

Designing and Implementing Decentralized Biogas Solutions for MSW

Lessons from the Field

October 2026



Credits

Authors: Shabarni Roy Chowdhury, Govind Singh, Aarti Sachdeva

Peer Review: Sunitha Jayaram

Case Study Inputs: Hitesh, Shahab Akhter, Rajkumar Kothuju, Jayakumara CN, Shubham Kamble, Naveen Kumar S., Deepti Ravi

Design and Layout: Pauravi Pathak, Smita Kulkarni

Suggested citation: Shabarni Roy Chowdhury, Govind Singh, Aarti Sachdeva, 2026, Designing and Implementing Decentralized Biogas Solutions for MSW: Lessons from the Field, Saahas, Bengaluru

Acknowledgements:

- Bengaluru Solid Waste Management Ltd. (BSWML), previously, part of Bruhat Bengaluru Mahanagra Palike (BBMP)
- Municipal Corporation of Gurgaon (MCG)
- **Funding Partners:** CGI Information Systems & Management Consultants Pvt. Ltd., Cadence Design Systems (India) Pvt. Ltd., NVIDIA Graphics Pvt. Ltd., Hyundai Motor India Ltd., KPMG Global, Shell India Market Pvt. Ltd., H.T. Parekh Foundation, Indospace.
- **Technology Providers:** Carbon Masters, GPS Renewable, Ahuja Engineering Services Pvt. Ltd, Avris Environment Technologies Pvt. Ltd., Balancing Bits (a channel partner for Homebiogas, an Israel based company), Chakraakaar Lifestyle Solutions Pvt. Ltd.

Disclaimer: *This report has been developed by Saahas based on field learnings from nine initiatives involving decentralised biogas units for the treatment and valorisation of organic waste. While every effort has been made to ensure the accuracy of the information presented, the views and interpretations expressed in this report are those of Saahas and are intended to inform and support stakeholder decision-making.*

About Saahas: *Saahas is a not-for-profit organisation, registered in 2001 under the Karnataka Societies Registration Act, 1960. Working towards a vision of making India a leading Circular Economy, Saahas focuses on sustainable solid waste management across India, including in urban, rural and eco-sensitive regions. Its work spans source segregation, resource recovery from organic and dry waste, and pilots in special waste streams such as e-waste and construction and demolition waste. Saahas also promotes circularity through initiatives on repair and reuse. It works with stakeholders across the waste ecosystem, including governments, entrepreneurs, corporates, communities and waste workers, while supporting dignified and sustainable livelihoods within the waste sector.*

Saahas has been an active member of the Rural WASH Partners Forum (RWPF) since its formation in August 2022 and was recognised as a Swachhata Knowledge Partner by the Ministry of Housing and Urban Affairs in 2023.



Head office:

#21, Ground Floor, MCHS Colony, 5th "C" Cross, 16th Main, BTM Layout 2nd Stage,
Bengaluru-560076, Karnataka

Regional office:

C-691, Block C, Sushant Lok 1, Sector 43, Gurugram - 122002, Haryana

Foreword



Saahas has always been a 'solutions' organization, with our feet firmly on the ground as we worked on solving the issues around improper waste management in the country. For the last twenty five years, Saahas has been demonstrating solutions to some of the most stubborn problems around solid waste management.

It started with a 'Less Plastic for Me' campaign in Bangalore, continued with decentralised composting and dry waste sorting systems, and expanded by adding waste streams like e-waste, construction & demolition waste and bulky waste. We experimented in different geographies, places with different levels of urbanization, different socio-economic-cultural-political scenarios and different waste generator profiles. The objective always being to align the solutions within the ambit of the Solid Waste Management Rules and to maximise the recovery of resources from waste. Along with demonstrating the solutions, we also worked on understanding the larger ecosystem and the systemic barriers, and finding ways to overcome some of them. We have been working with the community for awareness and sensitization, with the Government stakeholders for handholding and capacity building support, with entrepreneurs and markets for different business models and with other development sector organizations to build circular systems, together.

As we celebrate 25 years of our work, we have documented the reflections from some of our experiments, which bring out specific learnings from our interventions as well as the implications of these learnings on the larger solid waste management ecosystem. As we move ahead, we hope to continue to run new experiments and document the results in the form of develop toolkits, methodologies, and frameworks which will help embed the solutions in the community, governance and market systems.

This report, along with few others are being released on the occasion of our 25th anniversary, are an outcome of our learnings from our work and we hope these will help practitioners implement solutions which will work reliably and sustainably on the ground.



Regards,

Archana Tripathi
CEO, Saahas





Saahas's CEO Archana Tripathi, at a Biogas installation site in Pune, Maharashtra.

Index

1 Introduction	9
2 Policy landscape for Biogas in India	15
3 Saahas's initiatives in decentralised biogas solutions	17
• 3.1 ULB (BSWML) owned, Biogas Unit, Bengaluru	19
• 3.2 ULB (MCG) owned, Biogas Unit, Gurugram	22
• 3.3 University (Osmania) owned, Biogas Unit, Hyderabad	26
• 3.4 University (VNR, VJIET) owned, Biogas Unit, Hyderabad	29
• 3.5 Community Kitchen owned, Biogas Unit, Chennai	32
• 3.6 School (Jawahar Navodaya Vidyalaya Residential School) Owned, Biogas Unit, Bengaluru	35
• 3.7 Small eateries (Five Dhabas) owned, Biogas Unit, Murthal	38
• 3.8 Anganwadi and Small Schools owned, Biogas Unit, Pune	41
• 3.9 Small School (Government School) owned, Biogas Unit, Luhari	44
4 Analysis	47
5 Critical Success Factors for Replication	55
6 Conclusion	57
References	58





Vignan Jyoti University, Hyderabad

Executive Summary

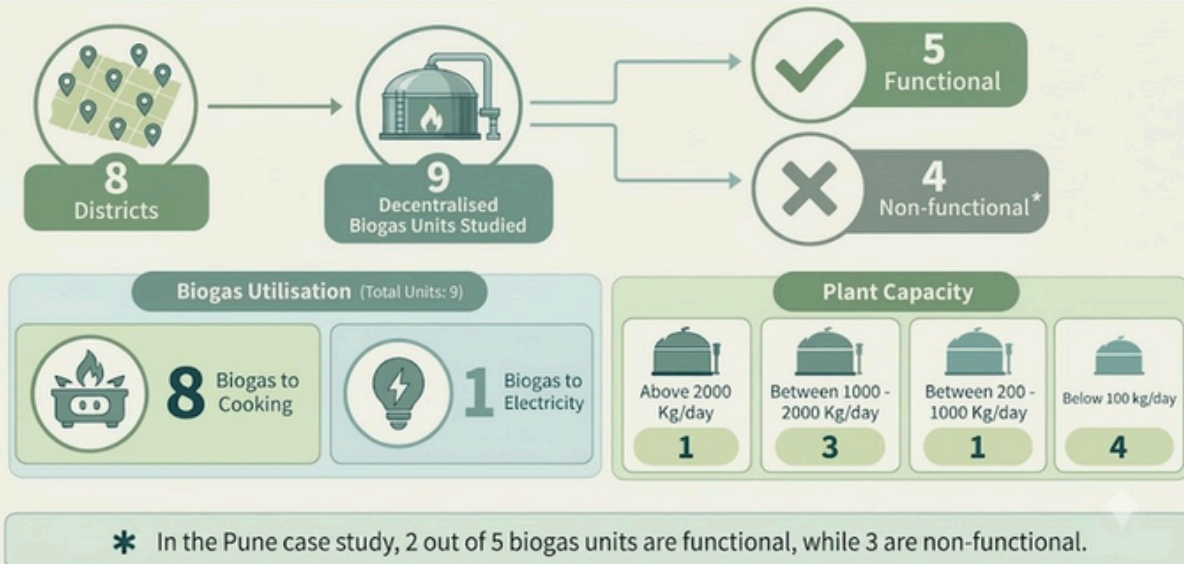
Decentralised biogas is emerging as an important pathway for the organic fraction of solid waste management in India's transition towards a circular, resource-recovery-oriented system. By treating organic waste closer to its source, these systems can reduce transportation requirements while enabling recovery of energy and nutrients. With lower space requirements, improving technologies, better monitoring and diverse options for gas utilisation, decentralised biogas systems are evolving to serve institutions, communities, markets and other local establishments. As organic waste volumes increase and space constraints grow, decentralised biogas is evolving beyond waste treatment into an integrated approach linking waste management, energy recovery and nutrient cycling.



Key Findings

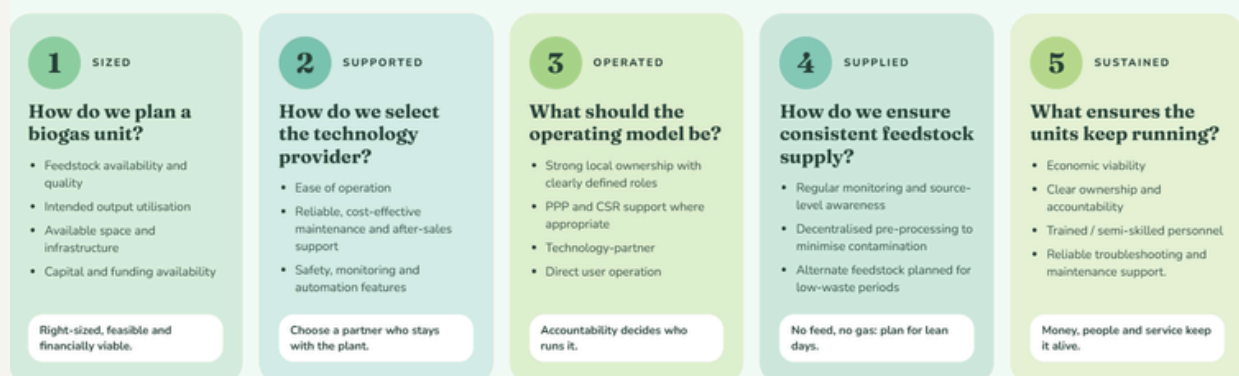
- **Ownership is the foundation of sustainability:** Clear ownership, defined responsibilities and strong institutional/local stakeholder support are critical for sustained operation and accountability.
- **Design must match waste and user needs:** Technology and capacity should be based on actual waste audits, available space, feedstock characteristics and energy demand, avoiding over-capacity and under-utilisation.
- **Consistent feedstock determines performance:** Reliable and consistent supply of well-segregated organic waste, supported by source-level awareness and monitoring, is essential for stable plant operation.
- **Operations and maintenance need local capacity:** Trained semi-skilled operators, affordable AMC and responsive technical support are key to preventive maintenance, troubleshooting and long-term functionality.
- **Financial viability requires a clear business model:** While CSR funding or Public Private Partnership can support capital investment; sustained operating revenue in form of reliable paying end-users or user fee can strengthen the financial sustainability.
- **End-use determines resource value:** Biogas systems perform best when gas utilisation is aligned with actual energy demand and when viable pathways are established for the use or sale of Fermented Organic Manure (FOM).
- **Technology and replication are evolving:** Continuous technological advancements, including improved monitoring, automation, gas purification and safety features, are enhancing the performance, reliability and user safety of decentralised biogas systems.
- **Institutional waste has better yield and profitability as compared to MSW based units:** Quality source-separated food waste, strong ownership, and onsite processing support higher gas yields, better capacity utilisation, and fuel-substitution savings, making institutional settings more conducive to sustained operation.

Decentralised Biogas Case Studies — At a Glance



Planning a Biogas Unit

Five questions to get it sized, supplied, operated, supported and sustained



1

Introduction:

1.1

India's Waste Management Landscape



India's solid waste management system faces a significant gap between waste generation and effective processing. According to the CPCB Annual Report (2024–25), India generated approximately 170,939 TPD of solid waste in 2022–23, of which 96% was collected but only 61% was treated. About 22% was landfilled, while 17% remained unaccounted for, highlighting gaps across the waste management chain. With rising population, urbanisation and consumption, waste generation is expected to increase further, reaching approximately 165 million tonnes annually by 2030. As OFMSW constitutes around 40–60% of municipal waste, there is a clear need to move beyond collection and disposal towards resource recovery and value retention.

1.2

Learning from the Circular Economy Model

The European Union's transition towards a circular economy marks a shift from the linear “take–make–dispose” model towards retaining the value of materials and resources within the economy. Waste is increasingly viewed as a potential source of secondary resources and economic value through recovery, reuse and recycling.



India's recent policy developments, including the Solid Waste Management Rules, 2026, which took effect on 1 April 2026, also incorporate circular economy principles to promote greater resource efficiency and recovery. Beyond environmental benefits, this transition offers significant economic and employment opportunities. According to MoEFCC, advancing circular economy principles could contribute up to USD 2 trillion to India's economy and generate over 10 million jobs by 2030. Thus, circular approaches to waste management can address waste challenges while conserving resources, creating livelihoods and supporting sustainable development.

1.3 Nature of organic waste

Addressing biodegradable and organic waste is critical to India's waste management strategy, as effective management can reduce the waste burden, odour, disease risks and methane emissions. The waste sector accounts for approximately 20% of global anthropogenic methane emissions (SQRD, 2025), largely from the anaerobic decomposition of organic waste in landfills and dumpsites. At COP29 in Baku, Azerbaijan, in November 2024, methane reduction was highlighted as a key near-term opportunity to slow global temperature rise (COP29, 2024).

Organic waste can broadly be classified into the following categories:



- **Food Waste:** Includes food preparation and consumption residues such as fruit and vegetable waste, eggshells, seeds, bones, oils, and other food residues. It also includes spoiled, surplus, or discarded food separated from its packaging.



