g}/\text{m}^3$	80 (24 Hours)
2	Nitrogen Dioxide	IS:5182 (Part-6): 2006	$\mu\text{g}/\text{m}^3$	80 (24 Hours)
3	Particulate Matter Size Less than 10 μm	IS:5182 (Part-23): 2006	$\mu\text{g}/\text{m}^3$	100 (24 Hours)
4	Particulate Matter Size Less than 2.5 μm	IS:5182 (Part-24): 2019	$\mu\text{g}/\text{m}^3$	60 (24 Hours)
5	Lead	IS: 5182 (Part -22) :2004	$\mu\text{g}/\text{m}^3$	4 (1hour)
6	Ammonia	IS: 5182 (Part -25) :2018	$\mu\text{g}/\text{m}^3$	1 (24 hour)
7	Ozone	IS: 5182 (Part -09) :1974	$\mu\text{g}/\text{m}^3$	180 (1hour)
8	Carbon Monoxide	IS:5182 (Part -10): 1999	mg/m^3	400 (24 hours)
9	Benzene	IS:5182 (P-11): 2006	$\mu\text{g}/\text{m}^3$	5 (Annual)
10	Benzo(a)Pyrene	IS:5182 (P-12): 2004	ng/m^3	1 (Annual)

S.No.	Pollutant	Test Method	Unit	NAAQ Standards
11	Arsenic	HECS/AA/SOP/019: 2016	ng/m ³	6 (Annual)
12	Nickel	HECS/AA/SOP/009: 2016	ng/m ³	20 (Annual)

c) Summary of the average baseline concentrations of pollutants

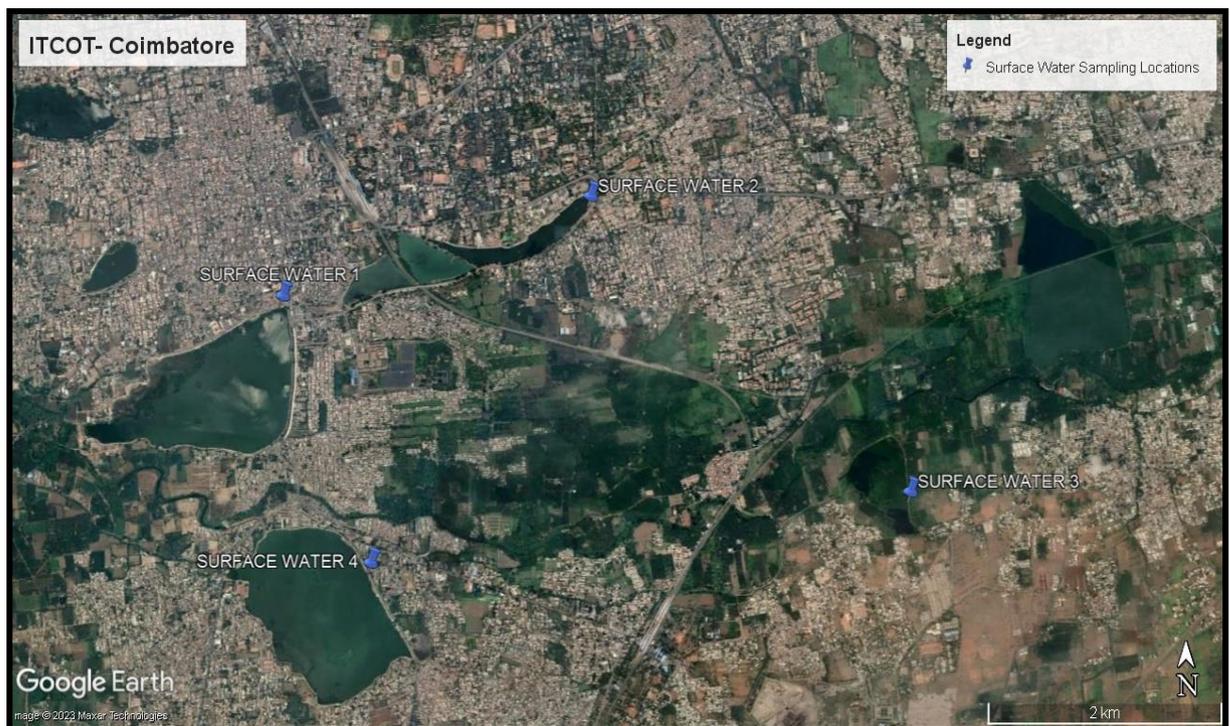
S.No.	Parameters	Conc.	NAAQ Standards	Location: Coimbatore			
				u/w	d/w	c/w	c/w
				AAQ1	AAQ2	AAQ3	AAQ4
1.	PM ₁₀ Conc. (µg/m ³)	Avg.	100 (24 Hours)	54.26	53.20	52.30	50.84
2.	PM _{2.5} Conc. (µg/m ³)	Avg.	60 (24 Hours)	24.58	22.82	21.58	23.62
3.	SO ₂ Conc. (µg/m ³)	Avg.	80 (24 Hours)	11.92	13.64	10.73	12.87
4.	NO ₂ Conc.(µg/m ³)	Avg.	80 (24 Hours)	23.51	25.15	21.48	24.50
5.	Carbon Monoxide (mg/m ³)	Avg.	4 (1hour)	BLQ(LOQ0.05)	BLQ(LOQ0.05)	BLQ(LOQ0.05)	BLQ(LOQ0.05)
6.	Lead - Pb (µg/m ³)	Avg.	1 (24 hour)	BLQ(LOQ0.05)	BLQ(LOQ0.05)	BLQ(LOQ0.05)	BLQ(LOQ0.05)
7.	Ozone (µg/m ³)	Avg.	180 (1hour)	10.44	11.26	10.29	11.37
8.	Ammonia(µg/m ³)	Avg.	400 (24 hours)	6.80	6.48	5.44	7.02
9.	Benzene (µg/m ³)	Avg.	5 (Annual)	BLQ(LOQ1)	BLQ(LOQ1)	BLQ(LOQ1)	BLQ(LOQ1)
10.	Benzo (a) pyrene, (ng/m ³)	Avg.	1 (Annual)	BLQ(LOQ1)	BLQ(LOQ1)	BLQ(LOQ1)	BLQ(LOQ1)
11.	Arsenic (ng/ m ³)	Avg.	6 (Annual)	BLQ(LOQ2)	BLQ(LOQ2)	BLQ(LOQ2)	BLQ(LOQ2)
12.	Nickel (ng/m ³)	Avg.	20 (Annual)	BLQ(LOQ10)	BLQ(LOQ10)	BLQ(LOQ10)	BLQ(LOQ10)

Note: BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³- Micrograms per cubic meter, mg/m³- Milligrams per cubic meter, ng/m³- Nanograms per cubic meter.

Remarks: The Tested Parameters are within the Limits of NAAQ Standards 2009.

9.2.2 Surface Water Quality Monitoring Locations

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
SW-1	Vellalur Lake	15.05.2023	10° 59' 19.42" N	76° 57' 37.24" E
SW-2	Kurichi Lake	15.05.2023	10° 45' 1.08" N	76° 57' 43.72" E
SW- 3	Noiyal Lake	15.05.2023	10° 58' 27.23" N	77° 0' 34.83" E
SW-4	Ukkadam Lake	15.05.2023	10° 58' 8.59" N	76° 58' 2.43" E



Google Earth Image Showing Surface Water Sampling Locations

a) Surface Water Sample Collecting Photos



b) Test Methods for Sampling and Analysis of Water Quality Parameters

S.No.	Parameters	Units	Test method	IS: 10500-2012	
				Acceptable limits	Permissible limits
1	pH (at 25 °C)	-	IS 3025 (Part - 11): 2022	6.5 - 8.5	No relaxation
2	Cadmium	mg/l	USEPA Method 200.8	0.003	No Relaxation
3	Fluoride	mg/l	IS 3025 (Part - 60): 2022	1.0	1.5
4	Electrical conductivity	µS/cm	IS 3025 (Part - 14): 2013	NA	NA
5	Colour	Hazen Unit	IS 3025(Part - 4): 2021	5	15
6	Odour	-	IS 3025 (Part - 5): 2018	Agreeable	Agreeable
7	Taste	-	IS 3025 (Part - 8): 2018	Agreeable	Agreeable
8	Total Hardness as CaCO ₃	mg/l	IS 3025 (Part - 21): 2009	200	600
9	Calcium as Ca	mg/l	IS 3025 (Part - 40): 2009	75	200
10	Chloride as Cl	mg/l	4500 Cl --- B APHA 23rd Edn: 2017	250	1000
11	Magnesium as Mg	mg/l	IS 3025 (Part - 46) Sec1: 1994	30	100
12	Total Dissolved Solids	mg/l	IS 3025(Part -16):1984	500	2000
13	Sulphate as SO ₄	mg/l	IS 3025(Part - 24): Sec1: 2022	200	400
14	Nitrate as NO ₃	mg/l	IS 3025 (Part 34): Sec3: 2021	45	No Relaxation
15	Iron as Fe	mg/l	IS 3025 (Part - 53): 2003	1.0	No Relaxation
16	Boron as B	mg/l	IS:3025 (Part - 57): 2021	0.5	1.0
17	Phenolic compounds as C ₆ H ₅ OH	mg/l	APHA 23rd edition (Method 5530C)	0.001	0.002
18	Anionic Detergents as MBAS	mg/l	Annex K of IS 13428: 2005	0.2	1.0
19	Zinc as Zn	mg/l	USEPA Method 200.8:1994	5	15

S.No.	Parameters	Units	Test method	IS:10500-2012	
				Acceptable limits	Permissible limits
20	Chromium as Cr	mg/l	USEPA Method 200.8:1994	0.05	No Relaxation
21	Copper as Cu	mg/l	USEPA Method 200.8:1994	0.05	1.5
22	Manganese as Mn	mg/l	USEPA Method 200.8:1994	0.1	0.3
23	Lead as Pb	mg/l	USEPA Method 200.8:1994	0.01	No Relaxation
24	Selenium as Se	mg/l	USEPA Method 200.8:1994	0.01	No Relaxation
25	Arsenic as As	mg/l	USEPA Method 200.8:1994	0.01	0.05
26	Mercury as Hg	mg/l	USEPA Method 200.8:1994	0.001	No Relaxation
27	Mineral Oil	mg/l	IS 3025 (Part39): 1991	0.5	No Relaxation
28	BOD,3 days @27°C as O ₂	mg/l	IS 3025 (Part - 44): 1993	NA	NA
29	Oil and Grease	mg/l	IS 3025 (Part - 39): 2021	NA	NA
30	Pesticide				
	Alpha HCH	mg/l	USEPA Method 525.2: 1995	0.00001	No Relaxation
	Beta HCH	mg/l	USEPA Method 525.2: 1995	0.00004	No Relaxation
	Gama HCH (Lindane)	mg/l	USEPA Method 525.2: 1995	0.002	No Relaxation
	Delta HCH	mg/l	USEPA Method 525.2: 1995	0.00004	No Relaxation
	O,P-DDT	mg/l	USEPA Method 525.2: 1995	0.001	No Relaxation
	P,P-DDT	mg/l	USEPA Method 525.2: 1995	0.001	No Relaxation
	O,P-DDD	mg/l	USEPA Method 525.2: 1995	0.001	No Relaxation
	P,P-DDD	mg/l	USEPA Method 525.2: 1995	0.001	No Relaxation
	O,P-DDE	mg/l	USEPA Method 525.2: 1995	0.001	No Relaxation
	P,P-DDE	mg/l	USEPA Method 525.2: 1995	0.001	No Relaxation
	Alpha Endosulfan	mg/l	USEPA Method 525.2: 1995	0.0004	No Relaxation

S.No.	Parameters	Units	Test method	IS:10500-2012	
				Acceptable limits	Permissible limits
	Beta Endosulphan	mg/l	USEPA Method 525.2: 1995	0.0004	No Relaxation
	Endosulfan sulphate	mg/l	USEPA Method 525.2: 1995	0.0004	No Relaxation
	Chlorpyrifos	mg/l	USEPA Method 525.2: 1995	0.03	No Relaxation
	Butachlor	mg/l	USEPA Method 525.2: 1995	0.125	No Relaxation
	Alachor	mg/l	USEPA Method 525.2: 1995	0.02	No Relaxation
	Atrazine	mg/l	USEPA Method 525.2: 1995	0.002	No Relaxation
	Aldrin	mg/l	USEPA Method 525.2: 1995	0.00003	No Relaxation
	Dieldrin	mg/l	USEPA Method 525.2: 1995	0.00003	No Relaxation
	Monocrotophos	mg/l	USEPA Method 525.2: 1995	0.001	No Relaxation
	Ethion	mg/l	USEPA Method 525.2: 1995	0.003	No Relaxation
	Phorate	mg/l	USEPA Method 525.2: 1995	0.002	No Relaxation
	2,4-D	mg/l	USEPA Method 8321B: 2007	0.03	No Relaxation
	Isoproturon	mg/l	USEPA Method 8321B: 2007	0.009	No Relaxation
	Methyl Parathion	mg/l	USEPA Method 8321B: 2007	0.0003	No Relaxation
	Malathion	mg/l	USEPA Method 8321B: 2007	0.190	No Relaxation
31	Anilophos	mg/l	USEPA Method 8321B: 2007	NA	NA
32	Nickel	mg/l	USEPA Method 8321B: 2007	0.02	No Relaxation
33	Free Carbon dioxide	mg/l	IS 3025 (Part - 61): 2008	NA	NA
34	Dissolved oxygen	mg/l	IS 3025 (Part - 38)	NA	NA
35	Barium as Ba	mg/l	USEPA Method 200.8: 1989	0.7	No Relaxation
36	Silver as Ag	mg/l	USEPA Method 200.8:1994	0.1	No Relaxation
37	Alpha Emitters	Bq/l	IS 14194 (Part - 2):	0.1	No Relaxation

