



Biogas: A Possible Solution for India's Energy Security and Decarbonisation Goals

The Indian Government is bringing in policy changes to revamp the biogas sector in the country as the fuel offers the benefits of being a cleaner alternative to imported fossil fuels.

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Key Findings

We expect the Indian government's recent emphasis on biogas to augur well for the sector and help in having clear policy direction and robust market.

The lack of guaranteed offtake for compressed biogas (CBG) has resulted in its slow adoption as entrepreneurs fear losses in case there are no buyers.

The recent revision of the CBG rate and plans to include a mandate on natural gas marketing companies for 5% CBG procurement, have reignited private sector interest.

India can cut its liquefied natural gas (LNG) import bill by approximately US\$29 billion between the fiscal year (FY) 2025 and FY2030 if it manages to replace natural gas consumption with biogas and biomethane incrementally to 20%.



Executive Summary

The biogas sector in India has received a boost given the government's rekindled interest. The bundling of different types of financial assistance and increased participation of private players can enhance the adoption of biogas, which is a cleaner alternative to natural gas. The increased use of biogas in India can be a multi-pronged approach to solving issues like waste management, reducing greenhouse gas emissions and increasing renewable energy production. Most importantly, compressed biogas (CBG) can directly replace compressed natural gas (CNG). With India's domestic natural gas production unable to meet its requirements, we estimate that replacing natural gas consumption with biogas and biomethane incrementally to 20% by 2030 can help India cut its import bills by approximately US\$29 billion.

In the last few months, the Indian government has introduced several policy changes to accelerate growth and investments in the biogas sector. It shows the government's renewed interest in biofuels and biogas, perhaps rightly so. Some recent announcements include the rollout of E20 – 20% ethanol blended in gasoline – from this year, with a target to achieve E20 for overall petrol supply by the financial year (FY) 2026 and the announcement to set up 500 new Waste-to-Wealth plants under the Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan) scheme. The Ministry of Jal Shakti recently launched a unified portal to make registering biogas projects easier. The portal serves as a one-stop repository for information on investments and projects. At the global level, in partnership with the United States of America (the U.S.) and Brazil, the Indian government has initiated the Global Biofuel Alliance to provide a platform for exchanging knowledge and technologies.

Increasing biogas projects in India is a multi-pronged solution as it will help manage waste, reduce greenhouse gas (GHG) emissions and increase renewable energy production. Using digester sludge from biogas plants as an organic fertiliser will complete a sustainable loop of recycling nutrients back into the soil. Using waste – not food crops – for biogas generation can also help lower GHG emissions. It is important to note that if there are changes in land use for producing biogas, for example, if sugarcane production requires an increase, it will harm the environment as these crops are water intensive and would warrant land use changes. Doing so will negate the purpose of promoting biogas or any other biofuel.

Biogas can substitute natural gas or other fossil fuels with high emissions. Due to its high methane content – 45% to 75% in volume – biogas can be used directly for cooking, electricity and heat. Removing carbon dioxide (CO₂) and other impurities like hydrogen sulfide can also upgrade its methane content to 90%, making it equivalent to natural gas in calorific value. This upgraded biogas, also known as biomethane, is a pipeline-ready gas and can be injected into the gas grids as a non-fossil gas. In addition, it can be compressed in cascades and transported like compressed natural gas (CNG) or in cylinders, like liquefied petroleum gas (LPG). Compressed biogas or CBG can

directly replace CNG as it has the same composition as natural gas and is compatible with CNG vehicles.

By undertaking the right production processes and plugging methane leakages in the production, upgradation and supply stages, biogas can offer India a cleaner alternative to its dependence on imported natural gas.

We estimate that replacing natural gas consumption with biogas and biomethane incrementally to 20% by 2030 can help India cut liquefied natural gas (LNG) import bills by US\$29 billion between the fiscal year (FY) 2025 and FY2030, taking a compounded annual growth rate of 22% in the natural gas sector and based on the assumption of 550 million standard cubic metres per day (MSCMD) of gas consumption in 2030 and varying import prices for each year based on the Japan Korea Marker price forecasts.



We estimate that replacing natural gas consumption with biogas and biomethane incrementally to 20% by 2030 can help India cut LNG import bills by US\$29 billion between the fiscal year (FY) 2025 and FY2030.

If biogas offers so many benefits, why does it have such a slow uptake? Why did we see only 48 CBG plants operationalise in five years under the SATAT scheme instead of the target of 5,000?

The reason is that the biogas and CBG sector lacked a comprehensive market ecosystem in terms of pricing and offtake, it did not have the right incentives and systems for obtaining clearance and permissions were complicated.

The disaggregated nature of government support and financial assistance to the biogas sector was also problematic. Multiple departments and ministries had different schemes and packages for biogas or CBG plants, with the end use defined in some cases and feedstock availability conditions set in others. This multi-department or multi-ministry approach, with everyone working in silos, had resulted in implementation gaps for biogas schemes and the slow uptake of the sector.