- **Plant Waste:** Includes leaves, branches, grass, and other residues generated from gardening, pruning, landscaping, and plant maintenance activities.



- **Paper and Cardboard Waste:** Includes paper, cardboard, tissues, napkins, and paper towels, particularly where these materials are contaminated with food or other organic matter.



- Coffee and Tea Waste: Includes coffee grounds, coffee filters, tea leaves, and tea bags. These materials are biodegradable and can be incorporated into appropriate composting or other biological treatment processes.



- Animal & Bio-wastes: Cattle dung (manure), poultry litter, carcass remains.

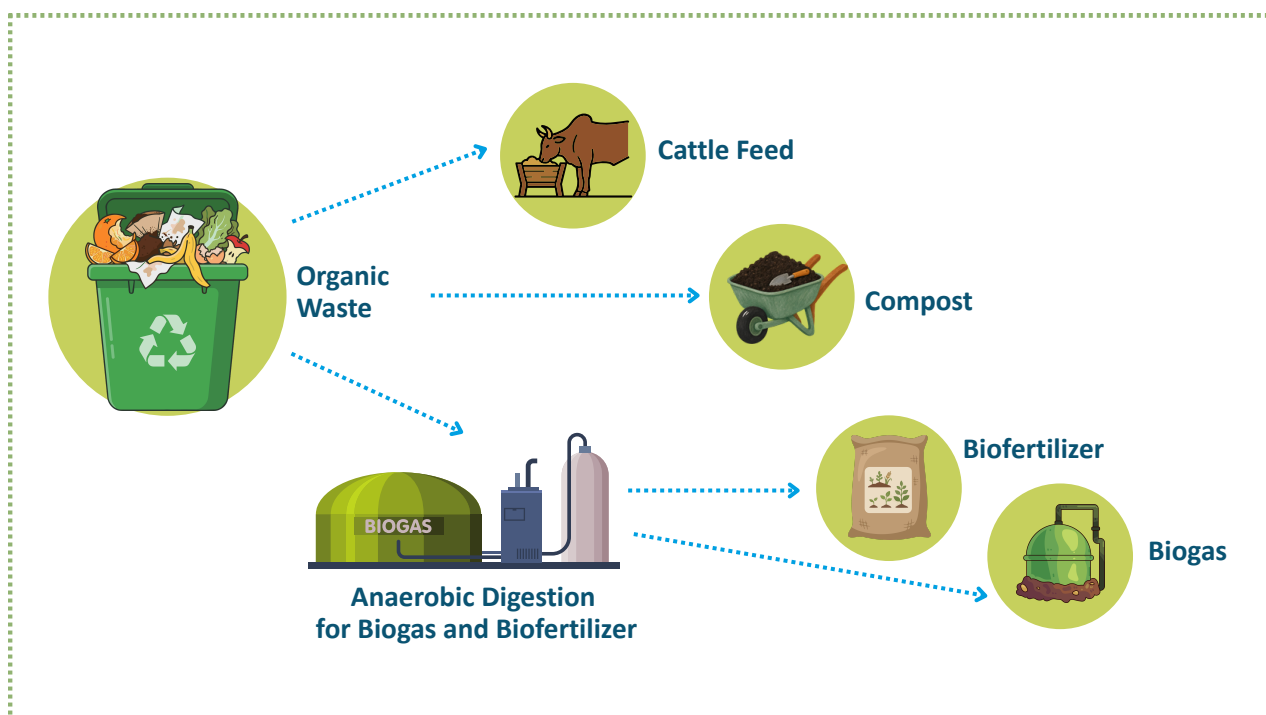
1.4

Organic Waste Management practices in India (Decentralised)

Organic waste management in India follows several complementary pathways, with decentralised approaches playing an important role in advancing a circular, resource-recovery-oriented system. Decentralised management involves treating organic waste closer to the point of generation, such as within households, institutions, communities, residential complexes, markets, or other local establishments, rather than transporting it over long distances to centralised facilities. This approach can reduce transportation requirements and associated costs and emissions, while enabling the recovery of nutrients and energy from organic waste at the local level. Composting and small-scale biomethanation are among the key decentralised options that can be adapted to local waste quantities, available space, infrastructure, and end-use requirements.



At Government School, Luhari, Haryana



This diagram illustrates the three main pathways through which organic waste can be utilised in decentralised way, rather than simply discarded:

1. **Cattle Feed** – A portion of organic waste (typically fresh food scraps, agricultural residues, etc.) can be directly used as fodder for livestock, providing a low-cost, low-processing route for waste reuse.
2. **Compost** – Organic waste undergoes aerobic decomposition (often with the help of microorganisms and earthworms) to produce compost, a nutrient-rich soil conditioner that can replace or supplement chemical fertilisers.
3. **Anaerobic Digestion for Biogas and Biofertilizer** – Organic waste is broken down in an oxygen-free environment inside a digester, producing two valuable outputs:
 - **Biogas** (methane-rich gas, shown as CH_4) that can be used as a clean cooking or energy fuel, and
 - **Biofertilizer**, the nutrient-rich digestate left over after digestion, which can be applied to agricultural land.

1.5 Strategies for decentralized organic waste management – compost vs biogas

Among the pathways available for organic waste valorisation, composting and anaerobic digestion (biogas generation) stand out as the two principal biological treatment methods employed in India for managing the organic fraction of municipal solid waste (OFMSW). Both processes can be implemented at the decentralised level and serve the dual purpose of diverting organic waste from landfills while recovering nutrients and energy. However, they differ fundamentally in their mechanisms, outputs, and suitability across different contexts.

Feature	Composting	Biogas (Anaerobic Digestion)
Process Type	Aerobic (requires oxygen)	Anaerobic (absence of oxygen)
Space requirement	High, depending on the method of composting	Less, can handle large quantities of waste in limited space
Capital investment on infrastructure	Low, if cost of land is not considered	Moderate to high (digester, gas handling infrastructure)
Primary Output	Nutrient-rich solid compost/fertilizer	Biogas (methane + CO ₂) and liquid/solid digestate
Operational complexity	Low to medium (windrows, pits, or vessels); semi skilled manpower	High (sealed biodigesters, gas clean-up systems); skilled manpower, technical supervision
Output	Compost	Biogas (Methane), Fermented Organic Manure (FOM)
Offtake of output	Low demand; difficult to compete with subsidized chemical fertilizers	High; Can be used as alternate cooking fuel or electricity, and FOM can be used as fertilizer

1.6 Why decentralized Biogas solutions?

Owing to low space requirement, improvements in technology, and potentially better offtake of the output, biogas is emerging as a promising method of organic waste management. As the volume of organic waste increases, conventional decentralised systems can become more space-intensive and operationally demanding, making biogas an increasingly viable solution for managing larger quantities of organic waste within limited space.

According to the International Energy Agency (May 2025), biogas is well suited to decentralised systems because transporting bulky organic feedstock over long distances is costly and inefficient. Locating biogas plants closer to the source of waste can therefore reduce transportation requirements while enabling the local conversion of organic waste into energy. In remote areas, decentralised biogas systems can also provide off-grid energy and strengthen local energy resilience.



Osmania University, Hyderabad

2 Policy landscape for Biogas in India

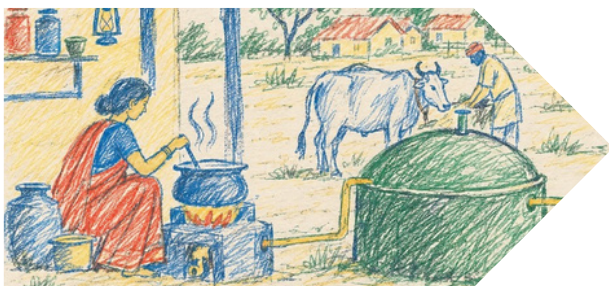
India's bioenergy policy ecosystem has evolved from localized, rural energy solutions into a multi-ministerial commercial sector. The governance landscape is divided into a Chronological Timeline (how policies evolved) and a Functional Policy Hierarchy (how programs are administered today under the GOBARdhan umbrella).

Evolution of India's Bioenergy Ecosystem

India's bioenergy ecosystem has evolved through successive policy phases, transitioning from decentralised household biogas systems to institutional and urban waste management, commercial biofuel development, and an increasingly integrated national governance framework. This evolution reflects the growing recognition of bioenergy as a means of addressing rural energy needs, waste management challenges, agricultural resource recovery, and national energy security.

1960s–1980s 1990s–2010s

Rural Cooking and Decentralised Biogas Era



The early development of India's biogas sector focused primarily on decentralised household energy solutions, particularly the provision of clean cooking fuel in rural areas. The introduction of the Khadi and Village Industries Commission (KVIC) floating-drum biogas model in the 1960s and the establishment of the National Project on Biogas Development during 1981–82 marked important milestones in promoting household-scale biogas digesters.

These initiatives aimed to reduce dependence on conventional cooking fuels, improve rural energy access, and utilise locally available food waste and cattle dung for biogas production and organic manure. Financial assistance for household digesters supported the adoption of biogas technology, particularly in rural communities.

Institutional and Urban Waste Management Era



During the 1990s and 2000s, the scope of bioenergy policy expanded beyond household applications to include institutional, agricultural, and urban waste management. The introduction of the Waste to Energy Scheme in 1995 and the National Biogas and Manure Management Programme in 2005 reflected the growing emphasis on energy recovery and the productive use of organic waste.

The sector gradually developed distinct pathways for household biogas systems and larger institutional or commercial applications. This period also saw increasing attention to municipal solid waste management, organic waste treatment, and the potential of waste-to-energy technologies to address urban environmental challenges.



2018–2023> Present Era

Commercial Biofuel and CBG Development Era



Policy attention subsequently shifted towards the development of commercial biofuels and compressed biogas (CBG) as alternatives to conventional fossil fuels. The launch of the Sustainable Alternative Towards Affordable Transportation (SATAT) initiative by the Ministry of Petroleum and Natural Gas in 2018 marked a significant step towards establishing a market for CBG produced from agricultural residues, cattle dung, and other organic waste streams.

The development of CBG-related initiatives, including blending obligations and market support mechanisms, sought to strengthen demand, encourage private investment, and integrate bioenergy into India's broader energy transition. These measures also highlighted the importance of reliable feedstock supply chains, assured offtake, infrastructure, and coordination across multiple stakeholders

Integrated and Unified Bioenergy Governance



India's current bioenergy landscape combines decentralised rural biogas development with commercial-scale CBG production and waste-to-energy initiatives. The sector involves multiple ministries and implementing agencies, reflecting the diverse applications of bioenergy across rural development, renewable energy, petroleum and natural gas, fertiliser production, and solid waste management.

1. GOBARDhan National Circular Bioenergy Scheme: A Decadal Framework
2. Decentralized Biogas Stream (National Bioenergy Programme (MNRE, 2022–2026)
 - Small Biogas Sub-Scheme (1–25 m³/day)
 - Medium Biogas Sub-Scheme (25–2,500 m³/day)

3 Saahas's initiatives in decentralised biogas solutions for SWM



Saahas has been working on biogas-based organic waste management initiatives since 2019. Being familiar with the solid waste management challenges across various geographies in India, addressing the need for a resource-efficient, economically viable solution for organic waste remained a critical priority. Furthermore, with India's national policy framework increasingly backing biogas as an aspirational solution, piloting emerging technologies—particularly at a decentralized level—became essential.

Saahas's initial foray into the biogas sector began in 2019 with its largest project to date: a massive 8.5 TPD facility owned by the Bengaluru Solid Waste Management Ltd (BSWML), previously part of Bruhat Bengaluru Mahanagara Palike (BBMP). The plant was expanding its capacity and required highly segregated organic waste from neighboring residential societies. Beyond mobilizing communities to ensure source segregation, Saahas was tasked with monitoring the expanded plant performance and supporting the operator in achieving financial viability. This foundational, hands-on experience provided the operational confidence needed to design and implement smaller decentralized units across various locations.

Consequently, what started in 2021 as a modest pilot converting just 10 kilograms of kitchen waste per day into cooking gas for local eateries (dhabas) has since matured into a robust model for establishing larger decentralized biogas units for major institutions. This progression reflects a steady expansion in operational capacity and outreach to larger institutional and commercial waste generators. While the journey has brought both successes and failures, a strong commitment to learning from setbacks and investing in technological upgrades positions Saahas for continued impact in sustainable waste management.



Bengaluru, Karnataka

This chapter documents the field practices and experiences drawn from **nine initiatives** where **decentralized biogas units** were established for treatment and valorisation of organic waste across India. These case studies provide practical insights into the planning, implementation, operation, and management of the plants, with a specific focus on their performance outcomes. The selected cases capture a diverse spectrum of project lifecycles: some demonstrate exemplary practices and successful approaches with strong replication potential, while not-so-successful ones offer invaluable lessons and capacity-building opportunities for sector stakeholders.