S.No.	Parameters	Units	Test method	IS:10500-2012	
				Acceptable limits	Permissible limits
			1994		
38	Phenols	mg/l	IS 3025(Part 43): Sec 1: 2021	0.001	0.002
39	Cyanide	mg/l	IS 3025 (Part-27): Sec1: 2021	0.05	No Relaxation
40	Polynuclear Aromatic Hydrocarbons	mg/l	USEPA Method 525.2 :1995	0.0001	No Relaxation
41	Total Arsenic	mg/l	USEPA Method 200.8 :1994	0.01	No Relaxation
42	Beta Emitters	Bq/l	IS 14194 (Part - 1): 1994	1.0	No Relaxation
43	Percent Sodium as Na	%	IS 3025(Part -45) : 1993	NA	NA
44	Sodium Absorption Ratio	-	IS 11624 :1986	NA	NA
45	Ammonia as NH ₃	mg/l	IS 3025 (Part - 34) :2021	0.5	No Relaxation

c) *Surface Water Quality Monitoring Results*

S.No.	Parameters	Units	SW1	SW2	SW3	SW4
1	pH (at 25 °C)	-	7.67	8.41	8.06	7.94
2	Cadmium		BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)
3	Fluoride	mg/l	0.46	0.44	0.41	0.48
4	Electrical conductivity	µS/cm	2430.0	1918.0	1803.0	2070.0
5	Colour	Hazen	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)
6	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable
7	Taste	-	Disagreeable	Disagreeable	Disagreeable	Disagreeable
8	Total Hardness as CaCO ₃	mg/l	410.0	120.0	250.0	530.0
9	Calcium as Ca	mg/l	76.15	20.04	44.09	96.19
10	Chloride as Cl	mg/l	569.11	277.13	296.92	321.67
11	Magnesium as Mg	mg/l	53.46	17.01	34.02	70.47
12	Total Dissolved Solids	mg/l	1312.0	1035.0	972.0	1098.0
13	Sulphate as SO ₄	mg/l	276.94	132.91	137.37	81.47
14	Nitrate as NO ₃	mg/l	9.67	13.02	8.51	49.7
15	Iron as Fe	mg/l	0.21	0.38	0.87	0.17
16	Boron as B	mg/l	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
17	Phenolic compounds as	mg/l	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
18	Anionic Detergents as MBAS	mg/l	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)
19	Zinc as Zn	mg/l	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)
20	Chromium as Cr	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
21	Copper as Cu	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
22	Manganese as Mn	mg/l	BLQ(LOQ0.05)	BLQ(LOQ0.05)	BLQ(LOQ0.05)	BLQ(LOQ0.05)
23	Lead as Pb	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
24	Selenium as Se	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)

S.No.	Parameters	Units	SW1	SW2	SW3	SW4
25	Arsenic as As	mg/l	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)
26	Mercury as Hg	mg/l	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)
27	Mineral Oil	mg/l	BLQ(LOQ 0.5)	BLQ(LOQ 0.5)	BLQ(LOQ 0.5)	BLQ(LOQ 0.5)
28	BOD,3 days @27° C as O2	mg/l	3.0	4.0	5.0	2.0
29	Oil and Grease	mg/l	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)
30	Pesticides					
	Alpha HCH	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Beta HCH	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Gama HCH (Lindane)	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Delta HCH	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	O,P-DDT	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	P,P-DDT	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	O,P-DDD	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	P,P-DDD	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	O,P-DDE	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	P,P-DDE	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Alpha Endosulfan	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Beta Endosulphan	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Endosulfan sulphate	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Chlorpyrifos	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Butachlor	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Alachor	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)

S.No.	Parameters	Units	SW1	SW2	SW3	SW4
	Atrazine	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Aldrin	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Dieldrin	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Monocrotophos	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Ethion	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Phorate	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	2,4-D	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Isoproturon	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Methyl Parathion	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Malathion	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
31	Anilophos	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
32	Nickel	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
33	Free Carbon dioxide	mg/l	2.64	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)	1.32
34	Dissolved oxygen	mg/l	6.3	6.2	6.3	6.5
35	Barium as Ba	mg/l	0.016	BLQ(LOQ 0.01)	0.011	0.015
36	Silver as Ag	mg/l	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)
37	Alpha Emitters	Bq/l	BLQ(LOQ:0.005)	BLQ(LOQ:0.005)	BLQ(LOQ:0.005)	BLQ(LOQ:0.005)
38	Phenols	mg/l	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
39	Cyanide	mg/l	BLQ(LOQ:0.01)	BLQ(LOQ:0.01)	BLQ(LOQ:0.01)	BLQ(LOQ:0.01)
40	polynuclear Aromatic Hydrocarbons	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
41	Total Arsenic	mg/l	BLQ(LOQ 0.005)	BLQ(LOQ (0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)
42	Beta Emitters	Bq/l	BLQ(LOQ:0.05)	BLQ(LOQ:0.09)	BLQ(LOQ:0.09)	BLQ(LOQ:0.09)

S.No.	Parameters	Units	SW1	SW2	SW3	SW4
43	Percent Sodium as Na	%	57.49	69.26	54.83	38.95
44	Sodium Absorption Ratio	-	5.84	5.53	4.1	3.05
45	Ammonia as NH ₃	mg/l	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)
46	Microbial Parameters					
	Total Coliform Bacteria	Per 100ml	Absent	Absent	Absent	Absent

* **Note:-** BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per litre.

9.2.3 Ground Water Sampling Locations

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
GW-1	Mahalingapuram	14.05.2023	10° 57' 22.96" N	77° 0' 32.85" E
GW-2	Near Bulltary Waste Processing Area	14.05.2023	10° 57' 23.82" N	76° 59' 58.72" E
GW-3	ELGI Nagar	15.05.2023	10° 57' 20.18" N	77° 0' 33.31" E
GW-4	Vermicompost Plant	15.05.2023	10° 57' 23.82" N	76° 59' 58.72" E



Google Earth Image showing Ground Water monitoring Locations

a) Ground Water Quality Sampling Photographs



b) Ground Water Quality Analysis Results

S.No.	Parameters	Units	GW-1	GW-2	GW - 3	GW -4
1	pH (at 25 °C)	-	7.75	7.56	8.11	7.64
2	Cadmium		BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ
3	Fluoride	mg/l	0.53	0.51	0.41	0.42
4	Electrical conductivity	µS/cm	8810.0	3230.0	1758.0	1567.0
5	Colour	Hazen	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)
6	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable
7	Taste	-	Disagreeable	Disagreeable	Agreeable	Agreeable
8	Total Hardness as CaCO ₃	mg/l	2350.0	560.0	620.0	520.0
9	Calcium as Ca	mg/l	260.52	112.2	128.25	132.26
10	Chloride as Cl	mg/l	1855.8	534.4	222.6	207.85
11	Magnesium as Mg	mg/l	413.1	68.04	72.9	46.17
12	Total Dissolved Solids	mg/l	5240.0	1671.0	895.0	802.0
13	Sulphate as SO ₄	mg/l	1363.0	290.6	55.17	81.2
14	Nitrate as NO ₃	mg/l	39.4	38.86	42.8	1.95
15	Iron as Fe	mg/l	0.21	0.14	0.036	0.032
16	Boron as B	mg/l	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
17	Phenolic compounds as C ₆ H ₅ OH	mg/l	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
18	Anionic Detergents as MBAS	mg/l	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)
19	Zinc as Zn	mg/l	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)
20	Chromium as Cr	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
21	Copper as Cu	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
22	Manganese as Mn	mg/l	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)
23	Lead as Pb	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
24	Selenium as Se	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
25	Arsenic as As	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
26	Mercury as Hg	mg/l	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)
27	Mineral Oil	mg/l	BLQ(LOQ 0.5)	BLQ(LOQ 0.5)	BLQ(LOQ 0.5)	BLQ(LOQ 0.5)

28	BOD,3 days @27° C as O2	mg/l	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)	BLQ(LOQ:1.0)
29	Oil and Grease	mg/l	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)
30	Pesticides					
	Alpha HCH	mg/l	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
	Beta HCH	mg/l	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)
	Gama HCH (Lindane)	mg/l	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)
	Delta HCH	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
	O,P-DDT	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
	P,P-DDT	mg/l	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)	BLQ(LOQ:0.05)
	O,P-DDD	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
	P,P-DDD	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
	O,P-DDE	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
	P,P-DDE	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Alpha Endosulfan	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Beta Endosulphan	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Endosulfan sulphate	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Chlorpyrifos	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Butachlor	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Alachor	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Atrazine	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Aldrin	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Dieldrin	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Monocrotophos	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Ethion	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Phorate	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	2,4-D	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Isoproturon	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)

	Methyl Parathion	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Malathion	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
	Anilophos	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
31	Nickel	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
32	Free Carbon dioxide	mg/l	2.2	1.76	BLQ(LOQ:1.0)	1.32
33	Dissolved oxygen	mg/l	6.4	6.4	6.6	6.7
34	Barium as Ba	mg/l	BLQ(LOQ 0.01)	1.76	0.041	0.067
35	Silver as Ag	mg/l	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)
36	Alpha Emitters	Bq/l	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)
37	Phenols	mg/l	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)
38	Cyanide	mg/l	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
39	Polynuclear Aromatic Hydrocarbons	mg/l	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)	BLQ(LOQ 0.00001)
40	Total Arsenic	mg/l	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)
41	Beta Emitters	Bq/l	BLQ(LOQ 0.09)	BLQ(LOQ 0.09)	BLQ(LOQ 0.09)	BLQ(LOQ 0.09)
42	Percent Sodium as Na	%	44.54	48.80	26.82	29.57
43	Sodium Absorption Ratio	-	8.12	4.73	1.86	1.95
44	Ammonia as NH ₃	mg/l	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)
45	Microbial Parameters					
	Total Coliform Bacteria	Per 100ml	Absent	Present	Absent	Absent

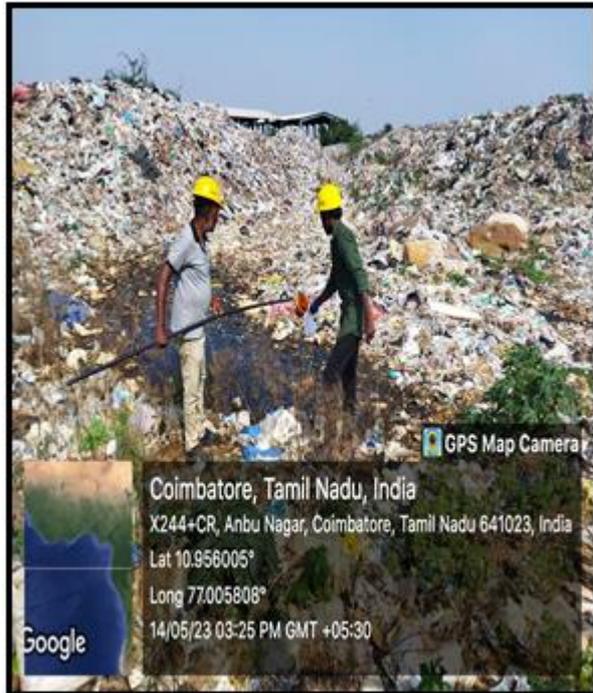
* Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per litre.