In 2021, the government bundled different types of assistance under the National Bioenergy Scheme to enhance the uptake of biogas plants. Moreover, the introduction of the GOBARdhan scheme as an umbrella initiative of the Government of India will help in this consolidation. It covers the entire gamut of schemes/policies promoting organic waste conversion to biogas or CBG.

The lack of guaranteed offtake for CBG has resulted in its slow adoption as entrepreneurs fear losses in case there are no buyers. However, recent policy initiatives, such as revising the CBG rate to reflect the increase in global gas prices and plans to include a mandate on natural gas marketing companies to 5% CBG procurement, have reignited private sector interest in CBG. Co-mingling of CBG in the city gas distribution network would add to CBG's credibility. Ensuring guaranteed offtake of CBG to producers also requires a take-or-pay arrangement.

Another major challenge in deploying biogas is the varying feedstock and its availability in a usable form. For instance, a biogas plant of 2 standard cubic metres is sufficient to meet the cooking needs of a family of five, but one household does not generate enough waste for that. This calls for biogas feedstock mapping of agriculture and industrial waste to which biogas plants or CBG plants can be linked. This will also prevent the use of food crops for biogas generation. There is also a need to shift from capital expenditure (CAPEX)-based incentives to generation-based incentives to ensure the operability of biogas plants.

Even in the case of biogas slurry, which farmers can use as organic manure, knowledge gaps hinder its use. The market development assistance package to the tune of Rs1,500 per tonne (US\$18 per tonne) with an outlay of Rs15 billion (US\$180 million) will help overcome some of these barriers and encourage farmers to use fermented organic manures (FOM).¹ Promoting this will lower the fertiliser subsidy burden of the government. As mentioned earlier, the initial cost of 5,000 SATAT plants was estimated to be Rs1.75 trillion (US\$21 billion), equal to the fertiliser subsidy estimate for the current FY2024.



The government needs to encourage increased investments and private participation in the biogas sector. It can increase the market viability of CBG and biogas slurry, ensure increased financial access for developing biogas plants and feedstock mapping to ensure the availability of inputs.

Encouraging the participation of private players in the sector will enable robust market development with minimum government support. With the government's rekindled focus on biofuels, two of the biggest industry conglomerates – Reliance Industries and Adani Group – have already expressed a keen interest in the sector with the announcement to set up 100 and five CBG plants, respectively, in the next five years. As a market starts developing and producers have guaranteed offtake, more private players will show interest.

The government is showing clear intent to develop the biogas sector. Policymakers still need to fill gaps to create a comprehensive market system for the smooth operability of the sector in India. The government needs to encourage increased investments and private participation in the sector. It can increase the market viability of CBG and biogas slurry, ensure increased financial access for developing biogas plants and feedstock mapping to ensure the availability of inputs.

¹ All INR to USD conversions in the report have been done on the exchange rate of USD = 83.23 INR as on October 17, 2023.

Introduction

In the wake of the global energy crisis sparked by geopolitical disturbances, the Indian government is considering a renewed push for biofuels in India. Recent policy moves indicate a strong interest in using biofuels as a carbon mitigation strategy.

This includes the announcement to roll out E20 or 20% ethanol blended in gasoline from 1 April 2023,² with a target to achieve this for overall petrol supply by FY2026. The FY2024 budget noted that 500 new Waste-to-Wealth plants would be set up under the Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan) scheme, which was introduced in 2018 to convert cattle dung and solid waste on farms to compost, biogas and bio-compressed natural gas (bio-CNG).³ Asia's largest compressed biogas (CBG) plant was inaugurated in February 2022 in Indore, which is helping fuel buses in the city.⁴ The government recently launched a unified portal to make the registration of biogas projects easier. The portal serves as a one-stop repository for information on investments and projects.⁵

At the G20 summit this year, India also announced the Global Biofuel Alliance as one of the top priorities of its G20 Presidency. The alliance, proposed by India, was launched on 9 September 2023, along with leaders from Singapore, Bangladesh, Italy, the United States of America (the U.S.), Brazil, Argentina, Mauritius and the United Arab Emirates (UAE). A total of 19 countries and 12 international organisations have agreed to join the alliance. The alliance aims to create strong biofuel markets, facilitate global biofuel trade, and enable policy lesson-sharing by serving as an expert hub and a catalytic platform.⁶



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Biofuels are considered a cleaner energy source than fossil fuels because they have lower greenhouse gas (GHG) emissions and can provide major economic gains. Focusing on biofuels can help tide over the challenges posed by fossil fuels in India, such as fuel insecurity, import dependence and massive current account deficits.

² Business Standard. [Petrol blended with 20% ethanol from April 1, says Hardeep Singh Puri](#). 10 January 2023.

³ PIB. [Launch of Gobar-Dhan Scheme announced to improve lives of villagers](#). 1 February 2018.

⁴ Indian Express. [PM Modi inaugurates Asia's biggest bio-CNG plant in Indore](#). 20 February 2023.