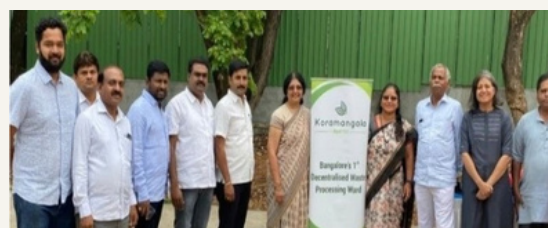
The case studies presented in this report are:

S. No.	Unit Owned by	Location	Type of waste	Capacity	Year of Installation
1	ULB (BSWML)	Bengaluru, Karnataka	Organic fraction of MSW from Ward & Bulk waste generators	8.5 TPD	2019
2	ULB (MCG)	Gurugram, Haryana	Municipal waste from Bulk waste generators	2 TPD	2022
3	University	Hyderabad, Telengana	Kitchen waste and left over food waste	2 TPD	2024
4		Hyderabad, Telengana	Kitchen waste and left over food waste	1 TPD	2026
5	Community Kitchen	Chennai, Tamilnadu	Kitchen waste	300 kg	2022
6	School	Bengaluru, Karnataka	Kitchen waste and left over food waste	75 kg	2025
7	Small eateries (Dhabas)	Murthal, Haryana	Kitchen waste and left over food waste	Five Biogas units (10kg each)	2021
8	Anganwadis and small school	Pune, Maharashtra	Kitchen waste and left over food waste	Five Biogas Units, (one 10kg, Four 5 kg)	2022
9		Luhari, Haryana	Kitchen waste and left over food waste	10 kg	2024



3.1 ULB (BSWML) owned, Biogas Unit, Bengaluru

- **Installed Capacity:** 8500 kg/day (8.5TPD) unit of which Saahas supported 4500 kg/day (4.5TPD)
- **Location:** Kasa Rasa 2, Kormangala, Bengaluru (Karnataka)
- **Funded By:** CGI Information Systems & Management Consultants Pvt. Ltd., Cadence Design Systems (India) Pvt. Ltd and NVIDIA Graphics Pvt. Ltd.
- **Technology Provider:** Carbon Masters
- **Owned by:** Bengaluru Solid Waste Management Ltd (BSWML), previously part of Bruhat Bengaluru Mahanagra Palike (BBMP)
- **Operated by:** Carbon Masters
- **Saahas Involvement:** Monitoring of operations; Support for feedstock - waste segregated at source
- **Year of Installation:** Dec 2019
- **Capex:** approx. Rs. 1.6 crore for 4.5 TPD
- **Output:** Cooking gas
- **Current Status:** Functional



Baseline Scenario

The decentralised biomethanation plant at Kasa Rasa, Koramangala, Bengaluru was a unique initiative processing 4.0 TPD of wet waste, operated by Carbon Masters in collaboration with BBMP under a PPP model. Saahas supported the expansion of the facility to a total capacity of 8.5 tonnes per day (TPD) of food waste by helping mobilize CSR funding for the expansion. In the first phase, 2 TPD of capacity was added, comprising 1.5 TPD supported by CGI and 0.5 TPD supported by NVIDIA. In the second phase, an additional 2.5 TPD was added, with 1.5 TPD supported by CGI and 1 TPD by Cadence. The key objectives of Saahas involvement were to improve segregation at source for better feedstock, and data management to ascertain operational viability.

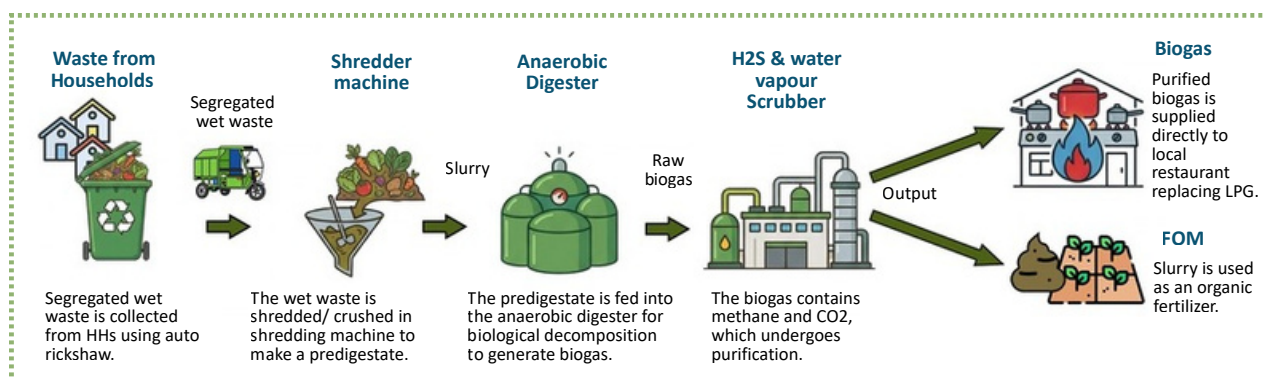


Technology & Design specification

Parameter	Specification
Type of Digester	Decentralised Biomethanation Unit
Digester Placement	On ground inside a refurbished shipping container
Space Requirement	680 sq m
Temperature and Moisture of the digester	35 - 40°C
System Power Consumption	Avg 40 Units per day
The pH of the predigestate	6.8 - 7.5
Water Mixing Ratio (Feed:Water)	1:1 (one part segregated food waste to one part water)
Construction Material of the Digester	Concrete
Hydraulic Retention Time (HRT)	15-30 days
Temperature Control Mechanism	The Programmable Logic Controller (PLC) automatically adjusts thermal valves
Agitation/Stirring Mechanism	Re-pumping the liquid from the bottom back to the top
Gas Storage Mechanism	Balloon
Feeding Mechanism	Feed pump
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	Gravity-assisted, and pump-fed mechanism

Feedstock Supply and Process Flow

Source-segregated household wet waste is collected from 10,000-12,000 households, including 2000 low income households and a slum across Ward 151, within a 5 km radius, using 15 collection autos. ULB and Koramangala ward's RWA ensures source segregation before collection. The collected waste is shredded/crushed to prepare an organic slurry, which is then fed into an anaerobic digester for biological decomposition in the absence of oxygen. The process generates raw biogas containing methane along with CO₂ and H₂S, which is subsequently treated for further utilisation. The raw biogas generated is purified on-site and piped directly into a local restaurant to replace commercial LPG.



Output and Utilisation of Biogas

The plant is currently operating at a capacity of 5 TPD and generates approximately 300 m³/day of biogas. The biogas produced & sold to a restaurant is equivalent to approximately 150 kg of LPG/day, corresponding to around 8 commercial LPG cylinders in a day. The Fermented Organic Manure (FOM) is provided free of cost to nearby farmers for use as a liquid fertilizer or sent to a larger plant.

Operation and Maintenance

Kormangala RWAs and ULB ensure a consistent supply of source-segregated feedstock, while the technology provider is responsible for shredding, digester feeding, gas purification, and overall system operation. The system is equipped with good quality flow meters, which were relatively expensive but were procured through CSR funding to ensure reliable and accurate monitoring. However, there is no digital dashboard for centralised data visualisation. The technology provider uses customised software to monitor gas generation, storage pressure, and cylinder-level gas inventory, enabling timely interventions and efficient system management. Regular maintenance of the digestion, purification, and compression systems supports reliable biomethane production and supply. Installation of good quality flow meters, along with a separate power connection and meter, supported regular and uninterrupted plant operation.

Financial Performance

Particulars (per month)	Amount (Rs. per month)
Plant Operation & O&M (including manpower)	4,50,000
Revenue (sale of gas to restaurant)	4,85,000
Surplus of Revenue over cost	35,000

*As shared by the operator for current operating capacity of STPD, as of August, 2026

**The operational cost analysis does not include the rental or lease charges for land, as the facility is located on government-owned premises, and the return on investment (ROI) on the initial capital expenditure on infrastructure. These components have also not been factored into the financial analysis of the other projects.



Current Status : Functional

Saahas supported the operations until March, 2024, post which the plant continues to operate successfully. Strong community ownership and BSWML supervision, a consistent supply of feedstock, and reliable paying end-user for gas, have been key factors in sustaining its operations.





3.2 ULB (MCG) owned, Biogas Unit, Gurugram

- **Installed Capacity:** 2TPD (Distributed)
- **Location:** Ecogram MRF Facility, Gurugram, Haryana
- **Funded By:** Hyundai Motor India Ltd.
- **Technology Provider:** GPS Renewable
- **Owned by:** Municipal Corporation of Gurgaon
- **Operated by:** Vendor empanelled by the MCG
- **Saahas Involvement:** Monitoring and Supervision
- **Year of Installation:** 2022
- **Capex:** ₹80 lakhs
- **Output:** Electricity
- **Current Status:** Functional



Baseline Scenario

Prior to the implementation of the Ecogram initiative, which is an integrated waste management facility offering scientific disposal of 7 TPD waste (2 TPD biogas and 5TPD MRF) located in Sector 53, Gurugram; waste generated by the Bulk Waste Generators (BWGs) was managed by independent agencies. While these agencies were responsible for the collection and removal of waste from the source, the subsequent disposal or treatment pathways were not known to the BWGs. Thus, the existing waste management system primarily focused on primary waste collection and transportation, with limited visibility on its end-use, processing, or disposal.



Technology & Design specification

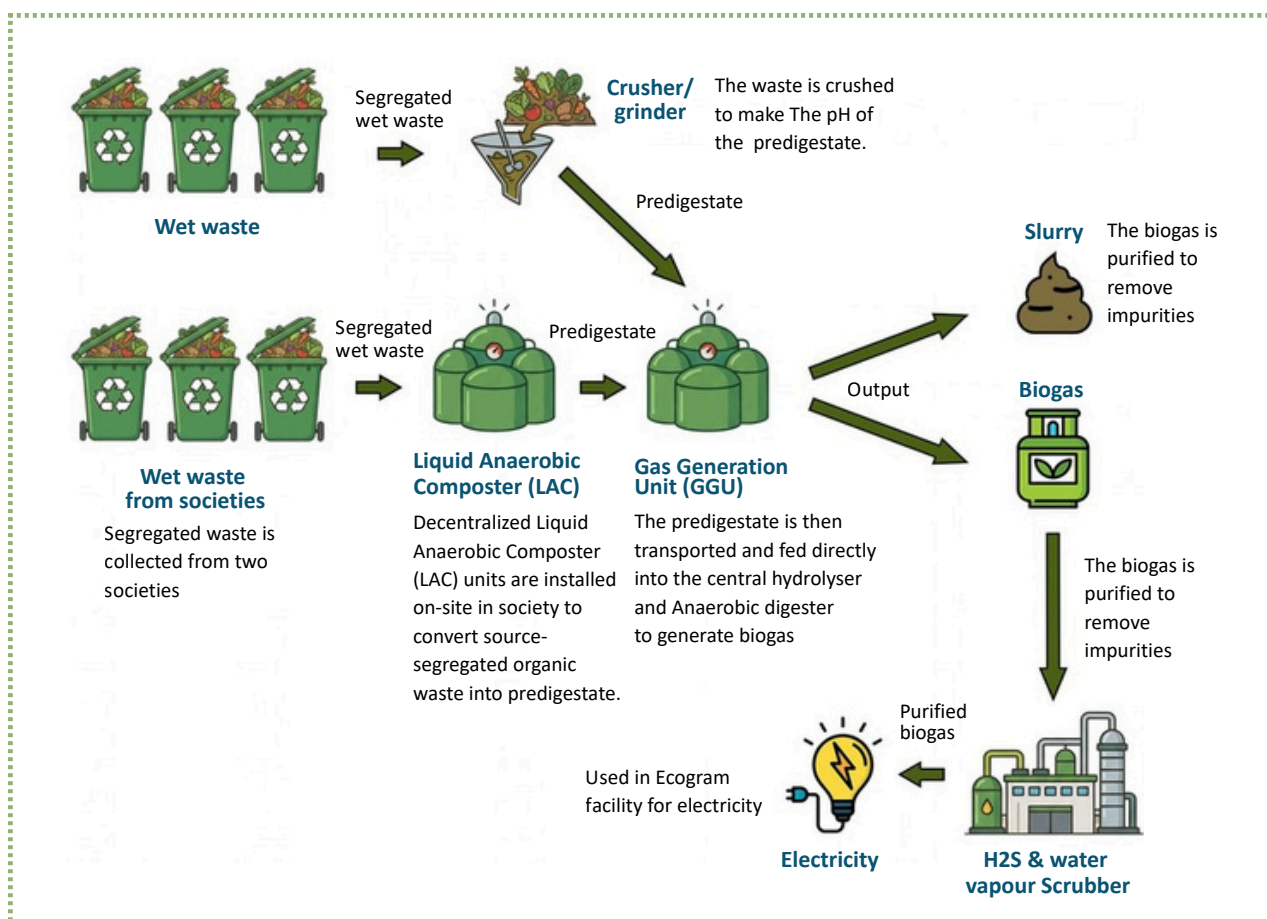
Parameter	Specification
Type of Digester	Fixed Dome
Digester Placement	On ground (not buried)
Space Requirement	Approximately 150 m ²
Temperature and Moisture of the digester	39–40°C, moisture content is less than 1%
Water Vapour	5-6 (regulated manually through the addition of Sodium Bicarbonate (NaHCO ₃))
The pH of the feed slurry	6.5 - 7.5
Water Mixing Ratio (Feed:Water)	1:0.3 (1 kg of waste to 0.3 litre of water)
Construction Material of the Digester	Mild Steel digester with insulation cover
Hydraulic Retention Time (HRT)	36 days
Temperature Control Mechanism	Electric geyser with proximity sensors; fully automated
System Power Consumption	70–85 kW at maximum capacity (varies with feed quantity and seasonal temperature)
Agitation/Stirring Mechanism	Mixing tank (Hydroliser)
Gas Storage Mechanism	Balloon connected to genset
Feeding Mechanism	Manual
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	An automated titration machine



Feedstock Supply and Process Flow

The facility features a 2 TPD fixed-dome anaerobic digester equipped with an agitator-equipped hydrolyser, a gas storage unit, and a bio-genset. Designed to process segregated Municipal Solid Waste (MSW) and food waste, the plant can generate around 220 units of electricity per day with full capacity. Feedstock arrives at the central facility in two distinct forms:

- **Predigestate Feedstock:** Approximately 800 kg of organic waste is sourced from two residential societies. Under the Ecogram distributed biogas model, these societies utilize two decentralized Liquid Anaerobic Composter (LAC) units installed on-site to convert source-segregated organic waste into slurry. This slurry is then transported and fed directly into the central hydrolyser.
- **Solid Feedstock:** The remaining 1,200 kg of waste is collected in solid form from corporate offices and SZW, which is processed directly at the central unit.