9.2.4 Leachate Quality monitoring Locations

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
LW-1	Waste Dumb Yard 1	14.05.2023	10° 57' 21.61" N	77° 0' 20.90" E
LW-2	Waste Dumb Yard 2	15.05.2023	10° 57' 21.61" N	77° 0' 20.90" E
LW-3	Waste Dumb Yard 3	15.05.2023	10° 57' 21.61" N	77° 0' 20.90" E
LW-4	Waste Dumb Yard 4	15.05.2023	10° 57' 21.61" N	77° 0' 20.90" E



Google Earth Image showing Leachate Water monitoring Locations

a) *Sample Collection Photographs*

b) Test methods for sampling and analysis of leachate quality parameters

S.No.	Parameters	Units	Test method
1	pH (at 25 °C)	-	IS 3025 (Part - 11):2022
2	Cadmium	mg/l	USEPA Method 200.8:1994
3	Chloride as Cl	mg/l	4500 Cl --- B APHA 23rd Edn: 2017
4	Total Dissolved Solids	mg/l	IS 3025(Part -16):1984
5	Fluoride	mg/l	IS 3025 (Part - 60):1986
6	Phenolic compounds as C ₆ H ₅ OH	mg/l	APHA 23rd edition (Method 5530C): 2017
7	Zinc as Zn	mg/l	USEPA Method 200.8:1994
8	Copper as Cu	mg/l	USEPA Method 200.8:1994
9	Lead as Pb	mg/l	USEPA Method 200.8:1994
10	Arsenic as As	mg/l	USEPA Method 200.8:1994
11	Mercury as Hg	mg/l	USEPA Method 200.8:1994
12	Total suspended solid	mg/l	IS 3025 (Part - 17):1984
13	BOD,3 days @27°C as O ₂	mg/l	IS 3025 (Part - 44):1993
14	Chemical oxygen demand as O ₂	mg/l	IS 3025 (Part - 58):2006
15	Nickel	mg/l	USEPA Method 200.8:1994
16	Total Kjeldahl Nitrogen	mg/l	IS 3025 (Part - 34):1988
17	Ammonical Nitrogen as NH ₃ -N	mg/l	IS 3025 (Part - 34):1988
18	Cyanide	mg/l	IS 3025 (Part-27): Sec1:2022
19	Total Chromium	mg/l	USEPA Method 200.8 : 1994

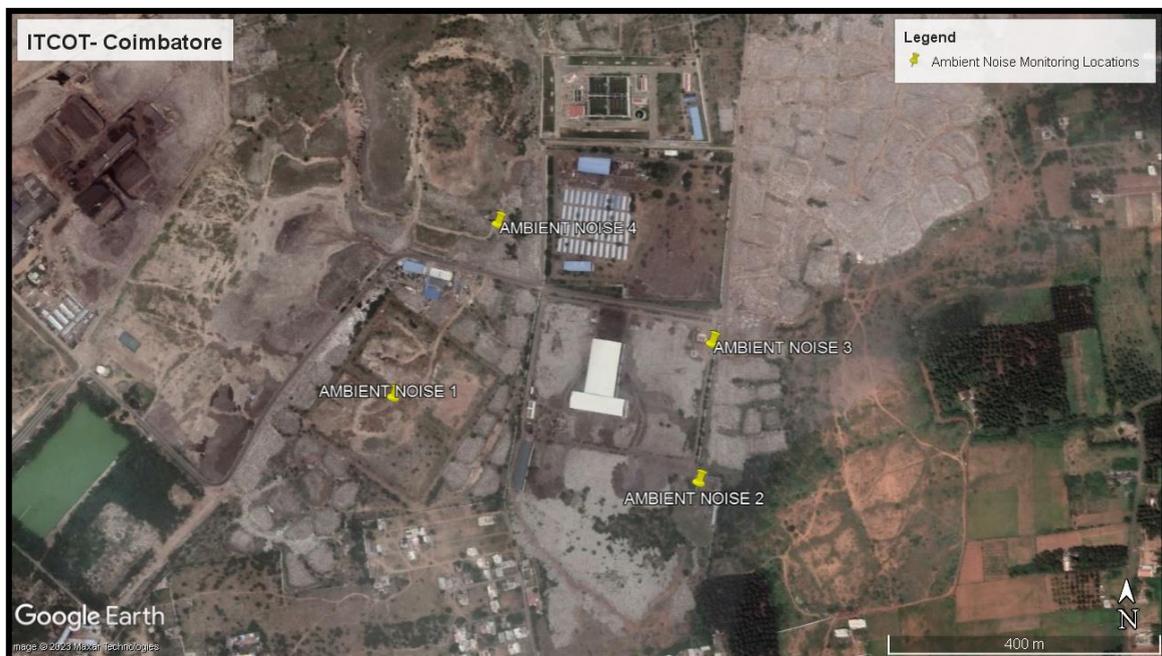
c) Leachate Quality Monitoring Results

S.No.	Parameters	Units	LW-1	LW -2	LW-3	LW-4
1	pH (at 25 °C)	-	7.96	7.94	8.10	8.03
2	Cadmium	mg/l	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)	BLQ(LOQ 0.001)
3	Chloride as Cl	mg/l	5998.14	2749.14	7747.59	7497.87
4	Total Dissolved Solids	mg/l	13457.0	9384.0	13837.0	13579.0
5	Fluoride	mg/l	BLQ(LOQ0.2)	BLQ(LOQ0.2)	BLQ(LOQ0.2)	BLQ(LOQ0.2)
6	Phenolic compounds as	mg/l	BLQ(LOQ0.1)	BLQ(LOQ0.01)	BLQ(LOQ0.01)	BLQ(LOQ0.01)
7	Zinc as Zn	mg/l	BLQ(LOQ0.1)	BLQ(LOQ0.1)	BLQ(LOQ0.1)	BLQ(LOQ0.1)
8	Copper as Cu	mg/l	BLQ(LOQ0.01)	BLQ(LOQ0.01)	BLQ(LOQ0.01)	BLQ(LOQ0.01)
9	Lead as Pb	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
10	Arsenic as As	mg/l	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)	BLQ(LOQ0.005)
11	Mercury as Hg	mg/l	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)	BLQ(LOQ0.0005)
12	Total suspended solid	mg/l	76.0	88.0	92.0	68.0
13	BOD,3 days @27° C as O ₂	mg/l	820.0	310.0	486.0	588.0
14	Chemical oxygen demand as	mg/l	8080.0	3040.0	4480.0	5360.0
15	Nickel	mg/l	BLQ(LOQ0.01)	BLQ(LOQ0.01)	BLQ(LOQ0.01)	BLQ(LOQ0.01)
16	Total Kjeldahl Nitrogen	mg/l	366.88	1138.36	422.0	392.82
17	Ammonical Nitrogen as NH ₃ -N	mg/l	238.24	739.2	274.08	255.08
18	Cyanide	mg/l	BLQ(LOQ0.01)	BLQ(LOQ0.1)	BLQ(LOQ0.01)	BLQ(LOQ0.01)
19	Total Chromium	mg/l	BLQ(LOQ0.01)	BLQ(LOQ0.01)	BLQ(LOQ0.01)	BLQ(LOQ0.01)

* Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per litre.

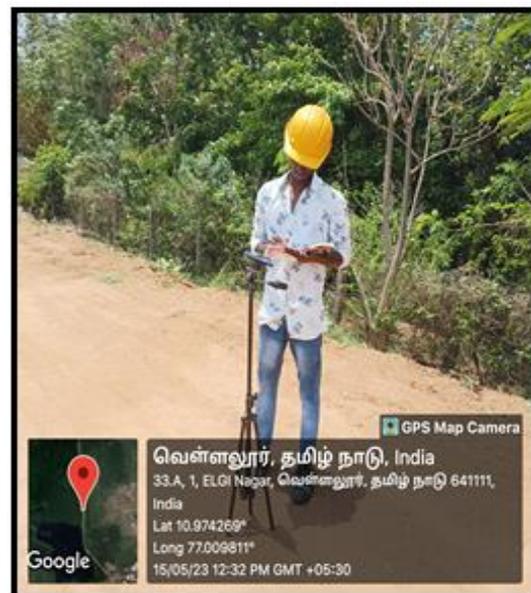
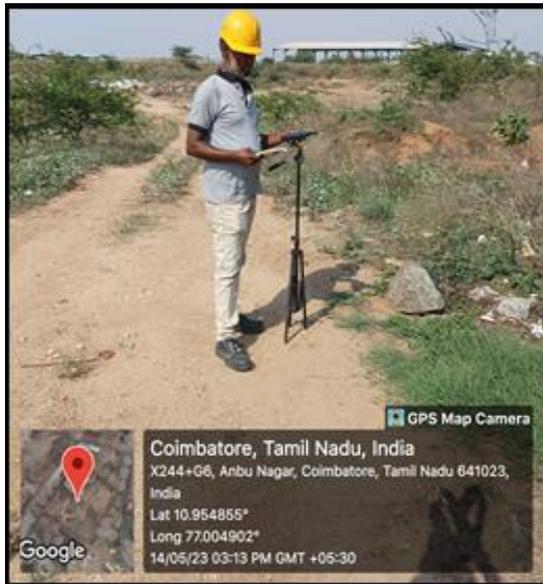
9.2.5 Ambient noise sampling locations

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
AN-1	UPL Main Gate	14.05.2023	10° 57' 17.58" N	77° 0' 17.64" E
AN-2	ELGI Nagar	14.05.2023	10° 57' 13.48" N	77° 0' 32.61" E
AN-3	Labour Shed	14.05.2023	10° 57' 20.18" N	77° 0' 33.31" E
AN-4	Vermi Compost Plant	15.05.2023	10° 58' 27.36" N	77° 0' 35.31" E



Google earth image showing Ambient Noise Sampling Locations

a) Ambient Noise Monitoring Photographs



b) Table Showing Ambient Noise Monitoring results

Sample Code	Name of the Monitoring Location	Day Time Noise Level dB(A)	Night Time Noise Level dB(A)
AN-1	UPL Main Gate	64.8	57.2
AN-2	ELGI Nagar	56.1	48.3
AN - 3	Labour Shed	59.3	51.4
AN- 4	Vermi Compost Plant	58.5	50.7

9.2.6 Soil sampling locations

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
S1	Vellalur Lake	14.05.2023	10° 57' 20.18" N	77° 0' 33.31" E
S2	Kurichi Lake	14.05.2023	10° 57' 12.55" N	77° 0' 32.56" E
S3	Noiyal Lake	14.05.2023	10° 57' 17.47" N	77° 0' 17.46" E
S4	Ukkadam Lake	14.05.2023	10° 57' 17.51" N	77° 0' 17.46" E



Google earth image showing Soil Sampling Locations

a) Soil Sample Collection Photographs



b) Table showing soil quality monitoring results

S.No	Parameter	units	Soil - 1	Soil - 2	Soil - 3	Soil - 4
1	Soil	-	CLAY LOAM	LOAM	CLAY	LOAM
2	Soil	%	22.4	38.8	22.9	38.9
3	Soil	%	43.7	45.3	34.6	42.5
4	Soil	%	33.9	15.9	42.5	18.6
5	pH (at	-	6.97	7.18	7.38	7.39
6	Potassium	mg/kg	39.51	28.45	67.44	34.45

7	Calcium as	mg/kg	600.45	605.45	840.44	570.19
8	Magnesium	mg/kg	180.45	170.55	365.35	165.24
9	Cadmium	mg/kg	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	0.36	BLQ(LOQ 0.1)
10	Copper as	mg/kg	19.42	3	163.80	6.14
11	Iron	mg/kg	5.81	5	4.12	4.39
12	Lead	mg/kg	8.57	0	2.69	1.89
13	Zinc	mg/kg	28.95	8.41	10.72	10.09
14	Sodium	mg/kg	261.45	275.19	495.45	319.45
15	Chlorides	mg/kg	615.48	605.39	954.49	741.56
16	Sulphates	mg/kg	150.45	142.54	221.84	192.45
17	Silica	mg/kg	41.35	49.54	53.45	57.47
18	Nickel	mg/kg	8.01	2.7	12.38	5.55
19	Oil and Grease	mg/kg	BLQ(LOQ 4.0)	BLQ(LOQ 0.1)	BLQ(LOQ 4.0)	BLQ(LOQ 0.1)
20	Hexavalent Chromium	mg/kg	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)
21	Moisture	%	6.71	2.59	5.39	5.76
22	Percentage	%	93.29	97.41	94.61	94.24
23	Volatile	%	0.81	0.72	0.74	0.79
24	Trivalent	mg/kg	3.36	4.68	15.23	2.37
25	Total	mg/kg	7.29	5.81	3.72	6.35
26	M-	mg/kg	169.45	181.25	191.31	187.43

9.2.7 Landfill sampling locations

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
LF1	ELGI Nagar	14.05.2023	10° 58' 27.01" N	77° 0' 34.66" E
LF 2	Vellalur Lake	15.05.2023	10° 57' 20.18" N	77° 0' 33.31" E
LF 3	Waste Dumb Yard	15.05.2023	10° 57' 20.18" N	77° 0' 33.31" E
LF 4	Project Site	15.05.2023	10° 57' 17.34" N	10° 57' 17.34" N



Google earth image showing Landfill Gas Sampling Locations

a) Landfill gas collection photographs





b) Landfilling Analysis

S.No.	Parameters	Units	LF1	LF2	LF3	LF4
1	Carbon dioxide	ppm	2.60	2.84	2.94	2.75
2	Methane	ppm	BLQ(LOQ 1.0)	BLQ(LOQ 1.0)	BLQ(LOQ 1.0)	BLQ(LOQ 1.0)

9.2.8 Odour inside and outside sampling locations

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
01	ODOUR -1	14.05.2023	10° 57' 17.37" N	77° 0' 17.33" E
02	ODOUR -2	15.05.2023	10° 57' 21.61" N	77° 0' 20.89" E
03	ODOUR -3	15.05.2023	10° 58' 20.84" N	77° 0' 47.30" E
04	ODOUR -4	15.05.2023	10° 57' 21.61" N	77° 0' 20.90" E



Google Earth Image showing Odour Monitoring Locations

c) Odour analysis results

S.No	Parameters	units	ODOUR -1	ODOUR -2	ODOUR -3	ODOUR -4
1	Volatile Organic Compound	ppm	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)

9.2.9 Meteorological data collecting location

Sample Code	Name of the Monitoring Location	Date of Sampling	Latitude	Longitude
M1	Vermin Compost Plant	15.05.2023	12° 51' 49.75" N	80° 8' 40.2" E



Google earth image showing Micrometeorology Monitoring Location

a) Micrometeorology data

Hours	Wind Speed Km/Hr	Cloud Cover	Relative Humidity	Wind Direction	Temperature	
					Dry °c	Wet°c
10.00	12.0	Fair	47	SSW	35.0	23.6
11.00	19.0	Fair	59	SSW	32.0	24.3
12.00	15.0	Fair	66	SSW	31.0	25.0
13.00	22.0	Fair	70	SSW	30.0	25.0
14.00	19.0	Haze	74	SW	29.0	24.9
15.00	17.0	Haze	74	SW	29.0	24.9

Hours	Wind Speed Km/Hr	Cloud Cover	Relative Humidity	Wind Direction	Temperature	
					Dry °c	Wet°c
16.00	13.0	Fair	74	SSW	28.0	23.9
17.00	19.0	Fair	84	SW	27.0	24.8
18.00	15.0	Fair	89	SSW	26.0	24.6
19.00	15.0	Fair	89	SW	26.0	24.6
20.00	15.0	Fair	94	SSW	26.0	25.5
21.00	13.0	Fair	94	SSW	26.0	25.5
22.00	15.0	Fair	94	SW	26.0	25.5
23.00	11.0	Fair	94	SSW	26.0	25.5
24.00	15.0	Fair	89	SW	26.0	24.6
01.00	13.0	Fog	89	SW	26.0	24.6
02.00	17.0	Fog	89	SW	26.0	24.6
03.00	13.0	Fog	74	SSW	28.0	23.9
04.00	15.0	Haze	74	SSW	29.0	24.9
05.00	7.0	Haze	62	S	31.0	24.1
06.00	15.0	Haze	59	SW	32.0	24.3
07.00	15.0	Fair	52	SSW	34.0	24.2
08.00	24.0	Fair	47	S	35.0	23.6
09.00	15.0	Fair	47	S	36.0	24.3

The establishment of Bio-CNG plant does not have any environmental impact, rather has a positive impact as listed below:

- Biogas is an eco-friendly fuel.
- Provides a non-Polluting and renewable source of energy.
- Has a calorific value of around 6kWh/m³ which is equivalent to half litre of diesel.