⁵ PIB. [Union Minister For Jal Shakti, Shri Gajendra Singh Shekhawat Launches Unified Registration Portal For GOBARdhan](#). 1 June 2023.

⁶ PIB. [Global Biofuel Alliance: One of the priorities under India's G20 Presidency](#). 11 February 2023.

This is not the first time that the government is focusing on biofuels. In the past, biofuels were considered energy gold mines for different sectors. However, to date, biofuels have not gained traction owing to technical, economic and supply chain challenges.

The government is looking to provide a fresh impetus to the biofuels market by pitching them as an alternative to fossil fuels used or as blending fuels in power, transportation and industry. Notably, biofuels consist of solid, liquid and gaseous fuels produced from biomass, which can be further classified as first-generation, second-generation and third-generation biofuels based on the raw material used for production.



Biogas is a renewable energy source produced through the anaerobic digestion of organic waste materials, such as agricultural residue, animal manure and food waste.

First-generation biofuel is produced from biomass of food crops or edible energy crops such as sugarcane, corn, barley or canola. Made from chemical processes, it has well-established technologies and markets. Second- and third-generation biofuels are referred to as advanced biofuels and are made from lignocellulosic biomass or non-edible byproducts of food crops or agricultural residue and waste. Third-generation biofuels are in a nascent stage and produced from microorganisms like algae.

Biogas is a renewable energy source produced through the anaerobic digestion of organic waste materials, such as agricultural residue, animal manure and food waste. It has the potential to substitute natural gas and enable the decarbonisation of critical sectors like cooking, transport and fertilisers.⁷ This report discusses the current status of biogas, its implementation in the country and the critical role that government support can play in promoting clean fuel.

⁷ US DoE. [Renewable Natural Gas Production](#).

Policy Landscape

Recent History

India has, time and again, implemented various schemes to encourage biogas development and deployment. The oldest one is the National Biogas and Manure Management Programme (NBMMP), launched in 1981 as a flagship programme of the Ministry of New and Renewable Energy (then known as the Department of Non-conventional Energy Sources). The scheme aims to provide fuel for cooking and lighting to rural and semi-urban households. The estimated number of biogas plants to be established under the scheme was 12.3 million, of which only 4.752 million plants were installed till 2014⁸, which increased to 4.96 million plants by March 2018.⁹

In May 2018, the government redesigned the scheme by introducing the New National Biogas and Organic Manure Programme (NNBOMP) to help establish multiple small-scale biogas plants with installed capacities ranging from 1 to 25 standard cubic metres (scm) per day for fulfilling cooking and organic fertiliser needs in rural areas. The scheme aimed to set up about 250,000 biogas plants that could generate a total of about 800,000scm per day with financial assistance of Rs7,500 (US\$90) to Rs35,000 (US\$421) per plant, based on the size of the plants.

The government also modified the existing biogas-based off-grid power scheme to Biogas-based Power Generation (off-grid) and Thermal Application Programme (BPGTP) to create a reliable decentralised renewable energy source. This was done to help generate thermal energy for heating, cooling or cooking with biogas plants of size 30scm to 2,500scm and power generation in the small capacity range of 3 kilowatts (kW) to 250kW.¹⁰ Capacity development through Biogas Development and Training Centres (BDTCs) is an important component of the BPGTP. Central Financial Assistance (CFA) under the scheme is on a reimbursement basis, on successful commission of biogas-based power generation at the rate of Rs25,000 (US\$300) to Rs40,000 (US\$ 481) per kW or Rs12,500 (US\$144) to Rs20,000 (US\$240) per kW equivalent to thermal applications based on the size of the plant.

In addition, large-size biogas plants (that produce over 2,500scm biogas per day) were covered under the Programme on Energy from Urban, Industrial, Agricultural Wastes/Residues and Municipal Solid Waste (Waste-to-Energy Programme). The main objective of the scheme was to promote the recovery of energy from municipal solid waste or biomass gasifiers for feeding power into the grid or meeting captive power and for the recovery of energy from urban, industrial and agricultural waste in the form of biogas, bio-CNG or power and captive power or thermal use through gasification in industries. The CFA for different plants varied from Rs2.5 million (US\$0.03 million) per 12,000scm per day for biogas generation, Rs40 million (US\$0.48 million) per 4,800kg per day for bio-CNG or CBG,

⁸ CAG. [National Biogas and Manure Management Programme](#).

⁹ PIB. [About 49.6 lakh household size biogas plants already installed under the programme](#). 22 March 2018.

¹⁰ MNRE. [Administrative cum Sanction Guidelines for implementation of Central Sector Scheme – BPGTP](#). 29 November 2018

Rs5 million (US\$0.06 million) to Rs50 million (US\$0.6 million) for power generation based on technology and Rs2,500 (US\$30) per kilowatt electric (kW_e) to Rs15,000 (180) per kW_e depending on end use.¹¹

All these schemes were co-terminus with the 14th Finance Commission until March 2020. The government extended the schemes to March 2021, and after that, it brought them under the National Bioenergy Programme. Under the programme, three sub-schemes were introduced, including the Waste-to-Energy Programme, biomass programme and biogas programme.