Output and Utilisation of Biogas

The biogas produced is utilized to meet the electricity requirements of the Ecogram facility, powering the biogas instruments and the genset on-site. The plant achieves a biogas production yield of 90 m³ per day, and the resulting slurry is repurposed as a soil conditioner after being mixed with water. The plant generates approximately 50–70 units (kWh) of electricity per day, depending on the facility's requirements, resulting in electricity bill savings of at least 80% to 90%.

Operation and Maintenance

The collected waste is fed into the digester within 12 hours of generation/pre-processing. Water consumption for waste mixing is 600 liters/ day along with 45 litres/ day for cleaning. The plant requires about 8 man-hours/day for secondary segregation of organic waste, processing, digester monitoring, and slurry circulation. Regular maintenance is required, with typical downtime of 10–15 days in a quarter depending on the feedstock. Gas purification is carried out through a two-step scrubbing process, targeting the removal of CO₂, H₂O, and H₂S.



Financial Performance

Particulars (per month)	Amount (Rs. per month) (average approximate)
Manpower – 2 persons @20,000 each	40,000
Minor breakdowns / pumps / electromechanical parts Rs. 10000-20000	15,000
Special Maintenance cost (scum removal, annual) - Rs.50000 in 2 years	2,083
Fixed electricity charge for commercial meters per month	30,000
Current operating cost, including minor maintenance & consumables	87,083
Tentative Non-comprehensive AMC (applicable from 2026), covers preventive visits, oiling, additives etc.	15,000
Indicative post-2026 operating cost	1,02,083
Revenue from User fee @Rs.3/kg from BWGs for offsite wet waste management. Current operating Capacity - 1200-1500 kg/month(till July 2026, revenue were coming from only from 2 BWG of amount INR 72000- , however from august 2026 onwards the 2 more BWGs have been onboarded which is resulting in overall revenue from both LACs & GGU INR 115000/-)	1,08,800
Electricity generated/saved @50-70 units per day. Commercial electricity charge -15/unit	22,500
Current operating savings & revenue	1,30,500
Current Surplus of revenue over cost	28,417
Indicative surplus after 2026 AMC	13,417

**Revenue is generated through a user-fee model, under which charges for waste processing are collected from Bulk Waste Generators as well as participating residential societies. The operational cost analysis does not include the rental or lease charges for land, as the facility is located on government-owned premises, and the return on investment (ROI) on the initial capital expenditure on infrastructure. These components have also not been factored into the financial analysis of the other projects.



Current Status : Functional

The facility remains functional due to continued handholding and technical support from Saahas, along with regular monitoring of its operations. The introduction of a user-fee model has created a revenue stream that contributes toward a portion of the operational costs. In addition, the facility is located on government-owned premises, eliminating rental or lease expenses.





3.3 University (Osmania) owned, Biogas Unit, Hyderabad

- **Installed Capacity:** 2TPD
- **Location:** Osmania University, Tarnaka, Hyderabad
- **Funded By:** KPMG Global
- **Technology Provider:** Ahuja Engineering Services Pvt. Ltd
- **Owned by:** Osmania University
- **Operated by:** Osmania University
- **Saahas Involvement:** Implementing Partner
- **Capex:** Approximately ₹1.01 crore
- **Output:** Cooking Gas
- **Current Status:** Functional



Baseline Scenario

Osmania University has approximately 7,500 students residing on campus, with its kitchens preparing thousands of meals daily and generating 1,100–1,200 kg of wet waste per day of organic kitchen waste. Initially all wet waste generated on the campus was transported to piggeries for disposal. The university relied heavily on firewood, approximately 13,000 kg per month, along with LPG for cooking, resulting in significant dependence on conventional fuels, associated greenhouse gas emissions, and monthly expenditure of approximately ₹59,000. This presented an opportunity to utilise the university's organic waste for on-site biogas production, thereby reducing dependence on firewood and lowering fuel costs and emissions.



Cooking with Biogas

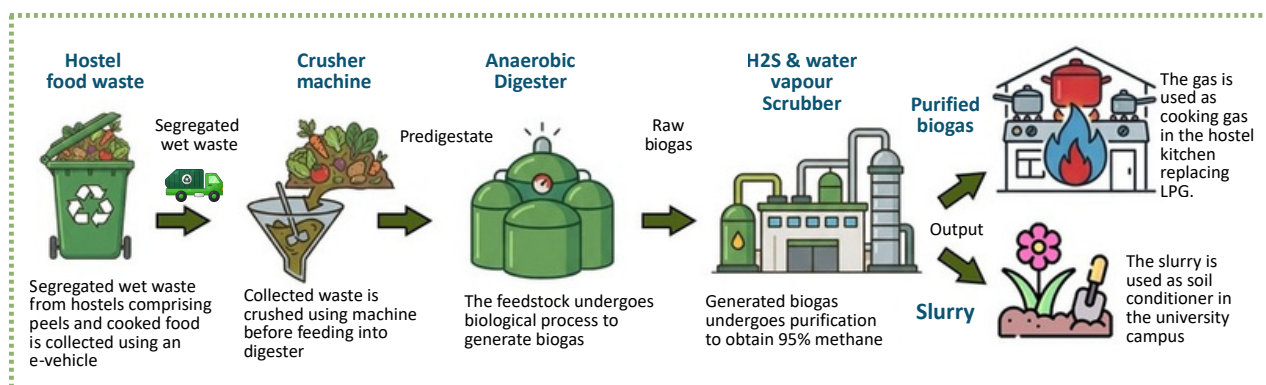
Technology & Design specification

Parameter	Specification
Type of Digester	Anaerobic Digester
Digester Placement	On ground (not buried)
Space Requirement	150 sq m
Temperature and Moisture of the digester	No provision of measurement
System Power Consumption	Avg 40 Units per day
The pH of the predigestate	6-7 (regulated manually)
Water Mixing Ratio (Feed:Water)	1:1 (1 kg of waste to 1 litre of water)
Construction Material of the Digester	FRP (MS)
Hydraulic Retention Time (HRT)	2 days
Temperature Control Mechanism	Installed heaters inside the Digester
System Power Consumption	Off - Grid
Agitation/Stirring Mechanism	Yes
Gas Storage Mechanism	Balloon
Feeding Mechanism	Feed pump
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	Sensors for Mixing and Auto Flare Unit

Feedstock Supply and Process Flow

Of the 17 operational hostels at Osmania University, 12 supply source-segregated wet waste to the biogas plant, thus, cumulatively managing approximately 1,100–1,200 kg/day. The waste comprises around 70% cooked food and 30% vegetable peels. Hostels are provided with 50 kg bins (1–4 per hostel) based on waste generation. Filled bins are collected and replaced every morning, and the segregated waste is transported to the plant using an electric vehicle, ensuring efficient and low-emission collection.

Collected wet waste is sorted, crushed into predigestate, and tested for pH before feeding into the digester. Anaerobic digestion converts the organic matter into biogas containing 60–65% methane, which is purified to approximately 95% methane for use as a clean energy source.



Output and Utilisation of Biogas

Since commissioning in October 2024, the plant has been processing approximately 1.5 tonnes of wet waste/day, producing around 240 m³ of biogas/day. This is nearly twice the projected output of 100–120

m³/day, primarily due to the high proportion of highly biodegradable cooked rice in the feedstock. The cooked rice has a higher biodegradability and biogas yield than originally estimated. Biogas use in one kitchen has replaced approximately 30 LPG cylinders and 13,000 kg of firewood per month. The excess biogas is now supplied to another kitchen, further reducing the university's dependence on conventional cooking fuels and associated biomass-combustion emissions.

Output and Utilisation of Biogas

Since commissioning in October 2024, the plant has been processing approximately 1.5 tonnes of wet waste/day, producing around 240 m³ of biogas/day. This is nearly twice the projected output of 100–120 m³/day, primarily due to the high proportion of highly biodegradable cooked rice in the feedstock. The cooked rice has a higher biodegradability and biogas yield than originally estimated.

Biogas use in one kitchen has replaced approximately 30 LPG cylinders and 13,000 kg of firewood per month. The excess biogas is now supplied to another kitchen, further reducing the university's dependence on conventional cooking fuels and associated biomass-combustion emissions.

Operation and Maintenance

The plant operates at an average loading rate of 1500 tonnes/day, with wet waste collected and fed daily. The typical lag between waste generation and feeding is 12–24 hours. Routine operations require approximately 4 man-hours per day, covering waste sorting and other processing activities. Occasional breakdowns have been reported involving compressor belts, electrodes, grinder, and collection bins. Five workers are engaged in waste collection using e-vehicles, and secondary segregation from the hostels.

Financial Performance

The plant diverts approximately 1500-2,000 kg of organic waste per day and produces around 200-240 m³ of biogas, equivalent to approximately 90 kg of LPG per day.

Particulars (per month)	Amount (Rs. per month)
Plant Operation and AMC (Includes manpower)	55,000
Waste collection & transportation - 5 persons@14,000/month	70,000
Electricity consumption (Plant Operation - 35 units/day@ Rs 10)	10,500
Special Maintenance cost (Supplementary cow dung during academic breaks) - 150–200 kg/day × ₹1/kg, assuming 3 months break in a year	4,500
Current operational Cost	1,40,000
Saving in terms of Commercial LPG substitution - ~140 cylinders/month (Rs. 2900/cylinder) (as per current rate in hyd.)	4,06,000
Surplus of Revenue over cost considering Commercial LPG substitution	2,66,000

**The operational cost analysis excludes land rental/lease charges, as the facility is located on University premises. ROI on the initial capital investment, including any savings from avoiding the earlier practice of transporting campus waste to piggeries, has not been considered. The initiative also reduced dependence on firewood, generating both financial savings and environmental benefits.

**The university also utilises the biogas plant slurry as a soil conditioner across the campus. While this practice provides potential savings through reduced dependence on chemical fertilisers, these savings have not been quantified or included in the current financial analysis.



Current Status : Functional

Segregated food waste, highly biodegradable cooked rice, systematic pre-processing and pH monitoring, and strong institutional leadership.



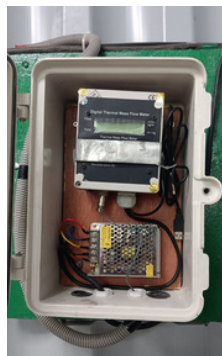
3.4 University (VNR, VJIET) owned, Biogas Unit, Hyderabad

- **Installed Capacity:** 1TPD
- **Location:** VNR Vignan Jyothi Institute of Engineering and Technology, Bachupally, Hyderabad
- **Funded By:** KPMG Global
- **Technology Provider:** Ahuja Engineering Services Pvt. Ltd.
- **Owned by:** VNR Vignan Jyothi Institute of Engineering and Technology
- **Operated by:** VNR Vignan Jyothi Institute of Engineering and Technology
- **Saahas Involvement:** Implementing Partner
- **Year of Installation:** 2026
- **Capex:** approximately ₹39.51 lakh
- **Output:** Cooking Gas
- **Current Status:** Functional



Baseline Scenario

The university has approximately 1,500 students residing in its hostels, and the hostel kitchen generates approximately 500 kg of wet waste per day, which was previously transported to piggeries and dairy farms as animal fodder. Prior to the installation of the biogas plant, the kitchen required around 2-3 commercial LPG cylinders per day.



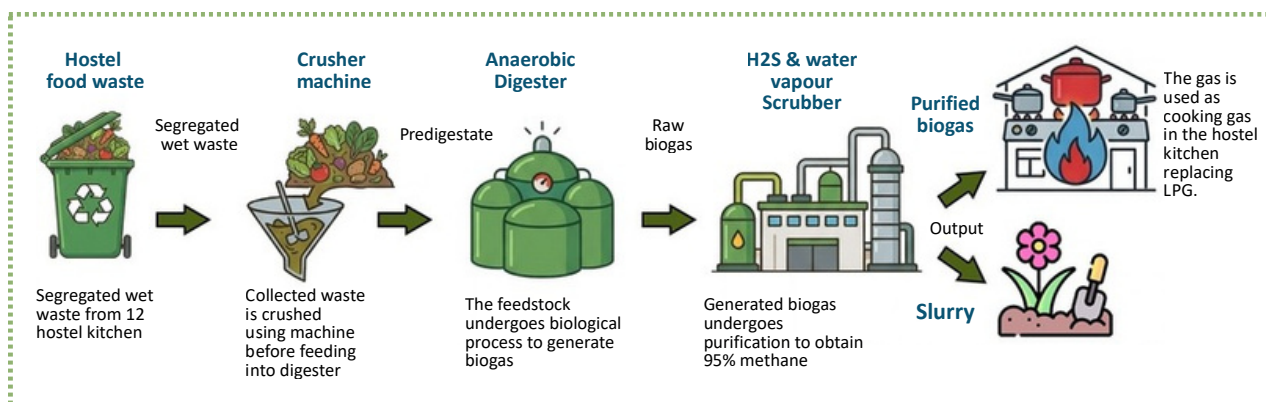
Technology & Design specification

Parameter	Specification
Type of Digester	Anaerobic Digester
Digester Placement	On ground (not buried)
Space Requirement	110 sq m
Temperature and Moisture of the digester	No provision of measurement
System Power Consumption	Avg 20 Units per day
The pH of the predigestate	6-7 (regulated manually)
Water Mixing Ratio (Feed:Water)	1:1 (1 kg of waste to 1 litre of water)
Construction Material of the Digester	FRP (MS)
Hydraulic Retention Time (HRT)	NA
Temperature Control Mechanism	Installed heaters inside the Digester
System Power Consumption	Off - Grid
Agitation/Stirring Mechanism	Yes
Gas Storage Mechanism	Balloon connected with compressor and pressure vessel
Feeding Mechanism	Manual followed by feedpump
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	Sensors for Mixing and Auto Flare Unit

Feedstock Supply and Process Flow

Approximately 15,000 kgs per month (450 kg/day) of segregated food waste from hostel kitchens is used as feed for the biogas plant. The waste is sourced directly from hostel kitchens and maintained at a high segregation level of approximately 95%, ensuring good-quality feedstock for efficient plant operation.