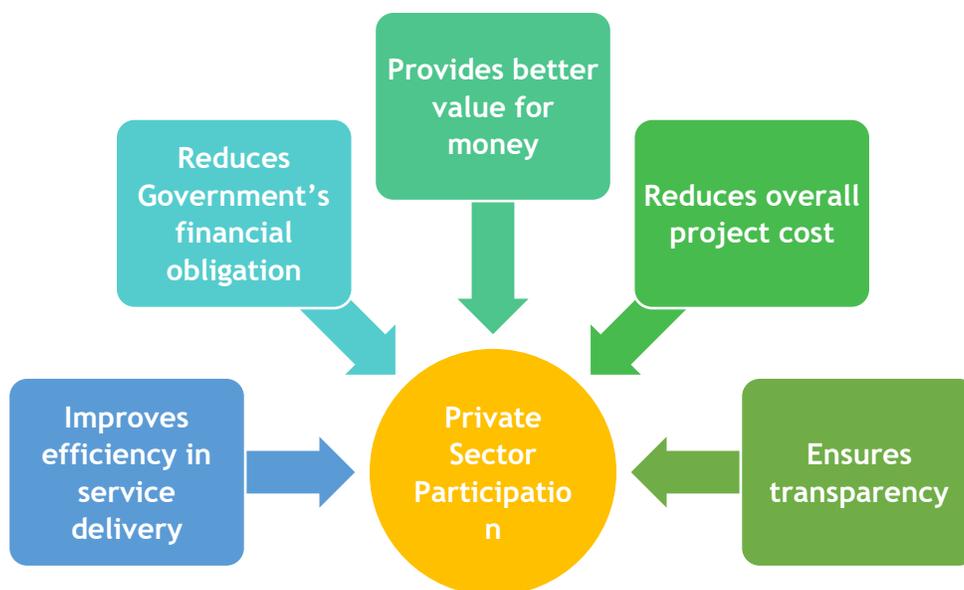
- The digested sludge is a high quality organic manure, completely natural and free from harmful synthetic chemicals. It can supplement or even replace chemical fertilizers.
- Leads to improvement in the environment, sanitation and hygiene.
- Household wastes and bio-wastes can be disposed of in a healthy manner.
- Anaerobic digestion inactivates pathogens and parasites, and is quite effective in reducing the incidence of water borne diseases.
- Environmental benefits on a global scale: Biogas plant significantly lowers the Greenhouse gas effects on the earth's atmosphere. The plant lowers methane emissions by entrapping and using it as fuel.

Overall, the study demonstrated that the proposed plant is socially desirable and environmentally compatible.

10 Legal Framework

10.1. Public Private Partnership model -An Overview

Public Private Partnership (PPP) means an arrangement between Government or statutory entity or Government owned entity on one side and a private sector entity on the other, for the provision of public assets and/or related services for public benefit, through investments being made by and/or management undertaken by the private sector entity for a specified period of time, where there is a substantial risk sharing with the private sector and the private sector receives performance linked payments that conforms to specified, predetermined and measurable performance standard.



There are various models used in PPP projects in India and the same is listed below:

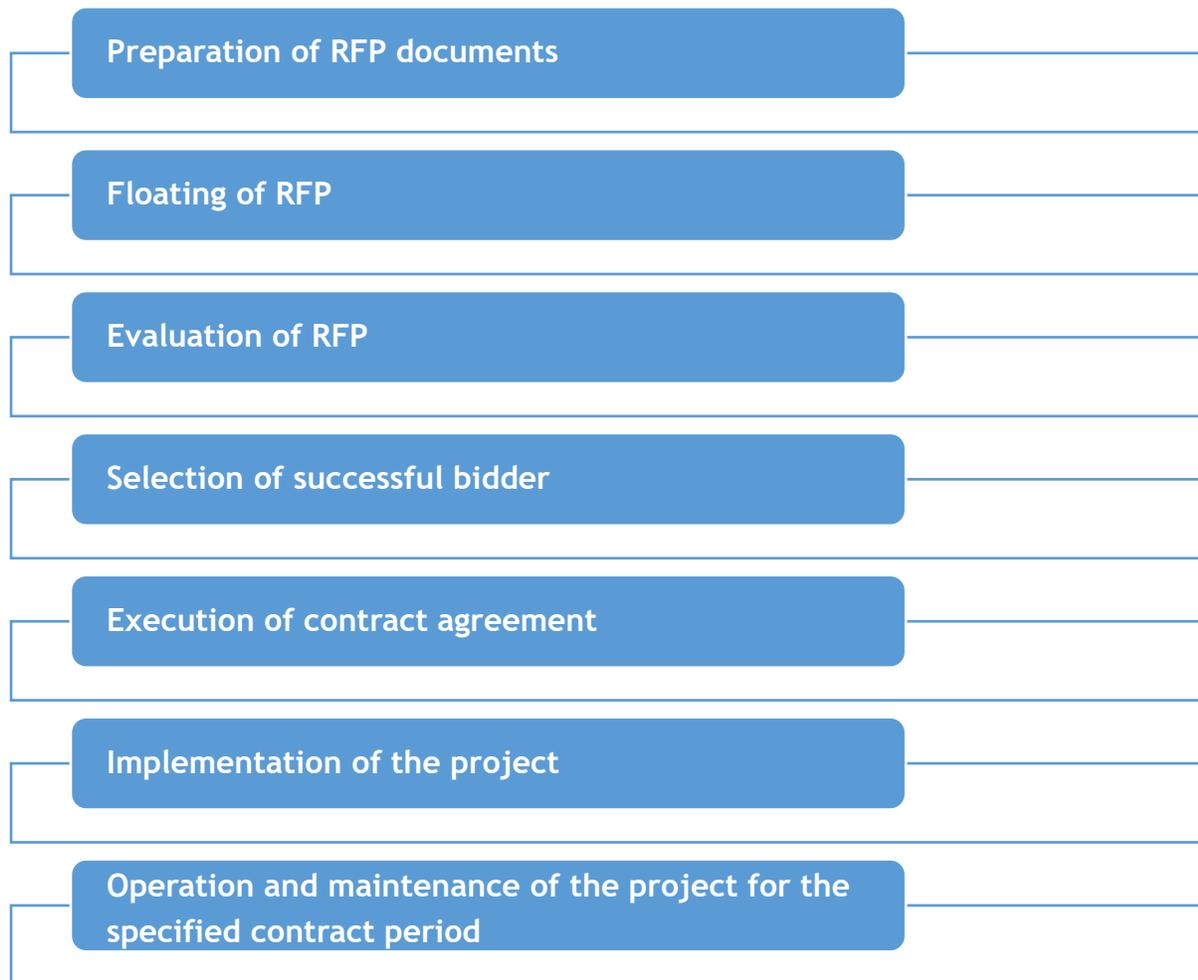
- Design-Build (DB)
- Design-Build-Operate (DBO)
- Design-Build-Finance-Own-Operate (DBFOO)
- Build-Operate-Transfer (BOT)
- Design-Build-Finance-Own-Operate-Transfer (DBFOOT)
- Build-Own-Operate (BOO)

10.2. Allocation of responsibilities

Responsibility	Execution	
	ULB	Private
Ownership		✓
Design		✓
Construction		✓
Finance		✓
Operation		✓
Maintenance		✓
Cost escalation in O&M		✓
Time overrun		✓
Condition precedents	✓	✓
Force Majeure	✓	✓
Change in Law	✓	✓
Revenue fluctuation - upside		✓
Revenue fluctuation - downside		✓
Extension of timelines	✓	✓
Extension in concession period	✓	✓
Independent Engineer	✓	
Termination	✓	✓

10.3. Process flow

The PPP process flow for implementation of project is shown below:



10.4. Proposed Project Implementation Structure

The project is proposed to be implemented on Design, Build, Finance, Own, Operate, Transfer (DBFOOT) model under Public Private Partnership (PPP) mode.

Design, Build, Finance, Own, Operate, Transfer (DBFOOT) Model

- The selected Private player shall Design, Build and Finance for establishment of Bio-CNG plant
- The entire responsibility of processing, operating & maintaining of the Bio-gas plant will be vested with the Private Player

- The selected private player has to install, operate and maintain the facility for a period of 20 years
- At the end of the contract period, the ownership of the entire facility will be transferred to ULB.

Roles & responsibilities

Role of ULB	Role of Private Player
<ul style="list-style-type: none"> ▪ Provide land for Bio-CNG Plant ▪ Supply of Segregated wet waste ▪ Collection of unprocessed waste (Reject waste) 	<ul style="list-style-type: none"> ▪ Establishment of Bio-CNG Plant ▪ Processing of wet waste ▪ Generation of Bio-CNG & Organic Manure ▪ Marketing of Bio-CNG & Organic Manure ▪ Payment of Royalty charges

11 Stakeholder Consultation Findings

Stakeholder consultations were conducted to gather input and perspectives from various parties involved in the project, including local government, residents, waste management authorities, environmental groups, and other interested parties. The consultations aimed to capture the following findings:

1. **Waste generation rates and types:** Through interactions with stakeholders, information regarding the quantity and types of waste generated in the area was gathered.
2. **Environmental concerns:** Environmental groups and other stakeholders expressed concerns about potential environmental impacts of the biogas plant on local ecosystems and wildlife. These concerns were considered, and mitigation measures were developed to address them. The design and operation of the plant were modified to minimize adverse effects on the environment.
3. **Community impacts:** Stakeholders, particularly residents, provided valuable feedback on the potential impact of the biogas plant on their community. Concerns such as noise, odours, and traffic were raised. The feedback helped in shaping the design of the plant to mitigate these potential negative impacts and ensure a harmonious coexistence with the community.
4. **Funding and financing:** During the consultations, the local government and other stakeholders expressed concerns about the project's cost and the availability of funding. These concerns were carefully considered, and financial aspects were considered during the project planning phase. Efforts were made to explore funding opportunities and ensure the project's financial feasibility.
5. **Regulatory and permitting requirements:** Stakeholder consultations facilitated the identification of relevant regulatory and permitting requirements that needed to be met for the project to proceed. These requirements were incorporated into the project planning and

implementation process to ensure compliance with applicable laws and regulations.

Overall, the stakeholder consultations played a crucial role in capturing the viewpoints and concerns of key stakeholders. The findings from these consultations informed the project design, addressing waste generation rates and types, environmental concerns, community impacts, funding and financing considerations, and regulatory requirements.

By incorporating the inputs and addressing the concerns raised during the consultations, the project aimed to achieve a higher level of stakeholder satisfaction, ownership, and successful implementation.

12 Value for Money Analysis

The Value for Money Analysis is given below:

	₹ in Crores	
	ULB	PPP
PV of costs		
Investments to be made for the project	69.20	-
Total costs for public finances	69.20	-
PV of receipts		
Net Income	100.10	-
Royalty	-	6.66
Total receipts for public finances	100.10	6.66
Net cash inflow to Public Finances (Receipts - Costs)	30.90	6.66
Risk adjustment		
Cost overrun risk (10% of investment)	6.92	-
Income risk (15% of PV of revenue)	33.40	-
Operational expenditure risk (15% of PV of OPEX)	19.19	-
Adjusted net cash inflow to Public Finances	(14.76)	6.66
Discount rate (10-year Govt. bond yield)	7.15%	

Thus, involving the Private Player is economically beneficial due to the ULB's limited expertise and capacity in handling the design, operation, and maintenance of the facility.

PART B: Project Structuring

13 Structuring for the selection of Private Player

13.1 Risk Assessment

The various risks associated with the project have been analysed and they have been allocated to both the Authority and the Private Entity. The following matrix explains each of the risk and its allocation:

Risk	Assessment	Contracting Authority	Private Entity	Mitigation Measures
Land	15 acres of land is required for the proposed project	✓		The Coimbatore Municipal Corporation owns 654.4 acres of land at Vellalore town, Coimbatore.
Project Design and construction	The design of the Bio-CNG plant must be carefully considered to ensure that it is both efficient and environmentally friendly. Any design flaws or construction errors can result in delays, cost overruns, or even project failure.		✓	Hire experienced designers and contractors with a proven track record in biogas plant construction. Ensure that the design and construction are in accordance with regulatory requirements and industry best practices. Timely completion will result in savings and early realization of revenues from the project.
Operational Risk	The operation of the biogas plant requires skilled staff, and effective maintenance practices. Failure to operate the plant efficiently can result in		✓	Train staff to operate the plant efficiently and implement effective maintenance practices. Implement monitoring and control systems to detect and address any issues that

Risk	Assessment	Contracting Authority	Private Entity	Mitigation Measures
	reduced revenue, increased costs, or even plant shutdown.			arise.
Commercial Risk	The revenue generated by the biogas plant may depend on the availability of feedstock, the price of biogas, and the demand for biogas products. Any changes in these factors can affect revenue realization and profitability		✓	<p>Ensure the requisite quantity of feedstock from the CCMC.</p> <p>Enter into a long term contract agreement with oil marketing companies for sale of Bio-CNG.</p> <p>Enter into an agreement for marketing of manure with FPO</p>
Non-Compliance Risk	Biogas plant operators must comply with environmental and safety regulations. Failure to comply with regulations can result in penalties, fines, or even plant closure.		✓	Develop and implement an environmental and safety management plan to comply with all relevant regulations. Regularly review and update the plan to stay current with regulatory changes.