Moreover, the introduction of the GOBARdhan scheme as an umbrella initiative of the government based on the 'whole of government' approach will help in this consolidation. It covers all the schemes/programmes/policies promoting organic waste conversion to biogas or CBG. A total of 507 plants are currently functional under the scheme across 151 districts in India.¹² Any plant or project that produces CBG/biogas (with daily output exceeding 10scm) and biogas slurry as primary outputs is eligible for GOBARdhan. Apart from the Waste-to-Energy Programme for bio-CNG and CBG, the government, through the Ministry of Petroleum and Natural Gas (MoPNG), also initiated a CBG scheme called Sustainable Alternative Towards Affordable Transportation (SATAT) in October 2018. The scheme's objective was to encourage the production of 15 million tonnes (MT) of CBG from 5,000 plants by 2023, which Oil and Gas Marketing Companies (OGMCs) would procure for sale as automotive and industrial fuels. While the government encouraged OGMCs to offtake all CBG production, it is not a take-or-pay arrangement. Till date, 48 plants have been commissioned and letters of intent (LOIs) have been issued for 4,090 plants. The ministry recently cancelled many LOIs due to non-performance, leaving 2,189 active LOIs.¹³ Notably, operational plants under the SATAT scheme sold 11,227 tonnes of CBG in FY2023.

While the Reserve Bank of India has brought loans for setting up CBG plants under priority sector lending since September 2020, the government has brought manure and digested biogas slurry under Fertiliser Control Order 1985 to ensure easy use of CBG waste as fertiliser. The government is also giving financial assistance to plants under the Waste-to-Energy Programme. It fixed the procurement price of purified CBG, compressed at 250 bar pressure and delivered to the oil marketing companies' retail outlets in cascades, at Rs46/kg (US\$0.55/kg) plus applicable taxes for the period October 2018 to March 2024, with minimum procurement price no lower than Rs46/kg (US\$0.55/kg), plus applicable taxes, up to March 2029. The government revised these rates to Rs70/kg (US\$0.84/kg) for better market alignment.

Fresh Impetus

In an attempt to consolidate the various schemes implemented by the Ministry of New and Renewable Energy (MNRE), the government announced the National Bioenergy Programme on 2

¹¹ Gobardhan. [Administrative approval for implementation of WTE Program](#). 2 November 2022.

¹² Down to Earth. [GOBAR-Dhan: Scheme announced in budget a welcome step, but challenges ahead](#). 8 February 2023.

¹³ The Economic Times. [After parliamentary panel flags limited CBG progress, state oil firms cancel 87 Lols](#). 3 August 2023.

November 2022, with effect from April 2021 to March 2026, with an outlay of Rs8.58 billion (US\$103 million) for biogas schemes for small, medium and large plants and biomass schemes – Support Manufacturing of Briquettes and Pellets and Promotion of Biomass (non-bagasse) based cogeneration in Industries – introduced before 2021. The programme is to be implemented in two phases, totalling Rs17.15 billion (US\$206 million).¹⁴

The National Bioenergy Programme included the Waste-to-Energy Programme (Rs6 billion or US\$72 million), Biomass Programme (Rs1.58 billion or US\$19 million) and Biogas Programme (Rs1 billion or US\$ 12 million). The Indian Renewable Energy Development Agency Limited (IREDA) is implementing the programme with the same CFA conditions as earlier.¹⁵

For the promotion of CBG, the FY2024 budget noted that in the near future, there will be a mandate for all companies marketing natural gas and biogas to procure 5% CBG.¹⁶ It also announced the setting up of 200 new CBG plants or commercial model plants and 300 cluster or community-based plants.

To improve the SATAT scheme, which was slow to pick up, the government issued guidelines for co-mingling of CBG in the total domestic gas supplied to the CNG and domestic piped natural gas (PNG) segment of the city gas distribution (CGD) sector in November 2021. To promote blended CNG, the government exempted excise duty on the amount of the goods and services tax (GST) paid on CBG in the blended CNG.

More importantly, with the increase in CNG prices in India, the price of CBG was indexed to the retail selling price of CNG, revising the lower limit set at Rs46/kg (US\$0.55/kg) till March 2029. The lowest slab for CBG procurement was set at Rs70/kg (US\$0.84/kg) till May 2023, with possible revision afterwards, in line with CNG prices.¹⁷ (*No update on the pricing was announced till the time of publishing.*)

Another recent policy initiative was setting up a unified portal to register biogas plants to enhance ease of business and enable private participation in the sector. Along with this, the government announced a Rs14.52 billion (US\$175 million) market development assistance package to promote organic fertilisers from biogas plants.¹⁸ MNRE has also announced a target of 15,000 biogas plants for the current fiscal, which, when onboarded, will provide a fillip to the sector.¹⁹

¹⁴ PIB. [MNRE initiates National Bio Energy Programme to utilize surplus biomass for power generation](#). 20 December 2022.