Collected wet waste undergoes pre-treatment using a food waste crushing grinder, followed by conversion into predigestate. The predigestate liquid is tested for pH before feeding into the digester, where anaerobic digestion converts the organic matter into biogas containing 60–65% methane. The biogas is then purified to approximately 95% methane for use as a clean energy source.



Output and Utilisation of Biogas

The biogas produced would be utilised as a cooking fuel in one of the hostel kitchens of VNR VJIET. The plant was commissioned two months ago and is currently in the initial operational stage, with biogas production and utilisation being progressively established.

Operation and Maintenance

The plant operates at an average loading rate of 0.5 tonnes/day, with wet waste collected and fed daily. Routine operations require approximately 2 dedicated operators, covering waste sorting and other processing activities.

Financial Performance

Particulars (per month)	Amount (Rs. per month)
Manpower - 2 operators @20,000 each	40,000
Electricity consumption (Plant Operation - 20 units/day@ Rs 10)	6,000
Current operational Cost	46,000
Tentative Non-comprehensive AMC (applicable from 2027), covers preventive visits, oiling, additives etc.	30,000
Indicative post-2027 operating cost	76,000
Indicative Saving in terms of Commercial LPG substitution - ~72 cylinders/month (Rs. 2,900/cylinder)	2,08,800
Indicative surplus of revenue over cost	1,32,800

As the plant is currently in the initial stage of operation (2months), the associated cost savings, revenue generation, and reduction in conventional fuel consumption are yet to be fully realised and reflected.

**The operational cost analysis excludes land rental/lease charges, as the facility is located on University premises and the return on investment (ROI) on the initial capital expenditure on infrastructure. These components have also not been factored into the financial analysis of the other projects.

The higher biogas generation at VNR can be attributed to the feedstock composition, particularly the presence of cooked rice, rice water, and non-vegetarian food waste, which have higher biodegradability and biogas-yield potential. A 500 kg/day plant at VNR generates approximately 118 m³ of biogas, compared with around 50–60 m³ /day generated by other plants processing mixed MSW or predominantly cooked food waste.



Current Status : Functional

The plant is in the initial phase hence supported by continuous handholding, monitoring, and supervision.



3.5 Community Kitchen owned, Biogas Unit, Chennai

- **Installed Capacity:** 300 kg (0.3 TPD)
- **Location:** Eco Kitchen, Padappai, Chennai
- **Funded By:** CGI, India
- **Technology Provider:** GPS Renewables
- **Owned by:** YRG Care
- **Operated by:** Eco Kitchen
- **Saahas Involvement:** Implementing Partner
- **Year of Installation:** 2022
- **Capex:** ₹30 lakh
- **Output:** Cooking Gas
- **Current Status:** Non-Functional



Baseline Scenario

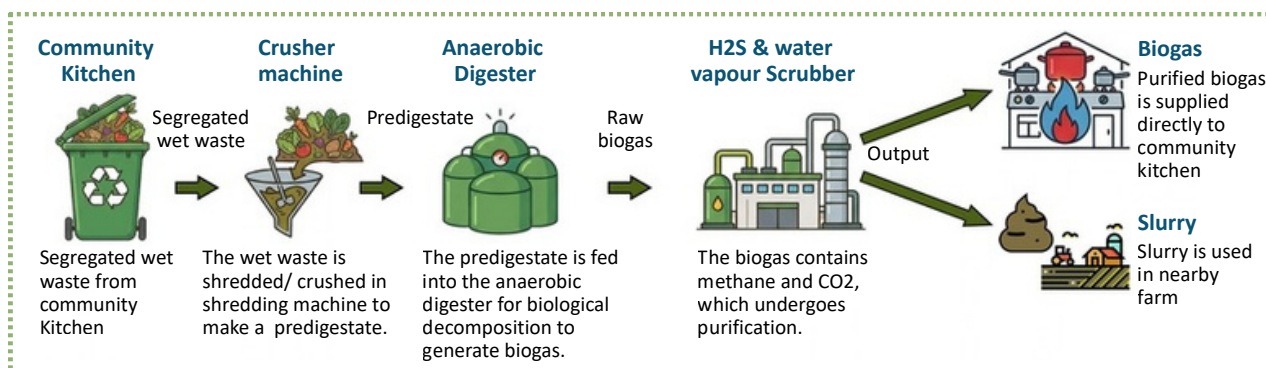
Eco Kitchen (Enhancing Community Opportunities) is a not-for-profit community kitchen managed by YR Gaitonde Medical Educational and Research Foundation. Before the intervention, organic kitchen waste was handed over to the municipality, with no clarity on its final destination. No system for circularity or resource recovery was in place. The availability of a consistent feedstock source (Kitchen waste and cooked food) and the potential to utilise the biogas within the same facility were key factors supporting the installation of the Bio Urja 300, with an installed capacity to process up to 300 kg of organic kitchen waste per day at ECO Kitchen.

Feedstock Supply and Process Flow

Saahas team developed and closely monitored a phase-wise implementation roadmap, covering the key activities required for project commissioning and operationalisation. This structured approach enabled the plant to achieve its full operational capacity within the planned 6–8-month timeframe.

When the biogas unit was in operation until 2025, approximately 200–300 kg of wet waste was processed daily, and the biogas generated by the unit replaced around 20% of the LPG cylinders traditionally consumed in the kitchen.

To ensure effective operation and maintenance, ECO Kitchen staff received training from Technology Provider on the operation and maintenance of the biogas unit.



Technology & Design specification

Parameter	Specification
Type of Digester	Fixed dome Anaerobic Digester
Digester Placement	On ground (not buried)
Space Requirement	30-35 Sq m
Temperature and Moisture of the digester	38-40°C
Water Vapour	Condensed water vapour may collect in the gas pipe must be emptied with the drainage outlet
The pH of the predigestate	6-7 (regulated manually)
Water Mixing Ratio (Feed:Water)	1:0.1
Construction Material of the Digester	Mild Steel digester with insulation cover
Hydraulic Retention Time (HRT)	36 days
Temperature Control Mechanism	Yes, autobuild
System Power Consumption	Avg 21 Units per day
Agitation/Stirring Mechanism	No
Gas Storage Mechanism	Balloon
Feeding Mechanism	Manual
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	Twin Balloon system, connected with automatic compressor

Output and Utilisation of Biogas

The unit processed 200 kg of wet waste daily, generating 20-22 m³/day biogas that replaced approximately 20% of LPG consumption for the kitchen within a few months of installation. The fermented organic manure (FOM) generated was utilised by nearby farms.

Operation and Maintenance

Close monitoring of key digester parameters, including pH and temperature, was essential to maintain optimal conditions for bacterial activity. GPS provided an online monitoring system, which was monitored daily by Saahas through an internal dashboard tracking plant performance and biogas yield. Monthly performance reviews, regular stakeholder reporting, prompt issue escalation, and daily WhatsApp communication helped address operational issues quickly while strengthening the capacity of local staff.

Financial Performance

Particulars (per month)	Amount (Rs. per month) (average approximate)
Manpower - 1 person × Rs. 20,000/month	20,000
Electricity consumption (21 units/day@12Rs per unit)	7,560
Non comprehensive AMC (72,000/year + 18% GST)	7,080
Electro-mechanical maintenance cost (approx.)	3,200
Total Operational cost	37,840
Saving in terms of commercial LPG substitution (at full capacity) - ~15 cylinders/month (Rs. 2,916 /cylinder)(Practically , these plants run avg 70-80% of their capacity in a year)	43,740
Surplus of revenue over cost	5,900

**The operational cost analysis excludes land rental/lease charges, as the facility is located on community kitchen premises and the return on investment (ROI) on the initial capital expenditure on infrastructure. These components have also not been factored into the financial analysis of the other projects.



Current Status : Non Functional

Following Saahas's exit, the plant became non-functional because the operator, a grant-funded, non-profit entity, did not prioritize the facility's financial yields or view it through a commercial, business-oriented lens. Consequently, the operational staff viewed managing the plant as an additional burden that offered no professional or financial incentives. The high AMC and maintenance costs further increased the operational burden.





3.6 School (Jawahar Navodaya Vidyalaya Residential School) Owned, Biogas Unit, Bengaluru

- **Installed Capacity:** 75 Kgs (0.075TPD)
- **Location:** Jawahar Navodaya Vidyalaya Residential School, Bengaluru, Karnataka
- **Funded by:** Shell India Market Pvt. Ltd.
- **Technology Provider:** Avris Environment Technologies Pvt. Ltd
- **Owned by:** Jawahar Navodaya Vidyalaya Residential School
- **Operated by:** Jawahar Navodaya Vidyalaya Residential School
- **Sahaas Involvement:** Monitoring and Supervision
- **Year of Installation:** 2025
- **Capex:** ₹5.4 lakh
- **Output:** Cooking Gas
- **Current Status:** Functional



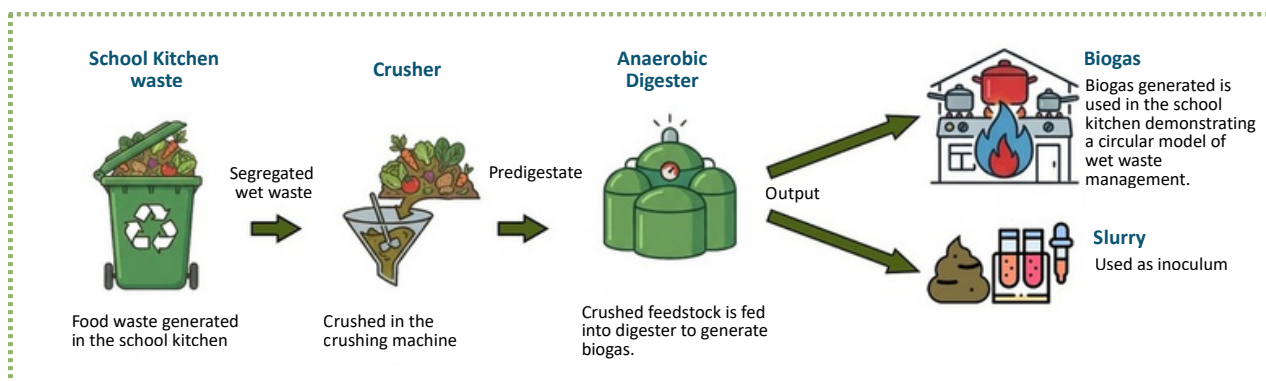
Baseline Scenario

During the baseline period, approximately 120 kg of wet waste was generated daily from the residential hostel kitchen of Jawahar Navodaya Vidyalaya Residential School, with only around 20% segregation at source. The segregated organic waste was managed through cattle feed and piggeries.



Feedstock Supply and Process Flow

The plant is fed with food waste generated from the school kitchen, with approximately 2,250 kg processed per month (0.075 TPD). The waste is first segregated at source (100%) and then crushed as a pre-treatment step before being fed into the digester. The digester has a capacity of 75 kg, with approximately 100 ml of slurry from the previous cycle used as inoculum. The plant was installed to promote sustainable kitchen waste management and demonstrate biogas-based practices in schools. The biogas produced typically contains 60–65% methane and 30–35% CO₂.



Technology & Design specification

Parameter	Specification
Type of Digester	Anaerobic Digester with nano technology
Digester Placement	On ground (not buried)
Space Requirement	6'6" X 3'10" X 7' (LXBXH)
Temperature and Moisture of the digester	NA
System Power Consumption	1 Unit per day
The pH of the predigestate	7-8 (regulated manually)
Water Mixing Ratio (Feed:Water)	01:1 (1 kg food waste to 1 litre of water)
Construction Material of the Digester	FRP(Fibre reinforced plastics)
Hydraulic Retention Time (HRT)	13 days
Temperature Control Mechanism	Not required. Maintained in ambient temperature
Agitation/Stirring Mechanism	Motor Agitator (Cycling)
Gas Storage Mechanism	Balloon
Feeding Mechanism	Pumping
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	Sensor for Biogas Booster pump

Output and Utilisation of Biogas

The biogas generated is used as a cooking fuel in the school kitchen, replacing LPG, with a production yield of approximately 4–5 m³/day, equivalent to around 2–2.5 kg of LPG savings per day. Although the system has a designed capacity of 75 kg/day, as the system is new, it currently processes around 15–20 kg of food waste per day, while the remaining waste is diverted to piggeries. The slurry generated is diluted with water and used in the school garden as a soil conditioner.

Operation and Maintenance

The plant currently processes approximately 15–20 kg of food waste per day, with waste collected and fed into the system daily. The typical lag between waste generation and feeding is 12–24 hours. The plant consumes approximately ₹8 per unit cost (1 unit of electricity per day) and 7–10 litres of water per day for cleaning and maintenance. Daily operation requires approximately 1 man-hour, including waste handling and other operational activities.