13.2 Key Commercial Principles

The project involves establishment of MSW based Bio-CNG plant by the bidder who will be responsible for design, construction, installation, operation and maintenance of Bio-CNG plant. The key commercial principles are summarized as below:

13.2.1 Concession Period

The concession shall be for a period of 20 years from the date of commencement of commercial operation.

13.2.2 Bid Variable

The bidder who quotes the Highest Royalty per MT of waste shall be awarded the Contract.

13.3 Scope of Work

The broad scope of the Concessionaire during the construction phase and operation phase would inter-alia include the following:

Construction Phase

- CCMC will earmark land to the Concessionaire in the dump yard. The Concessionaire shall set-up the plant along with all required machineries and civil works for processing 250 TPD wet waste into Bio-CNG.
- All required support infrastructures covering yard, storage, water tank, drying - area etc. shall be constructed by the Concessionaire as per the requirement while full-filling all the statutory norms.
- The Concessionaire shall be responsible for availing electricity connection and water provisions at the site earmarked. The expenses related to electricity and water shall be borne by the Concessionaire.
- The Concessionaire shall be responsible for obtaining all requisite statutory approval and certifications as required for the regular operations of the plant.

Operations and Maintenance Phase

- The Concessionaire shall undertake operation and maintenance of the plant for a period of 20 years from the date of commencement of operation.
- CCMC shall deliver the wet waste at the project site. If there is a mix of solid dry waste in the waste delivered, the Concessionaire should segregate the same and utilize the wet waste fully and dry rejects will be taken back by CCMC, whenever accumulation of quantity reaches 5 tonnes from the processing site.
- The Concessionaire shall ensure that the minimum quantity of wet waste processed is 250 TPD.

-
- The Concessionaire should process the wet waste scientifically and convert to Bio-CNG and solid fertilizers.
 - It shall be the responsibility of the Concessionaire to account for the quantity of wet waste processed on any given day and the quantity of Bio-CNG produced and solid fertilizers as part of conversion. The Concessionaire should have a mechanism to scientifically weigh the quantity of wet waste, Bio-CNG produced and solid fertilizers. There should be an automated weighing provision for the quantity of wet waste received at the plant and also for produced Bio-CNG and solid fertilizer. This will have to be automatically fed in to the designated software without any manual intervention.
 - A real-time online MIS needs to be set-up by the Concessionaire with full access to officials of CCMC.
 - The Concessionaire should identify the potential buyers for the Bio-CNG and will sell the same to these buyers. CCMC will have no role in identifying the buyers, determining the selling price and the profit margin.
 - The Concessionaire shall ensure the Bio-CNG specifications as per latest Indian Standard Norms and the gas should be suitable to fill in the gas cylinders as per PESO Gas Cylinder Regulations. Necessary NOC from Fire and Rescue service Department and other statutory licenses should be obtained by the Concessionaire.
 - The Concessionaire shall ensure the entire process of conversion of wet waste to Bio-CNG takes place in a completely environment friendly process (including bottling and transportation of CNG) without causing any health hazard to people employed, people living in the nearby areas and the flora and fauna inhabited in the plant-set-up area.
 - Deployment of required labour, technical staff and management staff and their costs shall be the responsibility of the Concessionaire. The labour wages and welfare schemes should be adhered to as per the existing statutory norms.
 - The Water and Electricity charges shall be borne by the Concessionaire.
 - The maintenance and service requirements of the plant, machinery and support infrastructure shall be the responsibility of the Concessionaire. The service

maintenance shall be planned in advance and the same need to be communicated to CCMC well in advance.

- The Concessionaire shall transfer the assets on completion of concession period or the extended / closure period of concession, whichever is applicable, without any cost.

13.4 Payment Terms

- The Concessionaire shall pay to the Concessioneing Authority, Royalty per MT of waste handled during the month.
- Royalty for each month shall be paid on or before the seventh Day of the immediately succeeding month.

13.5 Force Majeure Event

i) Force Majeure Event

Force Majeure Event means the occurrence of any of the Non-Political Events, the Political Events or the Other Events in India, including the impact / consequence thereof which :

- a. is beyond the control of the Party claiming to be affected thereby (the “Affected Party”);
- b. prevents the Affected Party from performing or discharging its obligations under the Agreement; and
- c. the Affected Party has been unable to overcome or prevent despite exercise of due care and diligence.

ii) Non-Political Events

Any of the following events which prevent the Affected Party from performing any of its obligations for a continuous period of not less than 7 (seven) Days from the date of its occurrence, shall constitute a Non-Political Event:

- a. act of God, epidemic, earthquake, cyclone, flood, volcanic eruption, chemical or radioactive contamination or ionizing radiation, fire or explosion (to the extent of contamination or radiation or fire or explosion originating from a source external to the Project Site and by reasons not attributable to the Concessionaire or the Contractor or any of the employees or agents of the Concessionaire or the Contractor);
- b. strikes or boycotts (other than those involving the Concessionaire, Contractors or their respective employees/representatives, or attributable to any act or omission of any of them), and not being an Other Event, labour disruptions or any other industrial disturbances not arising on account of the acts or omissions of the Concessionaire or the Contractor;
- c. any failure or delay of a Contractor caused by any of the Non-Political Events, for which no offsetting compensation is payable to the Concessionaire or on behalf of the Contractor;
- d. the discovery of geological conditions, toxic contamination or archaeological remains on the Project Site that could not reasonably have been expected to be discovered through a site inspection; or
- e. any event or circumstance of a nature analogous to any of the foregoing.

iii) Political Events

Any of the following events shall constitute Political Event:

- a. Change in Law resulting in Material Adverse Effect;
- b. action of a Government Authority having Material Adverse Effect including but not limited to (i) acts of expropriation, compulsory acquisition or takeover by any Government Authority of the Project/Project Facilities and Services or any part thereof or of the Concessionaire's or the Contractor's rights under any of the Project Contracts, and (ii) any unlawful, unauthorized or without jurisdiction refusal to issue or to renew or the revocation of any Applicable Permits, in each case, for reasons other than the Concessionaire's or the Contractor's breach or failure in complying with the Project Requirements, Applicable Laws, Applicable Permits, any judgment or order of a Governmental Agency or of any contract by which the Concessionaire or the Contractor as the case may be is bound;

- c. early determination of the Agreement by Concessioneing Authority for reasons of national emergency, national security or the public interest;
- d. any failure or delay of a Contractor caused by any of the aforementioned Political Events, for which no offsetting compensation is payable to the Concessionaire by or on behalf of the Contractor; or
- e. any event or circumstance of a nature analogous to any of the foregoing.

iv) Other Events

Any of the following events which prevents the Affected Party from performing any of its obligations under the Agreement for a continuous period of not less than 7 (seven) days from the date of its occurrence, shall constitute the Other Event:

- a. an act of war (whether declared or undeclared), invasion, armed conflict or act of foreign enemy, blockade, embargo, riot, insurrection, terrorist or military action, civil commotion or politically motivated sabotage;
- b. industry wide or State wide strikes or industrial action;
- c. any civil commotion, boycott or political agitation which prevents collection of Fee by the Concessionaire;
- d. any judgment or order of a court of competent jurisdiction or statutory authority in India made against the Concessionaire or the Contractor in any proceedings which is non-collusive and duly prosecuted by the Concessionaire; and any judgment or order of a court of competent jurisdiction or statutory authority in India made against the Concessionaire or the Contractor in any proceedings which is non-collusive and duly prosecuted by the Concessionaire other than relating to proceedings (i) pursuant to failure of the Concessionaire to comply with any Applicable Law or Applicable Permit, or (ii) on account of breach of any Applicable Law or Applicable Permit or of any contract, or (iii) enforcement of the Agreement or (iv) with respect to exercise of any of its rights under the Agreement by Concessioneing Authority; or
- e. any event or circumstance of a nature analogous to any of the foregoing.

13.6 Events of Default

Event of Default means the Concessionaire Event of Default or the Concessions Authority Event of Default or both as the context may admit or require.

a. The Concessionaire Event of Default

The Concessionaire Event of Default means any of the following events unless such an event has occurred as a consequence of the Concessions Authority Event of Default or a Force Majeure Event:

- i. the Concessionaire's failure to perform or discharge any of its obligations in accordance with the provisions of the Agreement;
- ii. Delay in payments to the Concessions Authority for 2 (two) consecutive Months or more than (5) (five) times in the aggregate during the Concession Period;
- iii. the Concessionaire's failure to perform or discharge any of its obligations under any other Project Contract, which has or is likely to affect the Project/the Project Facilities and Services, materially;
- iv. any representation made or warranties given by the Concessionaire under the Agreement is found to be false or misleading;
- v. the Concessionaire passing a resolution for voluntary winding up;
- vi. appointment of a provisional liquidator, administrator, trustee or receiver of the whole or substantially whole of the undertaking of the Concessionaire by a court of competent jurisdiction in proceedings for winding up or any other legal proceedings;
- vii. levy of an execution or restraint on the Concessionaire's assets which has or is likely to have Material Adverse Effect and/or affect the Project/Project Facilities and Services, materially and such execution or restraint remaining in force for a period exceeding 90 (ninety) Days;

- viii. the Security Deposit / Performance Guarantee is not maintained in terms of the provisions hereof;
- ix. the Concessionaire abandons or expresses its intention to revoke/terminate the Agreement without being entitled to do so as is expressly provided in the Agreement;
- x. a change in shareholding such that the beneficial interest of the Applicant in the Concessionaire reduces below the limits set;
- xi. amalgamation of the Concessionaire with any other company or reconstruction or transfer of the whole or part of the Concessionaire's undertaking other than transfer of assets in the ordinary course of business; and
- xii. the Concessionaire engaging or knowingly allowing any of its employees, agents, Contractor or representative to engage in any activity prohibited under the Agreement and/or by law or which constitutes a breach of the Agreement or breach of or an offence under any law, in the course of any activity undertaken pursuant to the Agreement.

b. The Concessions Authority Event of Default

- i. The Concessions Authority's failure to perform or discharge its obligations in accordance with the provisions of the Agreement unless such failure has occurred as a consequence of any Concessionaire Event of Default or a Force Majeure Event.
- ii. any representation made or warranties given by the Concessions Authority under the Agreement is found to be false or misleading.
- iii. appointment of a provisional liquidator, administrator or receiver of the whole or part of the Assets in any legal proceedings initiated against the Concessions Authority (unless such proceedings are initiated as a consequence of any Concessionaire Event of Default).
- iv. levy of an execution or restraint on the Assets in any proceedings against the Concessions Authority (unless such proceedings are initiated as a consequence of any Concessionaire Event of Default)

which has or is likely to have Material Adverse Effect and such execution or restraint remaining in force for a period exceeding 90 (ninety) Days.

13.7 Compensation

- Termination due to Force Majeure Event
 - (i) If the termination is due to a Non Political Event, compensation payable to the Concessionaire shall be the lower of the Book Value or the Debt Due LESS any amount due to the Concessioneing Authority by the Concessionaire under the Agreement LESS all insurance claims received or admitted.
 - (ii) If the termination is due to Other Event compensation payable to the Concessionaire shall be the higher of the Book Value or the Debt Due LESS any amount due to the Concessioneing Authority by the Concessionaire under the Agreement LESS all insurance claims received or admitted. Provided, the Book Value or the Debt Due, as the case may be shall not exceed the Total Project Cost.
 - (iii) If termination is due to a Political Event, compensation payable to the Concessionaire shall be the same as that stipulated for termination due to a Concessioneing Authority Event of Default.

Provided, no compensation shall be payable to the Concessionaire if the Concessionaire fails to maintain Insurance Cover.

- Termination due to Concessionaire Event of Default

If the termination is after the Date of Commercial Operation, due to a Concessionaire Event of Default, the compensation payable by the Concessioneing Authority to the Concessionaire shall be the lowest of:

- (i) the Book Value;
- (ii) 90% (ninety percent) of Debt Due;
- (iii) the Total Project Cost;

Provided, no compensation shall be payable to the Concessionaire if the Concessionaire fails to maintain Insurance Cover as contemplated in the Agreement.

- Termination due to Concessioneing Authority Event of Default

If the termination is due to a Concessioneing Authority Event of Default, the compensation payable by the Concessioneing Authority shall be equal to the aggregate of (i) Debt Due plus (ii) 150% (one hundred and fifty percent) Equity.

- No Compensation on Expiry of Concession Period

In the event of expiry of Concession by efflux of time (the Concession having run its full course), the Concessionaire shall hand over/ transfer peaceful possession of the Project Site, Assets and the Project Facilities and Services free of cost and Encumbrance.