¹⁵ MNRE. [Administrative approval for implementation of Waste-to-Energy Programme under Umbrella scheme of National Bioenergy Programme](#). 2 November 2022.

¹⁶ Budget 2023-24. [Budget Speech](#). 1 February 2023.

¹⁷ SATAT. [Purchase price of CBG under SATAT scheme](#). 20 May 2022.

¹⁸ PIB. [Unique package for farmers announced](#). 28 June 2023.

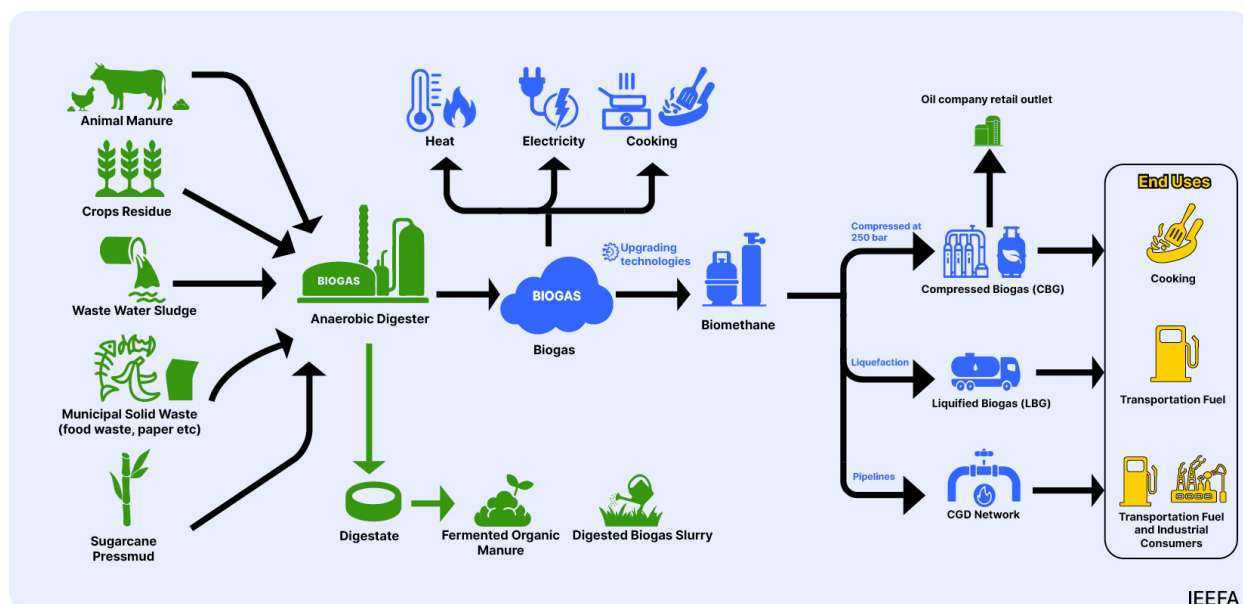
¹⁹ Mercom. [MNRE Targets over 15,000 Plants In Phase II of Biogas Program for FY24](#). 28 June 2023.

Current Status of Biogas: A Sectoral Overview

Biogas has high methane content, varying from 45% to 75% in volume. The remaining percentage is CO₂ and traces of other gases like hydrogen sulfide. The composition varies according to the feedstock and production process. The most prevalent process is production through biodigesters or biogas plants. Other methods of producing biogas include landfill gas recovery system, which involves decomposing municipal waste at the landfill site, after which the gas is captured through pipes and extraction wells. This process has not been executed in India till now due to high cost and lack of specific legislations. Sewage sludge from wastewater treatment plants can also be used as feedstock to produce biogas.

The methane content in biogas can be increased by removing CO₂ and other impurities like hydrogen sulfide through technologies like pressure swing adsorption, water scrubbing and membrane separation. The upgraded gas, also known as biomethane, has more than 90% methane content. It can be compressed and used as compressed biogas as a direct substitute for CNG as it has the same composition as natural gas and is compatible with CNG vehicles. It can also be injected into the gas grid.

Figure 1: Production and Distribution of Biogas



Source: IEEFA

According to the International Energy Agency (IEA), more than 700 million tonnes of oil equivalent (Mtoe) to biomethane can be produced, which would be equivalent to 20% of global natural gas demand, with the global average production cost at US\$19 per million British Thermal Units (mBtu),

including biogas production cost, with US\$2-4 for purification.²⁰ This is lower than the price of natural gas during volatile periods, such as after the start of the Russia-Ukraine war when the Japan-Korea marker, the benchmark for Asian gas prices, touched US\$51/mBtu and averaged around US\$30/mBtu for March 2022 and again rose to US\$69/mBtu in August 2022.