Financial Performance

Particulars (per month)	Amount (Rs. per month)
Manpower	No Manpower - Hostel and Kitchen staff
Electricity consumption (Plant Operation - 1 units/day@ Rs 8)	240
Addition of Lime Powder in a year (10 kgs @Rs. 30)	25
AMC (Rs. 30,000/year)	250
Current operational Cost	515
Saving in terms of Commercial LPG substitution - ~1.5 cylinders/month (Rs. 2900 /cylinder)	4,350
Surplus of revenue over cost	3,835

*Approximately 1,200 kg of cow dung, costing around ₹5,000, was required during installation for initial plant commissioning, which is not included as it was paid through CSR support.

**The operational cost analysis excludes land rental/lease charges, as the facility is located on school premises and the return on investment (ROI) on the initial capital expenditure on infrastructure. These components have also not been factored into the financial analysis of the other projects.



Current Status : Functional

The low operating cost and strong local ownership, with the hostel warden and kitchen staff responsible for daily operation and supervision, have enabled the plant to continue operating sustainably.



3.7 Small eateries (Five Dhabas) owned, Biogas Unit, Murthal

- **Installed Capacity:** 10 kg/day
- **Location:** 5 Dhabas, Murthal, Haryana
- **Funded By:** H.T. Parekh Foundation
- **Technology Provider:** Balancing Bits (a channel partner for Homebiogas, an Israel based company)
- **Owned by:** 5 Dhabas
- **Operated by:** Dhaba Owners
- **Saahas Involvement:** Implementing Partner
- **Year of Installation:** March 2021
- **Capex:** Approximately ₹1.65 lakh
- **Output:** Cooking gas
- **Current Status:** Non-Functional



Baseline Scenario

Mixed waste collection was prevalent at Murthal, with the municipality-appointed vehicles collecting and transporting waste from dhabas to designated municipal dumpsites. Despite awareness initiatives, multiple cleaning staff appointed by dhabas, working across shifts, often mixed the segregated waste, resulting in limited ownership of waste segregation. At some dhabas, the absence of regular collection led to waste being dumped in backyards or vacant plots. Based on the primary survey and discussions with dhaba owners regarding their readiness and space availability, five dhabas were selected, and one HomeBiogas system was installed at each location.



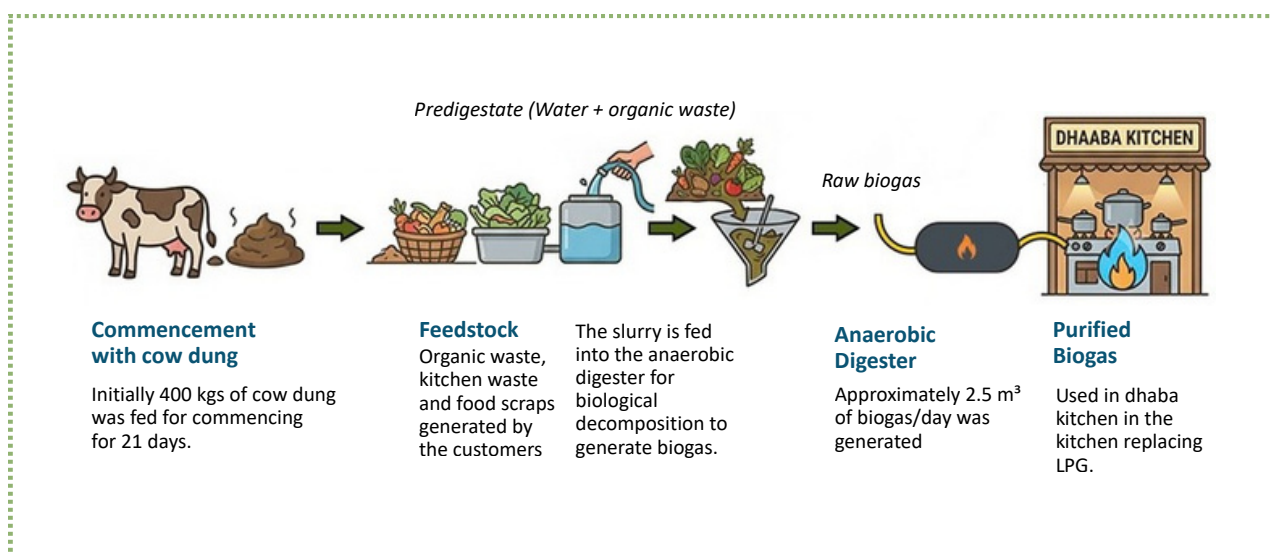
Technology & Design specification

Parameter	Specification
Type of Digester	HBG 7.0
Digester Placement	On ground (not buried)
Space Requirement	16 feet by 8 feet (length by breadth)
Temperature and Moisture of the digester	Above 15°C
Water Vapour	Condensed water vapour may collect in the gas pipe must be emptied with the drainage outlet
The pH of the predigestate	6.5 - 7.5
Water Mixing Ratio (Feed:Water)	1:1
Construction Material of the Digester	High quality UV protected Polyethylene and Polypropylene
Hydraulic Retention Time (HRT)	21 days
Temperature Control Mechanism	Stop feeding below temp of 20°C
System Power Consumption	Off - Grid
Agitation/Stirring Mechanism	By Plunger
Gas Storage Mechanism	Gas tank
Feeding Mechanism	Manual

Feedstock Supply and Process Flow

Each system was initially inoculated with cow dung, followed by food and kitchen waste feeding after approximately 21 days, once biogas generation commenced. The system processed up to 18 - 20 litres of predigestate (mixing with water) or 40–45 kg of cow dung in a day, producing approximately 2.5 m³ of biogas/day, equivalent to 1–1.25 kg of LPG per day.

The feedstock sources included kitchen organic waste and food scraps generated by customers. daily feed of food waste was required for consistent methane gas production.



Output and Utilisation of Biogas

Between October 2021 and June 2022, the five HomeBiogas systems collectively received approximately 6,952 kg of food waste, which was converted into around 614 m³ of biogas. This corresponded to an estimated 309 kg of LPG equivalent, demonstrating the potential of the systems to substitute a portion of conventional LPG consumption at the dhabas. The generated biogas was used for cooking and provided approximately 2-2.5 hours of gas availability per day. Although the gas was generated at low pressure, it was utilised for activities such as boiling water and potatoes, cooking rice, and preparing tea.

Operation and Maintenance

The HomeBiogas system operated through natural methanogenesis and did not require external electricity. The system required only 0.5 person-hours per day, for routine waste feeding, operation and monitoring. Biogas generation occurred at temperatures above approximately 15°C, with direct sunlight supporting the process. However, during winter months, when temperatures in North India frequently drop below the required range, the process slows down substantially leading to incomplete digestion.

Financial Performance

The system produced approximately 2.27 m³/day or 1-1.25 kg/day LPG equivalent, with a low flame comparable to that of a commercial LPG stove.

Particulars (per month)	Amount (Rs. per month) (average approximate)
Electricity	No external electricity required; system operated using sunlight
Manpower - 0.5 person-hours/day	Covered by existing manpower
Operational cost	Negligible
Operational Revenue (Saving in terms of LPG substitution (Rs 76–90/day)	3,000 - 3,500
Surplus of revenue over cost	3,000 - 3,500

*The unit had minimal operating costs, as it required no external electricity and only limited staff time for routine operation.

**Instead of a conventional AMC, the plant primarily requires regular training and coordination with the Original Equipment Manufacturer (OEM) to ensure effective system upkeep. This includes training the staff on stove cleaning, basic system health checks, scum removal, and regular feeding practices to maintain optimal plant performance.

*****The operational cost analysis excludes land rental/lease charges, as the facility is located on Dhaba premises and the return on investment (ROI) on the initial capital expenditure on infrastructure. These components have also not been factored into the financial analysis of the other projects.



Current Status : Non Functional

All 5 units operated only for a few months only as small dhabas, particularly those serving truck drivers, frequently modified or relocated their structures, affecting the continuity of the intervention. Limited ownership and engagement from the dhaba operators along with low and inconsistent biogas pressure received by the users further contributed to the units becoming non-operational.



3.8 Anganwadi and Small Schools owned, Biogas Unit, Pune

- **Installed Capacity:** Five biogas units (One unit of 10 Kg/day and 4 units of 5kg/day)
- **Location:** Bhamboli and Mahalunge Ingle, Khed block, Pune district
- **Funded by:** Indospace
- **Technology Provider:** Chakraakaar Lifestyle Solutions Pvt. Ltd
- **Owned by:** 3 Anganwadi centers and 2 Schools
- **Operated by:** 3 Anganwadi centers and 2 Schools
- **Sahaas Involvement:** Implementing Partner
- **Year of Installation:** 2022
- **Capex:** Approx. ₹4-4.5 lakh (for five biogas units)
- **Output:** Cooking Gas
- **Current Status:** Functional



Baseline Scenario

Biogas units in three Anganwadis and two schools were installed and commissioned in 2019, but they became defunct following the COVID-19 pandemic, with some units subsequently getting damaged. Saahas revived and operationalised all units in January 2022 under project “Swachh Sundar Chakan” funded by Indospace. The five units can collectively process 7–9 kg/day of organic waste that was previously openly dumped due to the absence of door-to-door waste collection services.

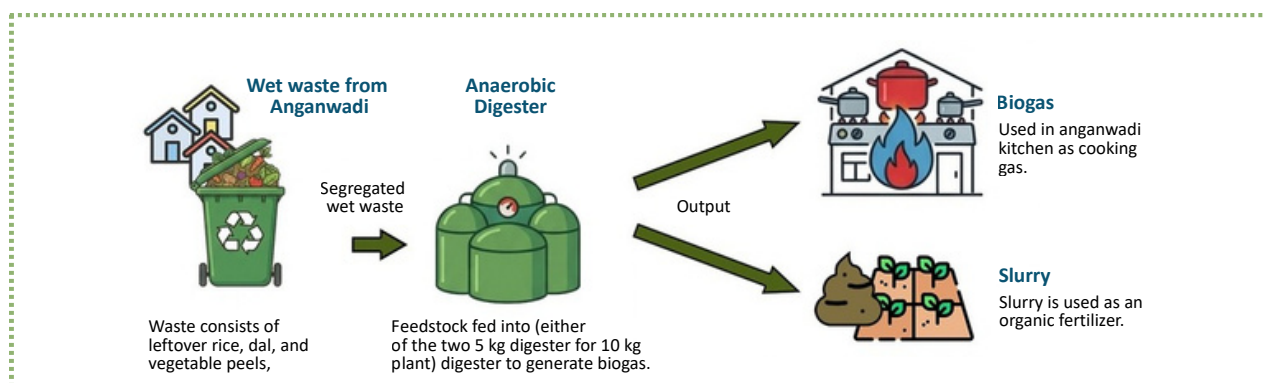


Technology & Design specification

Parameter	Specification
Type of Digester	Anaerobic Digester
Digester Placement	On ground (not buried)
Space Requirement	25 sq feet (Digester)+ 40 sq feet (Balloon) for each unit
Temperature and Moisture of the digester	No provision of temperature measurement, Moisture trap installed
System Power Consumption	Off - Grid
The pH of the predigestate	6-7 (regulated manually through the Sugar, Caustic Soda)
Water Mixing Ratio (Feed:Water)	1:1 (1 kg of waste to 1 litre of water)
Construction Material of the Digester	Syntax
Hydraulic Retention Time (HRT)	NA
Temperature Control Mechanism	NA
Agitation/Stirring Mechanism	By Plunger
Gas Storage Mechanism	Balloon
Feeding Mechanism	Manual
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	Manual

Feedstock Supply and Process flow

Waste generated mainly consists of leftover rice, dal, and vegetable peels, which are directly fed into the digesters by Anganwadi and school workers and the biogas produced is used for cooking. The system operates through anaerobic digestion by methanogens and requires no electricity under tropical conditions, while heating is required below 15°C. One school (Jopaiwadi) has two 5 kg/day digester units, occupying approximately 90 sq. ft., which are operated alternately to ensure continuity in case of breakdowns. The resulting slurry is used as organic fertilizer.



Output and Utilisation of Biogas

Out of 5 Biogas units only two are functional. The five units collectively serve more than 220 students and currently two plants are processing approximately 7–9 kg/day of organic waste, generating an estimated 0.70–0.90 m³/day of biogas. This is equivalent to an estimated LPG replacement of approximately 0.29–0.38 kg/day.

Operation and Maintenance

The Anganwadi workers maintain input and output records and monitor pH regularly, while any operational concerns are flagged to the Saahas team and technology provider through a WhatsApp group. During periods of strikes or holidays, nearby workers supply household food waste to maintain digester operation. Maintenance requirements are minimal, with approximately one person required for each plant digester, however Annual Maintenance Contract (AMC) is required for sustained operations.

Financial Performance

It is estimated that 0.70 - 0.90 m³/day of biogas is generated which is equivalent to 0.29 - 0.38 kg/ day of LPG replacement for each plant.

Particulars (per month)	Amount (Rs. per month)
Electricity	No electricity required
Manpower cost	Nil – Anganwadi and school staff manage routine feeding and operation
Operational Cost	Negligible
Operational revenue (Saving in terms of LPG substitution (Rs 76–90/day)	800-1100
Surplus of revenue over cost	800-1100

*There is no recurring monthly maintenance cost, to date, only one repair has been undertaken at a single plant, incurring a one-time cost of ₹30,000.

**AMC Recommendation: As recommended by the technology vendor, an annual AMC cost of ₹1,000–1,250 per 10 kg/day biogas unit may be considered.



Current Status : 2 out of 5 biogas units are functional

As the plant was operated without an AMC, regular maintenance and timely technical support emerged as key challenges. During periods of high cooking demand, the users also tended to prefer LPG over biogas due to the convenience and speed of cooking, resulting in lower utilisation of the biogas system. During vacation periods, the regular supply of feedstock was disrupted, which contributed to non-functionality.