13.8 Insurance

The Concessionaire should, at his cost and expense, purchase and maintain insurances as are prudent, including but not limited to the following:

- i. Loss, damage or destruction of the Project Facilities and Services;
- ii. Comprehensive third-party liability insurance including injury or death to personnel who may enter the Project Site;
- iii. Workmen's compensation insurance; and
- iv. Any other insurance that may be necessary to protect the Concessionaire, its employees and its assets and agents engaged in or connected to the project including all Force Majeure Events that are insurable and not otherwise covered in items (i) to (iii).

13.9 Evaluation criteria for selection of the private player

The criteria for selection of the Private Player shall be as follows:

1. The bidder should be a registered company in India and should be in existence for the past three years as on 31st March 2023.
2. The bidder should have experience in setting up, operating and maintaining a Bio-CNG plant of capacity at least 150 TPD or should be technically supported

by original equipment manufacturer/technology provider who has successfully completed implementation of at least 150 TPD Bio-CNG plant.

3. The bidder should have reported an Average Annual Turnover of at least ₹50 Crores in the last three consecutive financial years i.e., 2020-21, 2021-22 and 2022-23
4. The bidder should have reported a positive net worth of at least ₹25.00 crores as on 31st March 2023.
5. The bidder should not have been blacklisted by Central Government, any State Government, a Statutory Body, any Public Sector Undertaking, Banks or Financial Institutions and declared as NPA by Banks or Financial Institutions as on the date of tender opening.

Financial Statements

						Statement 1
COST OF PROJECT AND MEANS OF FINANCE						₹ in Crores
			Allocation			
Cost of Project		Cost	Cont.	Pre-oper.	IDC	Total
Civil works		16.71	0.84	0.17	1.14	18.86
Mechanical and Electrical Equipments		43.15	2.16	0.43	2.95	48.68
Miscellaneous Fixed Assets		1.41	0.07	0.01	0.10	1.59
Laboratory Equipments		0.06	0.00	0.00	0.00	0.06
Sub Total		61.32	0.00	0.00	0.00	0.00
Contingencies	5.00%	3.07	0.00	0.00	0.00	0.00
Preoperative expenses	1.00%	0.61	0.00	0.00	0.00	0.00
Interest During Construction		4.19	0.00	0.00	0.00	0.00
Total		69.20	3.07	0.61	4.19	69.20
MEANS OF FINANCE						
		₹ in Crores				
Equity	25%	17.30				
Central Financial Assistance under WTE scheme, MNRE	7%	5.07				
Term Loan	68%	46.83				
Total		69.20				
Debt-Equity Ratio	2.09	:	1			

							Statement-2
PHASING OF FUND REQUIREMENT							₹ in Crores
Year ending March 31	1		2				
	Q3	Q4	Q1	Q2	Q3	Q4 (Trail Run)	Total
Civil works	4.18	4.18	2.51	2.51	3.34	0.00	16.71
Mechanical and Electrical Equipments	4.31	8.63	8.63	8.63	12.94	0.00	43.15
Miscellaneous Fixed Assets	0.14	0.28	0.28	0.28	0.42	0.00	1.41
Laboratory Equipments	0.00	0.00	0.00	0.00	0.06	0.00	0.06
Contingencies	0.43	0.65	0.57	0.57	0.84	0.00	3.07
Preoperative expenses	0.61	0.00	0.00	0.00	0.00	0.00	0.61
Fund Requirment	9.68	13.74	11.99	11.99	17.60	0.00	65.00
LOAN DRAWAL SCHEDULE							
~ Equity	2.90	4.81	4.20	4.20	1.19	0.00	17.30
~ CFA, MNRE	2.54	0.00	0.00	0.00	0.00	2.54	5.07
~ Term Loan	4.24	8.93	7.79	7.79	13.88	0.00	42.63
~ Bridge Loan	0.00	0.00	0.00	0.00	2.54	0.00	0.00
Total	9.68	13.74	11.99	11.99	17.60	2.54	65.00
Month	18	15	12	9	6	3	
Interest During Construction (IDC)	0.70	1.23	0.86	0.64	0.76	0.00	4.19

											Statement 3
COST OF PRODUCTION & PROFITABILITY											₹ in Crores
Year ending March 31		1	2	3	4	5	6	7	8	9	10
Installed capacity per day	MT	250	250	250	250	250	250	250	250	250	250
No. of working days per annum	Days	365	365	365	365	365	365	365	365	365	365
Capacity Utilization	%	85%	90%	95%	95%	95%	95%	95%	95%	95%	95%
Waste Processed per annum	MT	77,563	82125	86687.5							
Output											
Bio Gas	Cum	50,41,563	53,38,125	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688
CNG	Kg	19,87,384	21,04,289	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194
Organic manure	Kg	77,56,250	82,12,500	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750
Selling Price											
-CNG	₹/kg	54.00	56.16	58.41	60.74	63.17	65.70	68.33	71.06	73.90	76.86
-Manure	₹/kg	4.00	4.20	4.41	4.63	4.86	5.11	5.36	5.63	5.91	6.21
Income											
-CNG	₹ in Crores	10.73	11.82	12.97	13.49	14.03	14.59	15.18	15.78	16.42	17.07
-Manure	₹ in Crores	3.10	3.45	3.82	4.01	4.21	4.43	4.65	4.88	5.12	5.38
Net Sales		13.83	15.27	16.80	17.51	18.25	19.02	19.82	20.66	21.54	22.45
Cost of Production											
Cost of consumables	Statement 4	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26	0.27	0.28
Cost of power	Statement 5	2.13	2.19	2.26	2.37	2.38	2.39	2.51	2.53	2.54	2.67
Cost of manpower	Statement 6	1.98	2.08	2.18	2.29	2.41	2.53	2.65	2.79	2.93	3.07
Cost of transportation	Statement 4	0.30	0.33	0.37	0.39	0.40	0.43	0.45	0.47	0.49	0.52
Repairs & maintenance	0.20%	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19
Administrative expenses	1.00%	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.19	0.20	0.21
Depreciation	Statement 7	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Interest on term loan	Statement 8	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33
Royalty charges payable to ULB	₹ 50.00	0.39	0.43	0.48	0.50	0.53	0.55	0.58	0.61	0.64	0.67
Total Expense		14.22	14.14	13.99	13.76	13.44	13.08	12.79	12.41	12.03	11.78
Profit Before Tax/ Loss		-0.39	1.13	2.81	3.75	4.81	5.94	7.03	8.26	9.51	10.67
Income Tax	Statement 9	0.00	0.19	0.47	0.63	0.80	0.99	1.17	1.38	1.82	3.50
Profit/(Loss) After Tax		-0.39	0.94	2.34	3.12	4.01	4.95	5.86	6.88	7.69	7.17
Add: Depreciation		3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Cash accruals		3.45	4.77	6.18	6.96	7.84	8.78	9.69	10.72	11.53	11.01

Contd...

Statement 3 contd...											
Year ending March 31		11	12	13	14	15	16	17	18	19	20
Installed capacity per day	MT	250	250	250	250	250	250	250	250	250	250
No. of working days per annum	Days	365	365	365	365	365	365	365	365	365	365
Capacity Utilization	%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Waste Processed per annum	MT	86687.5									
Output											
Bio Gas	Cum	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688	56,34,688
CNG	Kg	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194	22,21,194
Organic manure	Kg	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750	86,68,750
Selling Price											
-CNG	₹/kg	79.93	83.13	86.46	89.91	93.51	97.25	101.14	105.19	109.39	113.77
-Manure	₹/kg	6.52	6.84	7.18	7.54	7.92	8.32	8.73	9.17	9.63	10.11
Income											
-CNG	₹ in Crores	17.75	18.46	19.20	19.97	20.77	21.60	22.47	23.36	24.30	25.27
-Manure	₹ in Crores	5.65	5.93	6.23	6.54	6.87	7.21	7.57	7.95	8.34	8.76
Net Sales		23.40	24.40	25.43	26.51	27.64	28.81	30.03	31.31	32.64	34.03
Cost of Production											
Cost of consumables	Statement 4	0.30	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44	0.46
Cost of power	Statement 5	2.68	2.69	2.83	2.84	2.86	3.00	3.02	3.04	3.19	3.21
Cost of manpower	Statement 6	3.23	3.39	3.56	3.73	3.92	4.12	4.32	4.54	4.77	5.00
Cost of transportation	Statement 4	0.54	0.57	0.60	0.63	0.66	0.69	0.73	0.76	0.80	0.84
Repairs & maintenance	0.20%	0.20	0.20	0.22	0.23	0.24	0.25	0.26	0.27	0.29	0.30
Administrative expenses	1.00%	0.23	0.24	0.25	0.26	0.27	0.29	0.30	0.32	0.33	0.35
Depreciation	Statement 7	3.76	3.68	3.68	3.68	3.68	3.06	0.60	0.60	0.60	0.60
Interest on term loan	Statement 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Royalty charges payable to ULB		0.71	0.74	0.78	0.82	0.86	0.90	0.95	0.99	1.04	1.10
Total Expense		11.63	11.82	12.23	12.53	12.85	12.68	10.58	10.94	11.46	11.86
Profit Before Tax/ Loss		11.77	12.57	13.20	13.98	14.79	16.13	19.46	20.37	21.18	22.17
Income Tax	Statement 9	3.90	4.19	4.45	4.74	5.03	5.28	5.58	5.88	6.14	6.46
Profit/(Loss) After Tax		7.87	8.38	8.75	9.24	9.76	10.84	13.88	14.49	15.04	15.71
Add: Depreciation		3.76	3.68	3.68	3.68	3.68	3.06	0.60	0.60	0.60	0.60
Cash accruals		11.63	12.06	12.43	12.92	13.44	13.90	14.48	15.09	15.64	16.31

			Statement 4
ASSUMPTIONS FOR COST OF PRODUCTION AND PROFITABILITY			
Installed capacity per day	250	MT	
No. of working days per annum	365	days	
Capacity Utilization			
1	85%		
2	90%		
3 onwards	95%		
Output			
Bio Gas	65	Cum per MT of waste	
Density of methane	0.657	kg/cum	
Bio-CNG	60%	of Bio Gas	
Organic manure	10%	of waste processed	
Selling Price			
-CNG	₹ 54.00	per kg and 4% increase in every subsequent year	
-Manure	₹ 4.00	per kg and 5% increase in every subsequent year	
Consumables			
-Cow dung requirement	5.00%	of the waste processed	
	12.5	TPD	
-Cost of cow dung including transporta	400	per MT	
	₹ 5,000.00	per day	
	₹ 0.18	crores per annum and 5% increase in every subsequent year	
Cost of transportation			
-CNG	₹ 1,500.00	per MT & 5% increase every subsequent year	
-Manure	Transportation of manure from the site shall be the responsibility of the purchaser		
Cost of TNEB power	₹ 6.90	per unit and 5% increase in every 3 years	
Cost of Genset power	₹ 25.00	per unit and 5% increase in every subsequent years	
Demand Charges	₹ 562.00	per KVA/month and 5% increase in every 3 years	
Cost of manpower	₹ 1.98	crores per annum and 5% increase in every subsequent years	
Repairs & Maintenance	0.20%	of cost of civil works and plant & machinery and 5% increase in every subsequent years	
Royalty Charges payable to ULB	₹ 50.00	per MT of waste and 5% increase in every subsequent year	
Interest on Term Loan	11.00%	per annum	
Income Tax	IT rates applicable for a Company have been considered.		
Depreciation			
Straight line depreciation is considered for profitability estimations and WDV depreciation is considered for IT purposes.			

ESTIMATION OF POWER REQUIREMENT & COST																				Statement 5	
																				₹ in Crores	
Total Connected Load	2218 KW																				
(i.e.)	2464 KVA																				
Max. Demand	1725 KVA																				
Year ending March 31		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Working Days		365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365
Capacity Utilization		85%	90%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Power Consumption	Lakhs Kwh	12.38	13.11	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84	13.84
TNEB Supply																					
Power consumption - TNEB	95%	11.76	12.46	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15
Generator Supply																					
Power Consumption - Generator	5%	0.62	0.66	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Current Consumption Charges-TNEB	₹/Kwh	6.90	6.90	6.90	7.25	7.25	7.25	7.61	7.61	7.61	7.99	7.99	7.99	8.39	8.39	8.39	8.81	8.81	8.81	9.25	9.25
Cost of TNEB power	₹ in Crores	0.81	0.86	0.91	0.95	0.95	0.95	1.00	1.00	1.00	1.05	1.05	1.05	1.10	1.10	1.10	1.16	1.16	1.16	1.22	1.22
Current Consumption Charges-Generator	₹/Kwh	25.00	26.25	27.56	28.94	30.39	31.91	33.50	35.18	36.94	38.78	40.72	42.76	44.90	47.14	49.50	51.97	54.57	57.30	60.17	63.17
Cost of Genset power	₹ in Crores	0.15	0.17	0.19	0.20	0.21	0.22	0.23	0.24	0.26	0.27	0.28	0.30	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44
Demand Charges	₹/KVA/month	562	562	562	590	590	590	620	620	620	651	651	651	683	683	683	717	717	717	753	753
Demand Charge per annum		1.16	1.16	1.16	1.22	1.22	1.22	1.28	1.28	1.28	1.35	1.35	1.35	1.41	1.41	1.41	1.48	1.48	1.48	1.56	1.56
Cost of power		2.13	2.19	2.26	2.37	2.38	2.39	2.51	2.53	2.54	2.67	2.68	2.69	2.83	2.84	2.86	3.00	3.02	3.04	3.19	3.21
Assumptions:																					
Power Factor	90%																				
Average machine running hours	9 hours per day																				
Average Load Factor	20%																				
TNEB - Power Cost/KWH	₹ 6.90 per KWh																				
Generator - Power Cost/KWH	₹ 25.00																				
Demand Charges	₹ 562.00 per KVA/month																				