It is worth noting that main component of biogas and upgraded biogas is methane which is a highly potent GHG and has a global warming potential higher than carbon dioxide. Its 100-year global warming potential is 28-34 times higher than carbon dioxide.²¹ This makes it paramount undertaking the right processes in the production, upgradation and supply stages of biogas and CBG to ensure there are no methane leakages. There is also a need to undertake whole lifecycle analysis for approval of biogas plants and mandatory methane emission detection systems and monitoring technologies during operations. The International Energy Agency has also called for harmonisation or setting up defined protocol for emission quantification to enable comparability, reproducibility and improved precision.²² Biogas methane emissions can negate the overall benefits of biogas and therefore it is important to monitor biogas supply chains and plug leakages. Doing so would truly close the loop on carbon emissions and bring in circularity.

Biogas, if processed through the thermal gasification process, such as fluidised bed steam gasification, can produce syngas or synthesis gas, which can be used as an input in gas power plants. Syngas can be upgraded to hydrogen by a separation process, but these technologies are yet to be established on a commercial scale.

Cooking

The use of biogas in cooking could be helpful in rural India, which is still dependent on traditional cooking methods like biomass collection and burning. The perils of direct use of biomass with traditional cooking stoves have been well documented, which include indoor air pollution with particulate matter, lung diseases, premature death and other illnesses. Replacing biomass with biogas can improve health with reduced indoor pollution and improved respiratory health. However, using biogas in cooking requires a push in the form of developing household, community or cluster-based biogas plants.

According to the International Renewable Energy Agency (IRENA), the key barriers to deploying biogas for cooking include lack of awareness and acceptance, capital cost of installation, competition from fossil fuel and intermittent support from government.²³

Notably, high fossil fuel prices globally have eroded the cost competitiveness of conventional fuels, which were available at cheaper rates due to established technologies, supply chains and

²⁰ IEA. [Outlook for biogas and biomethane](#). 2020.

²¹ UNECE. Methane Management.

²² IEA Bioenergy. [Methane emissions from biogas plants](#). 2017.

²³ IRENA. [Biogas for Domestic Cooking](#). December 2017.

consumers. To compete with these fuels, clean fuels like biogas with fragmented markets need a massive government push, which would also make economic sense while enhancing energy security.

The government's support for 300 community or cluster-based plants under the GOBARdhan scheme will effectively increase biogas use for cooking and enhance private sector participation as it is developing these plants with support from stakeholder ministries and departments. The line ministries should ensure that the earlier challenge of the nationwide shutdown of many community biogas plants does not happen again. Some reasons for the shutdown included non-maintenance of plants, lack of annual maintenance contracts (AMCs), lack of sufficient feedstock and high cost of waste segregation.²⁴

There is also a need to bring in innovative methods to minimise cost barriers, such as the pay-as-you-go model to ease the burden of upfront payment, microfinancing, the option of making monthly payments to ease the financial burden, mandatory product warranties for lower maintenance expenses and financial assistance to meet some part of capital costs.

Power

The government's Biogas Power Generation (Off-Grid) and Thermal Energy Applications Programme (BPGTP) is aimed at promoting biogas-based decentralised renewable energy sources of power generation (Off-Grid), in the capacity range of 3kW to 250kW. These plants are planned for cogeneration in rural and semi-urban areas in dairy or poultry farms or small industrial units.

The biomass power and cogeneration sector has installed a total capacity of 10,206 megawatts (MW). Of this, 1,871MW is with independent power producers, 7,562MW is bagasse cogeneration and the remaining 772MW is non-bagasse cogeneration.

While the above scheme is for medium-sized plants, the Programme on Energy from Urban, Industrial, Agricultural Wastes/Residues and Municipal Solid Waste or simply the Waste-to-Energy Programme is for large-sized biogas plants consuming more than 2,500scm biogas daily. This scheme has the largest outlay under the National Bioenergy Programme, at Rs6 billion (US\$72 million). There are various components under the scheme, such as biogas generation and bio-CNG generation, with financial support for power generation based on biogas to the tune of Rs7.5 million/MW (US\$0.09million/MW).

²⁴ Times of India. [Community bio-gas plants in Thiruvananthapuram go out of order](#). 19 June 2017.

According to the latest available data as of October 2022, the capacity of Waste-to-Energy (WTE) projects is 223.14MW (grid-connected) and 272.09MWeq (off-grid).²⁵ The total estimated energy generation potential from urban and industrial organic waste in India is approximately 5,690MW.²⁶

WTE plants, however, are not cost-effective, mainly due to the lack of waste segregation at source. Even though the National Green Tribunal has ordered that only non-recyclable, non-biodegradable, high-calorific-value waste should be used as waste feed for WTE, unsegregated waste unsuitable for burning is sent to WTE, requiring additional fuel. Additionally, even after subsidies covering 40% of the cost, the electricity produced costs around Rs7/kWh (US\$0.08/kWh), more than the average electricity price and not picked up by electricity distribution companies (DISCOMs).²⁷ The Central Electricity Regulatory Commission's (CERC) 2022-23 annual levelised tariffs for bagasse-based cogeneration project ranged from Rs6.05/kWh (US\$0.07/kWh) in Telangana to Rs7.7/kWh (US\$0.09/kWh) in Haryana and was fixed at Rs8.59/kWh (US\$0.1/kWh) for biogas-based generation projects, assuming a project cost of Rs65.2 million/MW (US\$0.78million/MW).²⁸