3.9 Small School (Government School) owned, Biogas Unit, Luhari

- **Installed Capacity:** 10 kg/day (0.01TPD)
- **Location:** Government Senior School, Luhari, Haryana
- **Funded By:** Indospace
- **Technology Provider:** Chakraakaar Lifestyle Solutions Pvt. Ltd.
- **Owned by:** Government Senior School
- **Operated by:** School staff
- **Saahas Involvement:** Implementing Partner
- **Year of Installation:** 2024
- **Capex:** Approximately ₹1.5 lakh
- **Output:** Cooking Gas
- **Current Status:** Non-Functional



Baseline Scenario

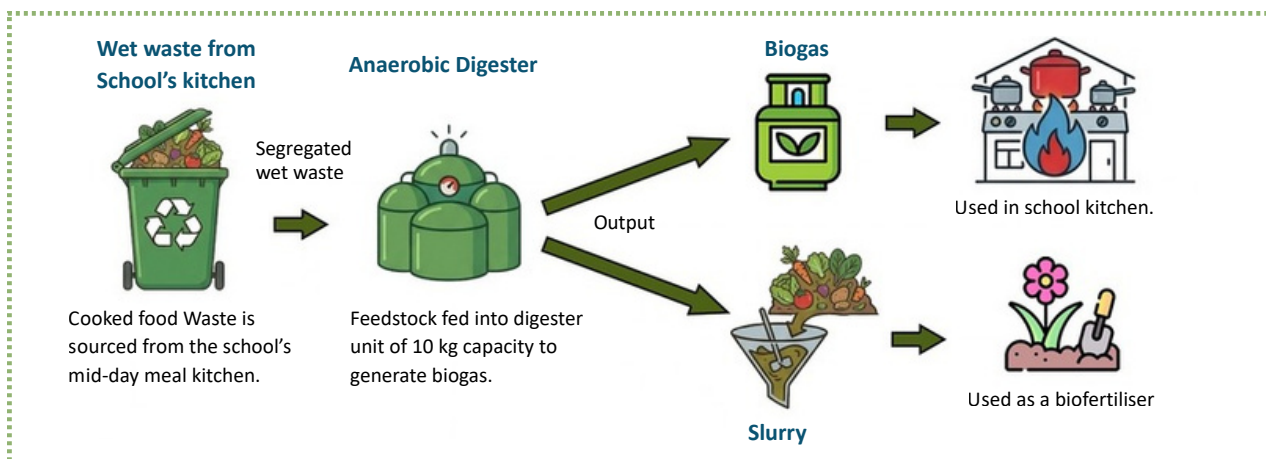
Prior to this intervention, the organic waste generated during mid-day meal preparation by the school kitchen was disposed of as mixed waste and subsequently transported to the dumping site. The school had sufficient space to accommodate a small-scale decentralised biogas plant behind the kitchen, hence the site was selected for this pilot intervention. The key motivation for installing the plant in school premises was to demonstrate the technology to schoolchildren and create awareness about decentralized waste-to-clean energy solutions.

Technology & Design specification

Parameter	Specification
Type of Digester	Anaerobic Digester
Digester Placement	On ground (not buried)
Space Requirement	25 sq feet (Digester)+ 40 sq feet (Balloon)
Temperature and Moisture of the digester	No provision of temperature measurement, Moisture trap installed
The pH of the predigestate	6-7 (regulated manually through the Sugar, Caustic Soda)
Water Mixing Ratio (Feed:Water)	1:1 (1 kg of waste to 1 litre of water)
Construction Material of the Digester	Syntax
Hydraulic Retention Time (HRT)	NA
Temperature Control Mechanism	NA
System Power Consumption	Off - Grid
Agitation/Stirring Mechanism	NA
Gas Storage Mechanism	Balloon
Feeding Mechanism	Manual
Monitoring of Digester health (including bacterial activity and indicating feed requirements accordingly)	Manual

Feedstock Supply and Process Flow

The Vaayu model is an off-grid, easily dismantlable biogas system with a capacity to process 10 kg of waste per day (0.01 TPD). Under operational conditions, the system generates cooking gas equivalent to approximately one 19-kg LPG cylinder every 3–3.5 months, or around 3–4 cylinders annually. The plant processes kitchen and cooked food waste generated by the school's mid-day meal kitchen. As the waste is directly sourced from the kitchen, the segregation level is approximately 95%, minimising contamination and supporting efficient digester performance.



Output and Utilisation of Biogas

The generated biogas is used in the kitchen for supporting activities such as tea/coffee preparation and water boiling. The plant produces approximately 12–15 m³ of biogas per month, or around 5.4–6.3 kg LPG equivalent, resulting in estimated LPG cost savings of around ₹570–₹665 in a month, reducing the use of conventional cooking fuel for these activities.



Operation and Maintenance

The plant operates at an average feed rate of 5 kg/day, with waste fed once daily, typically within 18–24 hours of generation. It requires no electricity or routine running costs, relying on natural anaerobic digestion. Water consumption is approximately 1 litre/day, with around 1 man-hour/day required for operation and maintenance.

Financial Performance

Particulars (per month)	Amount (Rs. per month) (average approximate)
Electricity	No electricity required
Water Consumption	From school facility, no extra cost
Manpower cost	Nil – school staff manage routine feeding and operation
Breakdown & Repair cost (Rs 35,000 in 3 years)	972
Operational Cost	972
Saving in terms of LPG substitution (Rs 76–90/day and 5.4–6.3 kg/month)	2,280–2,700
Surplus of Saving over Cost	1,500–1,700

*The facility is located on government school premises, eliminating rental or lease expenses.

**AMC recommendation: per 10 kg/day biogas unit per year, as recommended by the technology vendor



Current Status : Non Functional

Non-functionality was primarily due to frequent breakdown, absence of an AMC, limited technical understanding, inadequate ownership, manual operation, and irregular feedstock availability during school holidays.

4 Analysis

4.1 Operational Analysis

Category 1: ULB owned units

Case studies: ULB, Bengaluru MCG, Gurugram

Challenges

Maintaining Source Segregation: Ensuring consistent segregation quality is critical for feedstock, which is difficult in case of MSW.

Output Distribution Infrastructure: In Bengaluru, the initial plan of supplying biogas to multiple restaurants would have required additional pipeline infrastructure, increasing the cost and complexity of distribution. In Gurugram, As the unit is not connected to the grid, gas utilisation is limited to on-site electricity requirements, the excess gas needs to be flared, limiting the plant's ability to operate at full capacity.

Shared utilities: In Bengaluru, earlier dependence on a common government utility connection and shared high-tension lines resulted in power outages that affected plant operations.

Operational issues: In Gurugram, common technical challenges included scum formation, which obstruct biogas flow, pH imbalance and overfeeding, which destabilised the digestion process, reduce efficiency, and lead to operational breakdowns (2-3 breakdowns/month of motor and pumps).

Staff Capability: In Gurugram, low staff retention and high training needs of the new joiners affect routine operation, monitoring, and troubleshooting.

Strategies

Awareness programs and RWA monitoring: In both locations, Saahas conducted door to door engagement with households in the neighborhood. Additionally, in Bengaluru, the RWA of Koramangala regularly monitors waste.

Manual secondary segregation: In both locations, some level of secondary sorting is carried out before feeding in the digester.

Optimize output utilization: In Bengaluru, a nearby restaurant uses all the biogas generated, making pipeline infrastructure simple and cost-effective. In Gurugram, alternative users are still being explored.

Technological and mechanical enhancements - In Gurugram, introduction of a two-step scrubbing process, an automated titration machine, and an automatic sensor-controlled valve fitted inside the gas balloons, have improved the plant's overall performance. In Bengaluru, good quality flow meters were installed through CSR support.

AMC: In Gurugram, a non-comprehensive Annual Maintenance Contract valid until 2026, was bundled into the initial plant cost. Post which, this has to be budgeted in operational cost, whereas in Bengaluru since the technology provides operates the unit, this is not required.

Category 1: ULB owned units (contd.)

Case studies: BSWML, Bengaluru MCG, Gurugram

Advantages	Learnings
Feed Stock Availability & Quality: In Bengaluru, source-segregated wet waste is collected from approximately 10,000 - 12,000 households, with ULB and RWA ensuring segregation at source before collection. In Gurugram, the LACs installed at BWG sites help process organic waste into a homogenised predigestate, which is transported to the Ecogram facility and fed into the central hydrolyser resulting in relatively high feedstock purity and consistency. Output: In Bengaluru, gas performance is identical to commercial LPG, which is supplied to a nearby restaurant. Whereas, in Gurugram, the plant generates electricity for internal use, resulting in an 80–90% reduction in the facility's electricity bills. Revenue Generation: In Bengaluru, gas is sold to the restaurant, whereas in Gurugram, a user-fee model generates revenue by charging the participating entities for waste processing, supporting the financial sustainability of the facility. ULB ownership: As both facilities are owned by ULB, there is no rental cost for operator. Location: In both the cities, biogas units are located in the heart of the city, where source of waste and end user for gas are located in close proximity, ensuring cost effectiveness.	Yes in my backyard: The success of both facilities reinstate the message that waste should be processed close to its source, where waste generators can see the processing. MSW based biogas is a reliable energy source: At the time when country was facing severe shortages in LPG owing to geo-political crises, the Bengaluru plant continued to provide gas to the restaurant, ensuring consistent operations. Biogas to Electricity generation is relatively less profitable: Electricity generation and utilization requires grid connectivity, which may involve clearances from multiple departments. In Gurugram, without grid connectivity, excess biogas may need to be flared, resulting in under utilisation of the plant. Direct use of biogas as a thermal fuel offers higher thermodynamic efficiency and better returns on investment, as is the case with Bengaluru. Biogas as an alternative to composting for BWGs: From Gurugram model, it is clear that BWGs who do not compost their waste in-situ, a distributed biogas model can provide a viable alternative at a cost comparable to off-site composting. Technology provider as operator: Unlike other biogas plants, MSW based units are an evolving industry. Having the technology provider also operate the plant enables continuous technology improvement based on field experience, while ensuring timely troubleshooting and maintenance, as in the case of Bengaluru unit.

Category 2: Units installed in Campuses (Universities and schools)

Case studies: *Osmania University and VNR VJIT, Hyderabad*
Jawahar Navodaya Vidyalaya Residential School, Bengaluru
Government School, Luhari
Anganwadis, Pune

Challenges	Strategies
Sustaining Source Segregation: Maintaining 95% waste segregation in campuses requires continuous awareness, monitoring, and handholding of staff and students to prevent contamination. Inconsistent feedstock availability: Reduced food waste generation during the vacation periods creates a challenge in maintaining the required daily feedstock supply. Prolonged closure causes digester acidification and eventual system shutdown, making restart technically challenging and costly. Maintenance issues: For relatively larger units, such as at Osmania University, AMC costs can be incorporated into operating costs while still generating net savings through gas utilisation. For smaller units, such as the 10 kg/day unit at Luhari, low gas output may not justify the cost of an AMC. Without regular maintenance support, breakdowns can disrupt operations and result in higher costs for plant revival. Lack of adequately trained personnel: Regular preventive maintenance and trained personnel are required for activities such as waste weighing, feeding, slurry circulation and system cleaning. This is particularly important for smaller units where clearly defined SOPs and dedicated operational staff may be lacking.	Enabling source segregation: In both universities, 50 kg bins were placed in each hostel for wet waste, which is then transported to the biogas plant using an electric vehicle. Supplementary feedstock: Cow dung is used during vacation periods to maintain the required feedstock supply at both universities. At Anganwadis, where its cost is not factored into the operating model, nearby staff members were requested to add small quantities of household food waste to the digesters.

Category 2: Units installed in Campuses (Universities and schools), contd.

Case studies: *Osmania University and VNR VJIT, Hyderabad*
Jawahar Navodaya Vidyalaya Residential School, Bengaluru
Government School, Luhari
Anganwadis, Pune

Advantages	Learnings
Control over Feedstock: Segregated waste is directly collected from hostel kitchens, which enables better control over feedstock, unlike MSW based units. High Biogas Yield: In some cases, high proportion of cooked rice, rice water, and non-vegetarian food waste enhanced digestion efficiency and resulted in higher-than-estimated biogas generation. Reduce dependence on conventional fuels: Biogas has reduced the university's reliance on firewood and LPG for cooking, lowering overall fuel cost and associated emissions. Ease of Operation: The Vaayu model demonstrates a small-scale system to convert intstutes kitchen waste into cooking gas on-site. Its dismantlable design enables deployment in resource-constrained or space-limited locations. The system also requires minimal manpower for routine operation and maintenance.	Building environmental awareness and stewardship: Setting up biogas units in campuses provide multi dimensional benefits such as decentralized waste management, clean energy, and also drive student consciousness and environmental stewardship. High replicability in bigger campuses: Captive biogas plants provide dependable clean energy, where quantum of wet waste generation is high. Higher operational costs for smaller campuses: Schools and anganwadis can install biogas units as a waste management initiative, more than a reliable source of energy, as the yield is low and cost of maintenance is high, if trained manpower is not available. Pre processing improves yield: Secondary sorting and crushing waste into pH tested predigestate before feeding supports effecient digestion.