			Statement 6
MANPOWER REQUIREMENT AND ESTIMATION OF COST			
			₹ in Crores
Description	Nos.	Salary	Annual
		per month	Salary (in ₹)
Plant Head	1	75,000	9,00,000
Maintenance Engineer	2	45,000	10,80,000
Supervisors	2	35,000	8,40,000
Technicians	10	30,000	36,00,000
Helpers	52	15,000	93,60,000
Accounts and Admin Staffs	5	25,000	15,00,000
Security	4	15,000	7,20,000
Total	76		1,80,00,000
Add: benefits (ESI, PF, Bonus etc.)	10%		18,00,000
Total			1,98,00,000
		₹ in crores	1.98

Statement 7												
ESTIMATION OF DEPRECIATION												
₹ in Crores												
Year ending March 31	Cost	Dep. Rate	1	2	3	4	5	6	7	8	9	10
Straight Line Method												
Civil works	18.86	3.17%	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Mechanical and Electrical Equipments	48.68	6.33%	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08	3.08
Miscellaneous Fixed Assets	1.59	9.50%	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Laboratory Equipments	0.06	9.50%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	69.20		3.84									
WDV Method												
	WDV	Rate	1	2	3	4	5	6	7	8	9	10
Civil works		10%	1.89	1.70	1.53	1.37	1.24	1.11	1.00	0.90	0.81	0.73
WDV	18.86		16.97	15.28	13.75	12.37	11.14	10.02	9.02	8.12	7.31	6.58
Mechanical and Electrical Equipments		15%	7.30	6.21	5.28	4.48	3.81	3.24	2.75	2.34	1.99	1.69
WDV	48.68		41.38	35.17	29.90	25.41	21.60	18.36	15.61	13.27	11.28	9.58
Miscellaneous Fixed Assets		15%	0.24	0.20	0.17	0.15	0.12	0.11	0.09	0.08	0.06	0.06
WDV	1.59		1.35	1.15	0.97	0.83	0.70	0.60	0.51	0.43	0.37	0.31
Laboratory Equipments		15%	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
WDV	0.06		0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
Total	69.20		9.44	8.12	6.98	6.01	5.18	4.46	3.85	3.32	2.87	2.48
Straight Line Method												
	Cost	Dep. Rate	11	12	13	14	15	16	17	18	19	20
Civil works	18.86	3.17%	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Mechanical and Electrical Equipments	48.68	6.33%	3.08	3.08	3.08	3.08	3.08	2.46	0.00	0.00	0.00	0.00
Miscellaneous Fixed Assets	1.59	9.50%	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laboratory Equipments	0.06	9.50%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	69.20		3.76	3.68	3.68	3.68	3.68	3.06	0.60	0.60	0.60	0.60
WDV Method												
	WDV	Rate	11	12	13	14	15	16	17	18	19	20
Civil works		10%	0.66	0.59	0.53	0.48	0.43	0.39	0.35	0.31	0.28	0.25
WDV	18.86		5.92	5.33	4.79	4.31	3.88	3.49	3.15	2.83	2.55	2.29
Mechanical and Electrical Equipments		15%	1.44	1.22	1.04	0.88	0.75	0.64	0.54	0.46	0.39	0.33
WDV	48.68		8.15	6.93	5.89	5.00	4.25	3.61	3.07	2.61	2.22	1.89
Miscellaneous Fixed Assets		15%	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01
WDV	1.59		0.27	0.23	0.19	0.16	0.14	0.12	0.10	0.09	0.07	0.06
Laboratory Equipments		15%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WDV	0.06		0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Total	69.20		2.14	1.86	1.61	1.39	1.21	1.05	0.91	0.79	0.69	0.60

Statement 8												
INTEREST ESTIMATION AND REPAYMENT SCHEDULE FOR TERM LOAN												
₹ in Crores												
Loan Amount	₹ 46.83	Crores										
Moratorium	18	months										
Repayment Period	120	months excluding moratorium										
Rol per annum	11.00%											
Rol per month	0.92%											
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1												
Principal o/s	46.83	46.69	46.55	46.42	46.28	46.14	46.01	45.87	45.73	45.60	45.46	45.32
Repayment	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Interest	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
2												
Principal o/s	45.19	44.91	44.64	44.37	44.09	43.82	43.55	43.27	43.00	42.73	42.46	42.18
Repayment	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Interest	0.41	0.41	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39
3												
Principal o/s	41.91	41.52	41.13	40.74	40.35	39.96	39.57	39.18	38.79	38.40	38.01	37.62
Repayment	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Interest	0.38	0.38	0.38	0.37	0.37	0.37	0.36	0.36	0.36	0.35	0.35	0.34
4												
Principal o/s	37.23	36.84	36.45	36.06	35.67	35.28	34.88	34.49	34.10	33.71	33.32	32.93
Repayment	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Interest	0.34	0.34	0.33	0.33	0.33	0.32	0.32	0.32	0.31	0.31	0.31	0.30
Contd...												

Statement 8 Contd...

5												
Principal o/s	32.54	32.15	31.76	31.37	30.98	30.59	30.20	29.81	29.42	29.03	28.64	28.25
Repayment	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Interest	0.30	0.29	0.29		0.28	0.28	0.28	0.27	0.27	0.27	0.26	0.26
6				0.29								
Principal o/s	27.86	27.40	26.93		26.00	25.54	25.08	24.61	24.15	23.68	23.22	22.75
Repayment	0.46	0.46	0.46	26.47	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Interest	0.26	0.25	0.25	0.46	0.24	0.23	0.23	0.23	0.22	0.22	0.21	0.21
7				0.24								
Principal o/s	22.29	21.82	21.36		20.43	19.97	19.50	19.04	18.57	18.11	17.65	17.18
Repayment	0.46	0.46	0.46	20.90	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Interest	0.20	0.20	0.20	0.46	0.19	0.18	0.18	0.17	0.17	0.17	0.16	0.16
8				0.19								
Principal o/s	16.72	16.25	15.79		14.86	14.39	13.93	13.47	13.00	12.54	12.07	11.61
Repayment	0.46	0.46	0.46	15.32	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Interest	0.15	0.15	0.14	0.46	0.14	0.13	0.13	0.12	0.12	0.11	0.11	0.11
9				0.14								
Principal o/s	11.14	10.68	10.22		9.29	8.82	8.36	7.89	7.43	6.97	6.50	6.04
Repayment	0.46	0.46	0.46	9.75	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Interest	0.10	0.10	0.09	0.46	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.06
10				0.09								
Principal o/s	5.57	5.11	4.64		3.71	3.25	2.79	2.32	1.86	1.39	0.93	0.46
Repayment	0.46	0.46	0.46	4.18	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Interest	0.05	0.05	0.04	0.46	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00
Consolidated	1	2	3	4	5	6	7	8	9	10		
Interest	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33		
Repayment Term Loan	1.64	3.28	4.68	4.68	4.68	5.57	5.57	5.57	5.57	5.57		

Statement 9											
₹ in Crores											
Year ending March 31		1	2	3	4	5	6	7	8	9	10
CALCULATION OF INCOME TAX											
Net Profit Before Tax		-0.39	1.13	2.81	3.75	4.81	5.94	7.03	8.26	9.51	10.67
Add: Depreciation as per Companies Act		3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Less: Depreciation as per Income Tax		9.44	8.12	6.98	6.01	5.18	4.46	3.85	3.32	2.87	2.48
		-5.99	-3.15	-0.34	1.57	3.47	5.31	7.02	8.77	10.48	12.03
Income before Incentives & after setting off of C/o Loss		0.00	0.00	0.00	0.00	0.00	0.87	7.02	8.77	10.48	12.03
Less: Deductions		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taxable Income		0.00	0.00	0.00	0.00	0.00	0.87	7.02	8.77	10.48	12.03
Income Tax	25.00%	0.00	0.00	0.00	0.00	0.00	0.22	1.75	2.19	2.62	3.01
Surcharge	%	7%	7%	7%	7%	7%	7%	7%	7%	12%	12%
Surcharge on Income Tax		0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.15	0.31	0.36
Health & Education Cess	4.00%	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.09	0.12	0.13
Income Tax		0.00	0.00	0.00	0.00	0.00	0.24	1.95	2.44	3.05	3.50
Loss C/F		5.99	9.14	9.48	7.91	4.44	0.00	0.00	0.00	0.00	0.00
MAT	15.00%	0.00	0.17	0.42	0.56	0.72	0.89	1.05	1.24	1.43	1.60
Surcharge	%	7%	7%	7%	7%	7%	7%	7%	7%	7%	12%
Surcharge on MAT		0.00	0.01	0.03	0.04	0.05	0.06	0.07	0.09	0.10	0.19
Health & Education Cess	4.00%	0.00	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07
MAT		0.00	0.19	0.47	0.63	0.80	0.99	1.17	1.38	1.59	1.86
Income Tax / MAT whichever is higher		0.00	0.19	0.47	0.63	0.80	0.99	1.95	2.44	3.05	3.50
Less : Set off of brought forward MAT		0.00	0.00	0.00	0.00	0.00	0.00	0.78	1.06	1.24	0.00
		0.00	0.19	0.47	0.63	0.80	0.99	1.17	1.38	1.82	3.50
Provision for Tax		0.00	0.19	0.47	0.63	0.80	0.99	1.17	1.38	1.82	3.50
MAT credit carry forward		0.00	0.19	0.66	1.28	2.09	3.08	2.30	1.24	0.00	0.00

Contd...

Statement 9 Contd...											
Year ending March 31		11	12	13	14	15	16	17	18	19	20
Net Profit Before Tax		11.77	12.57	13.20	13.98	14.79	16.13	19.46	20.37	21.18	22.17
Add: Depreciation as per Companies Act		3.76	3.68	3.68	3.68	3.68	3.06	0.60	0.60	0.60	0.60
Less: Depreciation as per Income Tax		2.14	1.86	1.61	1.39	1.21	1.05	0.91	0.79	0.69	0.60
		13.39	14.40	15.27	16.27	17.26	18.13	19.15	20.18	21.09	22.17
Income before Incentives & after setting off of C/o Loss		13.39	14.40	15.27	16.27	17.26	18.13	19.15	20.18	21.09	22.17
Less: Deductions		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taxable Income		13.39	14.40	15.27	16.27	17.26	18.13	19.15	20.18	21.09	22.17
Income Tax	25%	3.35	3.60	3.82	4.07	4.31	4.53	4.79	5.04	5.27	5.54
Surcharge	%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
Surcharge on Income Tax		0.40	0.43	0.46	0.49	0.52	0.54	0.57	0.61	0.63	0.67
Health & Education Cess	4%	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.25
Income Tax		3.90	4.19	4.45	4.74	5.03	5.28	5.58	5.88	6.14	6.46
Loss C/F		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAT	15%	1.77	1.89	1.98	2.10	2.22	2.42	2.92	3.06	3.18	3.33
Surcharge	%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
Surcharge on MAT		0.21	0.23	0.24	0.25	0.27	0.29	0.35	0.37	0.38	0.40
Health & Education Cess	4%	0.08	0.08	0.09	0.09	0.10	0.11	0.13	0.14	0.14	0.15
MAT		2.06	2.20	2.31	2.44	2.58	2.82	3.40	3.56	3.70	3.87
Income Tax / MAT whichever is higher		3.90	4.19	4.45	4.74	5.03	5.28	5.58	5.88	6.14	6.46
Less : Set off of brought forward MAT		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		3.90	4.19	4.45	4.74	5.03	5.28	5.58	5.88	6.14	6.46
Provision for Tax		3.90	4.19	4.45	4.74	5.03	5.28	5.58	5.88	6.14	6.46
MAT credit carry forward		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PROJECTED CASH-FLOW STATEMENT											Statement 10	
											₹ in Crores	
Year ending March 31	Imp. Period	1	2	3	4	5	6	7	8	9	10	
Source of Funds												
Equity	17.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Central Financial Assistance, MNRE	5.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Term Loan	46.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Profit Before Int., Dep. & Tax	0.00	8.60	9.77	11.02	11.44	11.99	12.56	13.04	13.65	14.29	14.84	
Total	69.20	8.60	9.77	11.02	11.44	11.99	12.56	13.04	13.65	14.29	14.84	
Application of funds												
Capital Expenditure	69.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Interest on Term Loan	0.00	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33	
Provision for Taxation	0.00	0.00	0.19	0.47	0.63	0.80	0.99	1.17	1.38	1.82	3.50	
Repayment of Term loan	0.00	1.64	3.28	4.68	4.68	4.68	5.57	5.57	5.57	5.57	5.57	
Total	69.20	6.79	8.27	9.53	9.17	8.83	9.35	8.92	8.51	8.33	9.41	
Surplus	0.00	1.81	1.50	1.50	2.28	3.16	3.21	4.12	5.14	5.96	5.43	
Opening Balance	0.00	0.00	1.81	3.31	4.80	7.08	10.24	13.45	17.57	22.71	28.67	
Closing Balance	0.00	1.81	3.31	4.80	7.08	10.24	13.45	17.57	22.71	28.67	34.10	

Contd...