The government has also mandated 5% biomass co-firing in thermal plants from FY2025, which will be enhanced to 7% by FY2026. Approximately 164,976 tonnes of agri residues-based biomass were co-fired in 47 coal-based thermal power plants until May 2023.²⁹

Transport

Biogas can be upgraded to natural gas quality and used in natural gas vehicles (NGVs), which can lower greenhouse gas emissions by 60-80% compared to internal combustion vehicles.³⁰ This can be either injected into the gas grid and used as per gas supply norms or compressed and sent through cascades to the existing fuel station.

According to an Indian Oil Corporation's white paper, the estimated CBG potential from various sources in India is nearly 62 tonne, with a bio-manure generation capacity of 370 tonne.³¹ In 2015, the Ministry of Road Transport and Highways permitted using CBG in vehicles as an alternative to CNG.

The government's SATAT scheme to set up 5,000 CBG plants by FY2024 has had a slow uptake, with only 48 plants commissioned to date, even though as many as 4,090 letters of intent (LOIs) have been issued. The 5,000 CBG plants will have a potential of 15 million tonne per annum (MTPA). This is equivalent to 54 million standard cubic metres per day (MSCMD) of gas,³² which is much lower

²⁵ PIB. [Year- End Review 2022- Ministry of New and Renewable Energy](#). 20 December 2022.

²⁶ ET Energy. [How India can rejuvenate its Waste-to-Energy sector](#). 24 August 2023.

²⁷ CSE. [Feasibility of Waste to Energy Plants in India](#). 2019.

²⁸ CERC. [CERC RE Tariff Order for FY2022-23](#). 7 November 2022.

²⁹ PIB. [Revised Biomass Policy mandates 5% biomass co-firing in Thermal Power Plants from FY 2024-25](#). 2 August 2023.

³⁰ IRENA. [Biogas for Road Vehicles](#). 2018.

³¹ IOCL. [White Paper on CBG Fuel of the Future](#).

³² Standing Committee on Petroleum and Natural Gas. [Review of Implementation of CBG \(SATAT\)](#). 21 December 2022.

than the CGD requirement of 33MMSCMD of FY2023.³³ The cost of 5,000 plants is estimated at Rs1.75 trillion (US\$21 billion).³⁴

The government has taken measures such as bringing the price of CBG on par with CNG and allowing the co-mingling of CBG in the CGD network to improve the offtake of CBG. The first such injection was done in 2021. Today, 15,500scm/day of gas is being supplied across twelve CGD areas under the CBG-CGD Synchronization scheme.³⁵ Twenty-six more agreements have been signed under the scheme. Currently, the blend is less than 1% but is targeted at 10% as more CBG plants come online.³⁶

Fertiliser

If upgraded biogas is injected into the gas grid, it implies that all fertiliser plants in India that are dependent on expensive liquefied natural gas (LNG) can switch to a blend of natural gas and biomethane or just biomethane.

In addition, the Ministry of Agriculture and Farmers Welfare, in 2020, issued guidelines for the inclusion of Fermented Organic Manure (FOM) and Liquid Fermented Organic Manure (LFOM) under the Fertiliser (Inorganic, Organic or Mixed) (Control) Act 1985, allowing their use in agriculture.

This implies that the liquid residue from biogas production can be used as an organic fertiliser, lowering methane emissions from manure storage. The solid residue can be fortified and converted into biofertilisers, as done by the Haridwar bio-CNG plant in Uttarakhand.

In its 2013 paper titled 'Biogas slurry = brown gold?', the Food and Agriculture Organization noted that despite the substantial cost benefits over traditional fertilisers, the use of biogas slurry has not been widely disseminated and is underutilised due to knowledge gaps.³⁷ It noted that the liquid effluent or biogas slurry after anaerobic digestion contains nitrogen (N), phosphorous (P) and potassium (K), as well as other macro- and micronutrients and more practical use-oriented studies can help increase offtake and iron out issues related to pest infestation and storage.

The government's recent market development assistance package to the tune of Rs1,500 per tonne (US\$18 per tonne) and budgeted at a total of Rs14.52 billion (US\$174 million) for three years from FY2024 will help overcome some of these barriers and encourage farmers to use FOM or LFOM.³⁸

³³ PPAC. [Monthly Report on Natural Gas Production, Availability and Consumption](#). August 2023

³⁴ Standing Committee on Petroleum and Natural Gas. [Review of Implementation of CBG \(SATAT\)](#). 21 December 2022.

³⁵ Standing Committee on Petroleum and Natural Gas. [Demand for Grants](#). 23 March 2023.