Category 3: Units installed in community and commercial kitchens

Case studies: *Community Kitchen, Padappai* *Small eateries (dhabas), Murthal*

Challenges	Strategies
Technological gaps: The basic, dismantlable units at the dhabas stopped operating during winter when temperatures fell below 15°C. The advanced system at the community kitchen faced frequent equipment breakdowns. AMC and skilled workforce: Both basic and automated systems require trained personnel for preventive maintenance. For advanced systems, a reliable AMC and prompt troubleshooting support are critical for sustained operation. Low acceptance of output utilisation: Non-purified biogas results in slower cooking, leading kitchen staff under time constraints to prefer commercial stoves, which offer faster cooking. Low staff ownership: Managing the biogas system was an additional responsibility for kitchen staff, which reduced ownership	Handholding support: While Saahas supported the operators with technical and operational upkeep, but after the handover, it did not sustain for long. Capacity building support: During the initial phases, Saahas conducted awareness and skilling sessions to improve staff understanding of the system and encourage greater use of biogas, including on a separate burner for boiling and tea-making. However, these practices were not sustained over time.
Advantages	Learnings
On-Site Location: Land available close to the kitchens reduced handling and transportation requirements. Low Operating costs: Both plants required negligible running costs - as no dedicated manpower was required for feeding the digester, and minimum power costs.	Ownership is essential for sustained operation: Even operationally viable units, such as the Community Kitchen, may not sustain without clear ownership. Staff received fixed salaries even as biogas-related responsibilities increased, creating limited incentive to take ownership. Small plants as waste management solutions, not energy sources: Smaller plants can be effective for decentralised wet waste management, but where waste quantities are low, they may not provide a reliable or significant source of energy.

4.2 Data Interpretation

Data Overview

Case Study	Design Capacity (kg/day)	Current Feed (kg/day)	Biogas Yield (m ³ /day)	Operational Cost (Rs/month)	Revenue (Rs/month)	Surplus (Rs/month)
BSWML Biogas Unit, Bangalore	8,500	5,000	300	450,000	485,000	35,000
MCG Biogas Unit, Gurugram	2,000	1,000	90	87,083 (1,02,083 indicative)	130,500	28,417 (13,417 indicative)
Osmania University, Biogas Unit, Hyderabad	2,000	1,500	240	140,000	406,000	266,000
VNR VJIET, Biogas Unit, Hyderabad	1,000	450	118	46,000 (76,000 indicative)	2,08,800 (indicative)	1,32,800 (indicative)
Community Kitchen, Biogas Unit, Chennai	300	200	20–22	37,840	43,740	5,900
Jawahar Navodaya Vidyalaya, Biogas Unit, Bengaluru	75	15–20	4–5	515	4,350	3,835
Five Dhabas, Biogas Unit, Bengaluru	10 each (5 units)	5–6	2.27	Negligible	3,000–3,500	3,000–3,500
Anganwadi & Small Schools, Biogas Unit, Pune	1 × 10 and 4 × 5	7–9 (only 2 plants operating)	0.70–0.90	Negligible	800–1,100	800–1,100
Government School, Biogas Unit, Luhari	10	4–5	0.40–0.50	972	2,280–2,700	1,500–1,700

Analysis

- **Scale doesn't guarantee profit**

The largest plant amongst all case studies is the Bengaluru one (8,500 kg/day capacity), but its surplus is only Rs. 35,000/month on Rs. 4.85 lakh revenue, a thin margin of about 7%. Osmania university, Hyderabad processes one third as much waste (1,500 kg/day) yet earns Rs. 2.66 lakh surplus, through cost savings on cooking fuel, about 7.6 times more than Bengaluru unit.

- **Gas Yield depends on the Feedstock quality**

Bengaluru facility unit gets only 0.06 m³/kg yield, while VNR gets 0.26 m³/kg and Osmania 0.16 m³/kg. This points to differences in feedstock quality, that organic fraction of MSW provides lower yield, as compared to more homogenous kitchen waste.

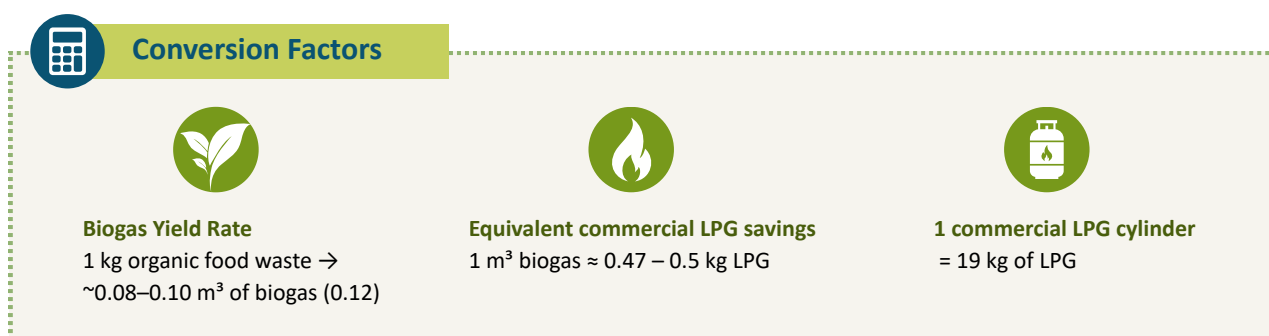
- **Institutional waste has better yield and profitability as compared to MSW based units**

Consistent and quality feedstock supply such as in Osmania and VNR university demonstrates a combination of relatively high gas yields, reasonable capacity utilisation and cost savings owing to fuel substitution, of approximately 65%. Whereas, both BSWML and MCG owned units have lower revenue generation. This can be attributed to relatively consistent supply of source-separated institutional/canteen food waste, and suggest that institutional settings with predictable waste generation and stronger ownership mechanisms may provide more favourable conditions for sustained biogas plant operation.

- **Smaller plants (small eateries, ananganwadis and schools) appear more profitable than they are**

Report "negligible" or near-zero operating costs. This does not account for breakdowns requiring repair, Annual Maintenance Cost and the additional personnel costs. The resulting monthly savings in form of LPG/fuel substitution, estimated at approximately Rs. 800– Rs. 4,350, are relatively modest. Therefore, the value of such micro-plants is better assessed in terms of organic waste diversion, localised waste management, and other environmental and institutional benefits, rather than solely on direct financial returns.

Conversion Factors Used for Calculating Biogas Yield and Equivalent Savings:





Ecokitchen, Chennai

5 Critical Success Factors for Replication

Below are the critical guiding questions which highlight the key conditions that supported successful implementation and identify the requirements that should be considered when replicating decentralised MSW based biogas models in other locations.

Question 1: What are the key considerations for planning biogas units?

- **Quantity and quality of organic waste:** Biogas systems require a consistent supply of suitable organic waste. Therefore, the availability, source segregation, quantity and variability of feedstock are critical considerations.
- **Output utilisation:** The intended end use should guide system design and infrastructure requirements. For example, electricity generation requires grid connectivity, while cooking applications require adequate gas purification and pressure based on user requirements.
- **Availability of space and infrastructure support:** Available space can influence the system configuration. In certain cases, a distributed architecture can be adopted, with separate LACs at multiple BWG sources for onsite pre-processing, followed by transfer of the slurry to a central GGU unit for biogas production.
- **Capital availability:** Budget and sources of funding influence technology selection and system configuration. For decentralised MSW-based units, Central Financial Assistance available under relevant government schemes can also be considered.

Question 2: How to select the most suitable technology provider?

- **Ease of operation:** The system should require minimal day-to-day intervention, with routine activities such as feeding, basic cleaning and monitoring manageable with limited manpower.
- **Maintenance and after-sales support:** Availability of comprehensive and non-comprehensive AMC options, backed by reliable after-sales service, supports cost-effective maintenance and sustained plant performance. It was observed that in very small biogas applications, the cost of AMC was higher than annual cost savings achieved by the operator.
- **Advanced features:** Features such as IoT-based monitoring, two-step gas scrubbing, sensor-controlled valves and titration systems can enhance plant safety, monitoring and operational efficiency.

Question 3: What should be the Operating Model?

- **PPP and Strong Local Ownership:** In case of MSW, a public–private partnership (PPP) model, supported by CSR funding for CAPEX, can improve early financial viability for the operator. Support from elected local representatives and strong ownership by waste generators further strengthens implementation and long-term sustainability.
- **Operation by Technology Partner:** In relatively bigger plants, operating on MSW, involving the technology partner in plant operations can help address ground-level operational challenges, ensure timely troubleshooting, and manage maintenance costs effectively.
- **Operator as User:** Where the user and operator are the same entity, such as a school or university campus, clear ownership and accountability can support regular operation, maintenance, and long-term sustainability. However, successful operations depend on clearly defined roles & responsibilities, and monitoring.

Question 4: How to ensure consistent supply of Feedstock?

- **Continuous monitoring and awareness:** Regular monitoring and awareness among waste generators is particularly important where feedstock is sourced from multiple municipal or institutional sources.
- **Decentralised pre-processing:** Kitchen waste from institutions and small eateries is generally available in relatively clean and segregated form. Installing LAC units at residential societies can enable organic waste to be converted into predigestate, reducing the risk of contamination before transfer to the central GGU unit.
- **Alternate feedstock during breaks:** During periods of reduced feedstock availability, such as institutional vacations, waste can be sourced from nearby establishments or supplemented with cow dung, following an appropriate SOP.

Question 5: What ensures sustenance of the biogas units?

- **Economic viability alongside environmental gains:** Sustained operation is unlikely when operating costs exceed the revenue generated or cost savings achieved by the operator. This requires a clear and reliable utilisation pathway for biogas, and market linkages for FOM
- **Ownership:** Clear ownership and accountability should be established from the outset, with the operator having a defined stake in the plant's performance and outcomes. This helps ensure sustained operation, maintenance, site upkeep and long-term continuity.
- **Stakeholder Support:** Strong support from key stakeholders—such as elected local representatives for community biogas units, institutional heads for campus-based units, and waste generators for source segregation—is critical to strengthening ownership and ensuring long-term continuity.
- **Availability of skilled personnel:** Basic technical knowledge and semi-skilled resources should be available on-site for routine monitoring, troubleshooting, and preventive maintenance. Training must be accompanied by clearly assigned responsibilities to ensure accountability.
- **Ease of troubleshooting:** Biogas systems are relatively complex and require regular upkeep and maintenance. This must be supported either through trained on-site personnel or AMC support from technology provider.

6 Conclusion

While centralized biogas plants can potentially offer better returns on investment, as higher volumes of feedstock enable more efficient utilisation of the infrastructure and improve the economics of the system. However, in the absence of effective source segregation, the availability of quality organic waste remains a key constraint in MSW based plants, often resulting in inadequate or inconsistent feedstock supply.

In contrast, **decentralised biogas systems offer greater control over feedstock**. When located close to the source of generation, particularly within institutions, campuses, markets or other bulk waste generators, the quantity and quality of organic waste entering the system can be better controlled. Biogas also offers advantages over conventional composting. The potential for better returns, lower land requirements and utilisation of the generated biogas makes it an attractive option for decentralised organic waste management.

At the same time, **biogas from MSW remains an evolving sector**. The complexity and variability of MSW presents challenges that are not encountered with more uniform feedstocks. Technology providers are continuing to experiment and adapt their systems, to address the specific challenges of MSW-based biogas plants. The sector is therefore still continuing to develop through field-level experimentation and learning.

Saahas has been supporting this emerging ecosystem by initiating pilots across **different capacities and institutional contexts**, ranging from municipalities and educational campuses to smaller establishments such as eateries. These pilots provide an opportunity to test different approaches under real-world conditions and systematically document the learnings, challenges and advantages associated with each.

A key lesson from this experience is that **plant sustainability depends not only on appropriate technology and initial handholding, but also on a clear long-term ownership and operational mechanism**. The nine case studies presented in this report capture this diversity of experience. Importantly, they include not only successful pilots but also interventions that did not take off, providing insights into the barriers to adoption alongside the enabling factors. Collectively, these experiences help identify the **critical success factors for the adoption of decentralised, MSW-based biogas in India**, and provide a foundation for further experimentation, refinement and scale-up of appropriate models.

References

Central Pollution Control Board. (2024-2025). Annual Report. Ministry of Environment, Forest and Climate Change. New Delhi

GIZ. (2021). Management of Organic Waste in India. <https://www.giz.de/en/projects/management-organic-waste-india#tab-project-db-tabs-2285-1>

International Energy Agency. (2025). Outlook for Biogas and Biomethane. A global Geospacial Assessment. <https://iea.blob.core.windows.net/assets/5b757571-c8d0-464f-baad-bc30ec5ff46e/OutlookforBiogasandBiomethane.pdf>

Ministry of New and Renewable Energy. (2025-2026). Annual Report. <https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2026/07/20260723515585394.pdf>

World Biogas Association. (2024). Policy and Market Briefing. India. In Association with Invest India. <https://www.worldbiogasassociation.org/wp-content/uploads/2024/10/WBA-India-Policy-and-Market-Briefing-2024.pdf>

Centre for Science and Environment. (2026). Compressed Biogas. A National Blueprint for Upscaling Policy and practice. Case Studies from Punjab, Gujrat and Haryana. India



Kormangala, Bangalore



Kormangala, Bangalore



info@saahas.org



www.saahas.org



[SaahasNothingsIsWaste](https://www.facebook.com/SaahasNothingsIsWaste)



[@saahas_ngo](https://www.instagram.com/@saahas_ngo)



[saahas](https://www.linkedin.com/company/saahas)



[@saahasngo](https://www.youtube.com/channel/UCsaahasngo)



Head Office: Bengaluru

#21, Ground Floor, MCHS Colony, 5th C Cross,
16th Main, BTM Layout, 2nd Stage,
Bengaluru - 560076
Ph: 080-41689889



Branch Office: Gurugram

C-691; Block C, Sushant Lok Phase 1 Sector 43,
Gurugram, Haryana.
Ph: 0124-4041713