Statement 10 Contd...										
	₹ in Crores									
Year ending March 31	11	12	13	14	15	16	17	18	19	20
Source of Funds										
Equity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Central Financial Assistance, MNRE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Term Loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Profit Before Int., Dep. & Tax	15.53	16.25	16.88	17.66	18.47	19.18	20.06	20.97	21.78	22.77
Total	15.53	16.25	16.88	17.66	18.47	19.18	20.06	20.97	21.78	22.77
Application of funds										
Capital Expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest on Term Loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Provision for Taxation	3.90	4.19	4.45	4.74	5.03	5.28	5.58	5.88	6.14	6.46
Repayment of Term loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3.90	4.19	4.45	4.74	5.03	5.28	5.58	5.88	6.14	6.46
Surplus	11.63	12.06	12.43	12.92	13.44	13.90	14.48	15.09	15.64	16.31
Opening Balance	34.10	45.74	57.80	70.23	83.15	96.59	110.49	124.97	140.07	155.70
Closing Balance	45.74	57.80	70.23	83.15	96.59	110.49	124.97	140.07	155.70	172.02

											Statement 11	
PROJECTED BALANCE SHEET											₹ in Crores	
Year ending March 31	Imp. Period	1	2	3	4	5	6	7	8	9	10	
Liabilities												
Share Capital	17.30	17.30	17.30	17.30	17.30	17.30	17.30	17.30	17.30	17.30	17.30	
Central Financial Assistance, MNRE	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	
Term Loan	46.83	45.19	41.91	37.23	32.54	27.86	22.29	16.72	11.14	5.57	0.00	
Reserves & Surplus	0.00	-0.39	0.55	2.89	6.01	10.02	14.96	20.82	27.70	35.39	42.56	
Total	69.20	67.17	64.83	62.49	60.93	60.25	59.62	59.91	61.21	63.34	64.93	
Assets												
Gross Block	69.20	69.20	69.20	69.20	69.20	69.20	69.20	69.20	69.20	69.20	69.20	
Less: Accu. Depreciation	0.00	3.84	7.67	11.51	15.35	19.18	23.02	26.86	30.69	34.53	38.36	
Net Block	0.00	65.36	61.52	57.69	53.85	50.01	46.18	42.34	38.50	34.67	30.83	
Closing Bank Balance	0.00	1.81	3.31	4.80	7.08	10.24	13.45	17.57	22.71	28.67	34.10	
Total	69.20	67.17	64.83	62.49	60.93	60.25	59.62	59.91	61.21	63.34	64.93	
Year ending March 31		11	12	13	14	15	16	17	18	19	20	
Liabilities												
Share Capital		17.30	17.30	17.30	17.30	17.30	17.30	17.30	17.30	17.30	17.30	
Central Financial Assistance, MNRE		5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	
Term Loan		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Reserves & Surplus		50.44	58.82	67.57	76.81	86.57	97.42	111.30	125.79	140.84	156.55	
Total		72.81	81.19	89.94	99.18	108.94	119.79	133.67	148.16	163.21	178.92	
Assets												
Gross Block		69.20	69.20	69.20	69.20	69.20	69.20	69.20	69.20	69.20	69.20	
Less: Accu. Depreciation		42.13	45.81	49.49	53.17	56.85	59.90	60.50	61.10	61.70	62.29	
Net Block		27.07	23.39	19.71	16.03	12.35	9.29	8.70	8.10	7.50	6.90	
Closing Bank Balance		45.74	57.80	70.23	83.15	96.59	110.49	124.97	140.07	155.70	172.02	
Total		72.81	81.19	89.94	99.18	108.94	119.79	133.67	148.16	163.21	178.92	

	Statement 12									
CALCULATION OF DEBT-SERVICE COVERAGE RATIO	₹ in Crores									
Year ending March 31	1	2	3	4	5	6	7	8	9	10
Profit After Tax	-0.39	0.94	2.34	3.12	4.01	4.95	5.86	6.88	7.69	7.17
Add: Non Cash Expenses	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Add: Int. On Term Loan	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33
Total (A)	8.60	9.58	10.55	10.82	11.19	11.57	11.86	12.27	12.48	11.34
Interest On Term Loan	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33
Add: Repayment	1.64	3.28	4.68	4.68	4.68	5.57	5.57	5.57	5.57	5.57
Total (B)	6.79	8.08	9.06	8.54	8.03	8.36	7.74	7.13	6.52	5.90
DSCR Weighted Average	1.45									

ESTIMATION OF BREAK-EVEN POINT	Statement 13									
	₹ in Crores									
Year ending March 31	1	2	3	4	5	6	7	8	9	10
Fixed Expenses										
Cost of consumables	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.26	0.27	0.28
Cost of Manpower	1.98	2.08	2.18	2.29	2.41	2.53	2.65	2.79	2.93	3.07
Repairs & Maintenance	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19
Interest on Term Loan	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33
Depreciation	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Total (A)	11.27	11.04	10.73	10.34	9.95	9.53	9.07	8.61	8.15	7.71
Variable Expenses										
Cost of power	2.13	2.19	2.26	2.37	2.38	2.39	2.51	2.53	2.54	2.67
Cost of transportation	0.30	0.33	0.37	0.39	0.40	0.43	0.45	0.47	0.49	0.52
Royalty charges payable to ULB	0.39	0.43	0.48	0.50	0.53	0.55	0.58	0.61	0.64	0.67
Total (B)	2.95	3.10	3.26	3.42	3.48	3.55	3.73	3.80	3.88	4.07
Income	13.83	15.27	16.80	17.51	18.25	19.02	19.82	20.66	21.54	22.45
Break-even Point	104%	91%	79%	73%	67%	62%	56%	51%	46%	42%
Cash Break-even Point	68%	59%	51%	46%	41%	37%	32%	28%	24%	21%

Contd...

Statement 13 contd...										
ESTIMATION OF BREAK-EVEN POINT	₹ in Crores									
Year ending March 31	11	12	13	14	15	16	17	18	19	20
Fixed Expenses										
Cost of consumables	0.30	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44	0.46
Cost of Manpower	3.23	3.39	3.56	3.73	3.92	4.12	4.32	4.54	4.77	5.00
Repairs & Maintenance	0.20	0.20	0.22	0.23	0.24	0.25	0.26	0.27	0.29	0.30
Interest on Term Loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciation	3.76	3.68	3.68	3.68	3.68	3.06	0.60	0.60	0.60	0.60
Total (A)	7.48	7.58	7.78	7.98	8.20	7.80	5.58	5.83	6.09	6.36
Variable Expenses										
Cost of power	2.68	2.69	2.83	2.84	2.86	3.00	3.02	3.04	3.19	3.21
Cost of transportation	0.54	0.57	0.60	0.63	0.66	0.69	0.73	0.76	0.80	0.84
Royalty charges payable to ULB	0.71	0.74	0.78	0.82	0.86	0.90	0.95	0.99	1.04	1.10
Total (B)	4.15	4.24	4.45	4.55	4.65	4.88	5.00	5.11	5.37	5.50
Income	23.40	24.40	25.43	26.51	27.64	28.81	30.03	31.31	32.64	34.03
Break-even Point	39%	38%	37%	36%	36%	33%	22%	22%	22%	22%
Cash Break-even Point	19%	19%	20%							

Statement 14												
ESTIMATION OF NET PRESENT VALUE AND INTERNAL RATE OF RETURN												
₹ in Crores												
	<i>Implementation Period</i>		<i>Project Period</i>									
Year ending March 31	1	2	1	2	3	4	5	6	7	8	9	10
Cash Outflows												
Capital Expenditure	25.35	43.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total cash outflow	25.35	43.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash Inflow												
Profit After Tax	0.00	0.00	-0.39	0.94	2.34	3.12	4.01	4.95	5.86	6.88	7.69	7.17
Interest on Term loan	0.00	0.00	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33
Depreciation	0.00	0.00	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84	3.84
Total cash inflow	0.00	0.00	8.60	9.58	10.55	10.82	11.19	11.57	11.86	12.27	12.48	11.34
Net Cash Flow	-25.35	-43.85	8.60	9.58	10.55	10.82	11.19	11.57	11.86	12.27	12.48	11.34
Year ending March 31	11	12	13	14	15	16	17	18	19	20		
Cash Outflows												
Capital Expenditure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Total cash outflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Cash Inflow												
Profit After Tax	7.87	8.38	8.75	9.24	9.76	10.84	13.88	14.49	15.04	15.71		
Interest on Term loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Depreciation	3.76	3.68	3.68	3.68	3.68	3.06	0.60	0.60	0.60	0.60		
Total cash inflow	11.63	12.06	12.43	12.92	13.44	13.90	14.48	15.09	15.64	16.31		
Net Cash Flow	11.63	12.06	12.43	12.92	13.44	13.90	14.48	15.09	15.64	16.31		
Net Present Value	₹ 15.27 Crores											
at 11% discount rate												
Internal Rate of Return	14.28%											

Statement 15												
₹ in Crores												
ESTIMATION OF EQUITY IRR	<i>Implementation Period</i>		<i>Project Period</i>									
Year ending March 31	1	2	1	2	3	4	5	6	7	8	9	10
Cash Inflow	0.00	0.00	8.60	9.58	10.55	10.82	11.19	11.57	11.86	12.27	12.48	11.34
Less: Interest on Term Loan	0.00	0.00	5.15	4.81	4.37	3.86	3.34	2.78	2.17	1.56	0.94	0.33
Less: Principal Repayment of Term Loan	0.00	0.00	1.64	3.28	4.68	4.68	4.68	5.57	5.57	5.57	5.57	5.57
Cash Flow Available to Equity	0.00	0.00	1.81	1.50	1.50	2.28	3.16	3.21	4.12	5.14	5.96	5.43
Equity Capital Invested	7.71	9.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cash Outflow	7.71	9.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Cash Flow	-7.71	-9.58	1.81	1.50	1.50	2.28	3.16	3.21	4.12	5.14	5.96	5.43
Year ending March 31	11	12	13	14	15	16	17	18	19	20		
Cash Inflow	11.63	12.06	12.43	12.92	13.44	13.90	14.48	15.09	15.64	16.31		
Less: Interest on Term Loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Less: Principal Repayment of Term Loan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Cash Flow Available to Equity	11.63	12.06	12.43	12.92	13.44	13.90	14.48	15.09	15.64	16.31		
Equity Capital Invested	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Cash Outflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Net Cash Flow	11.63	12.06	12.43	12.92	13.44	13.90	14.48	15.09	15.64	16.31		
Equity IRR	20.79%											

ANNEXURE II
Letter of Acceptance issued by CCMC)

Municipal Administration and Water Supply Department

From

M.Sivaguru Prabakaran, I.A.S.,
Commissioner
Coimbatore Corporation,
Town Hall, Coimbatore – 641 001



To

M/s.Reflex Gren Power Limited,
No.1,By171, Old Mahabalipuram
Road,
Thandalam Village Thiruporur,
Kancheepuram – 603 110.

Roc. No : /2025/

Dated : 04.2025

Sir,

Sub : Coimbatore Corporation – “Swachh Bharat Mission Urban 2.0-
Solid Waste management- Selection of Concessionaire for
establishment of 250TPD Municipal Solid Waste based Bio-CNG
Plant at Coimbatore under PPP Mode on Design, Build, Finance,
Operate and Transfer Basis under PPP mode-Issuance of **LOA**-
Regarding.

- Ref :
- 1) G.O.(D)145 MAWS (MC7) department dated. 11.03.2024
 - 2) The Principal Secretary to Government, Municipal
Administration and Water Supply Department Letter
No.2201/MC6/2024-1 dated.14.03.2024
 - 3) G.O.MS No.78MAWS (MC-6)department dated.10.06.2024
 - 4) Tender dated 26.06.2024
 - 5) Meeting Minutes dated.02.09.2024 and 02.12.024
 - 6) Price bid opened on 14.03.2025
 - 7) Director of Municipal Administration, Mission Director
SBM(U)2.0, ROC No.34180/2022/SBM2 dated.03.04.2025.

This is to notify you that your Bid dated: 26.06.2024 for execution of the
Selection of Concessionaire for establishment of 250TPD Municipal Solid Waste
based Bio-CNG Plant at Coimbatore under PPP Mode on Design, Build, Finance,
Operate and Transfer Basis under PPP mode for a period of 20 years. The royalty
of Rs.468/- per MT of wet waste payable to the authority has been accepted.

You are requested to furnish the performance security/Unconditional
Irrevocable Bank Guarantee of **Rs.3,45,00,000/- (Rupees Three Crore Forty-Five
Lakhs Only)** within 10 (Ten) working days, in the form of an Unconditional
Irrevocable Bank Guarantee with an initial validity period of 3 years and renewable
thereon every year within 15 days before the expiry of validity until completion of
concession period from any Indian Nationalized/Scheduled Commercial Bank.

This letter of acceptance incorporates the conditions mentioned in the bid documents as well as the conditions mentioned below:

1. Bid has been accepted with royalty payment of Rs.468/- per MT of wet waste to be supplied by the Coimbatore City Municipal Corporation with escalation of 5% every year.
2. All applicable permits shall be obtained as per the prevailing conditions and rules & regulations time to time.
3. The quantum of MSW whatever produced during contract period shall be processed & disposed as per bid conditions.
4. You are instructed to form SPV and complete the signing of Concession agreement within 30 working days on receipt of LOA.
5. Company shall adhere to RFP, Concession agreement conditions and work plan mutually agreed between you and Coimbatore City Municipal Corporation.
6. The Conditions Precedent set forth in Article-4 to be fulfilled by the concessionaire.


Commissioner
Coimbatore Corporation

Copy Submitted to

The Director of Municipal Administration
Urban Administrative office campus,
75 Santhome High Road,
Raja Annamalaipuram,
Chennai – 600 028.


5/11/15