³⁶ Standing Committee on Petroleum and Natural Gas. [Review of Implementation of CBG \(SATAT\)](#). 21 December 2022.

³⁷ FAO. [Bioslurry = brown gold?](#). 2013.

³⁸ PIB. [Unique package for farmers announced](#). 28 June 2023.

Biogas as an Alternative to Natural Gas

The use of biogas has been demonstrated in cooking, heating and lighting. On the other hand, upgraded biogas and biomethane (also known as renewable natural gas or RNG) have been widely recognised as a pipeline-ready gas that can be used interchangeably with conventional natural gas. In addition, it can be compressed in cascades and transported like CNG or in cylinders like liquefied petroleum gas (LPG). Due to its composition and calorific value, it can be a clean substitute for natural gas, but its adoption has been slow.

A major challenge in deploying biogas is varied feedstocks and their availability in a usable form. For instance, a biogas plant of 2scm is sufficient to meet the cooking needs of a family of five, but one household does not generate as much waste.³⁹ Therefore, community or cluster plants are recommended for meeting cooking needs, which can source additional feedstock. It is not an unsurmountable challenge and can be overcome with the right policy direction, pilot projects, clear targets and private sector participation.

The cost and amount of gas from a plant varies as per the feedstock. Table 1 shows the tentative feedstock requirement for 2.2scm of biogas or 1kg of CBG:

Table 1: Feedstock Requirement for 1 KG CBG

Feedstock	Amount Required
Agriculture residue	10kg
Pressmud	25kg
Sewage sludge	20kg
Bagasse	10kg
Municipal solid waste	25kg
Cow dung	50kg
Chicken litter	25kg
Forest residue	15kg
Napier grass	10kg

Source: Centre for Science and Environment

Additionally, the biogas equivalent of other fuels is as follows:

Table 2: As Equivalent of LPG Cylinder and Electricity

Fuel	Equivalent value of 1scm	Common Use	Equivalent value of biogas (scm)
LPG	0.42kg	14.2kg	34.08
Electricity	2kWh	1kWh	0.5

³⁹ Plug India. [Advantages & Uses of Biogas](#). 2011.

Producing biogas can help solve multiple environmental problems like stubble burning-related pollution in the National Capital Region, overuse of landfill sites and discarding of sewage sludge in rivers.

For instance, the total stubble generation in Punjab and Haryana is 25.5 million tonnes⁴⁰, which can produce 255 million kilos of CBG or 116 million scm of biogas. Only 0.75scm of biogas is required to produce 1kWh of electricity, or 0.24scm of biogas is sufficient per person per day of cooking.⁴¹ This implies that stubble generated in Punjab and Haryana itself has the potential to produce approximately 155 gigawatt per hour of electricity or meet the per day cooking needs of 96.5 million families, comprising five members each.



Bringing online the 5,000 proposed SATAT biogas plants could help meet more than the current gas consumption of the CGD sector. While the current consumption is 33MSCMD, 5,000 plants will potentially produce 54MSCMD of gas.

As mentioned earlier, just bringing online the 5,000 proposed SATAT biogas plants could help meet more than the current gas consumption of the CGD sector. While the current consumption is 33MSCMD, 5,000 plants will potentially produce 54MSCMD of gas.

In FY2022 gas consumption was about 169MSCMD⁴² which came down marginally to 160MSCMD⁴³ in FY2023 due to high LNG prices. In the current fiscal 75MSCMD of gas was consumed in the first five months. The key importing sectors are fertiliser, CGD, power and industry. With proposed increase in CGD and LNG import infrastructure, gas consumption is expected to increase which would mean higher imports. The total natural gas consumption is expected to reach 550 MSCMD by 2030.⁴⁴ This would take the annual consumption to 200,750 million standard cubic metre (MSCM) from current average of 60,000MSCM. In terms of monetary expenses, this means that much higher gas import bills which was at already staggering US\$17 billion in 2022-23.

Taking a CAGR of 22% in the natural gas sector based on the assumption of 550 MSCMD consumption in 2030 and varying import prices for each year based on Japan Korea Marker price forecasts, there can be a saving of US\$28.9 billion between FY2025 and FY2030 if there is a gradual shift of 10% (in FY2025 and FY2026) to 15% (in FY2027 and FY2028) to 20% (in FY2029 and FY2030) of natural gas to biogas or CBG.

⁴⁰ Mongabay. [Stubble burning is back, smothering north India with concerns for the upcoming winter](#). 13 October 2022.

⁴¹ IIT-D. [Biogas: A Fit Option for Rural Energy](#).

⁴² PPAC. [Natural Gas Production, Availability and Consumption](#). August 2022.

⁴³ PPAC. [Natural Gas Production, Availability and Consumption](#). August 2023.

⁴⁴ ET Energy. [India's gas consumption to jump more than 3 times by 2030](#): GAIL Director. 27 November 2021.

Policy Recommendations for Unleashing India's Biogas Potential

The potential of biogas in key gas-consuming sectors, such as transport and cooking, is well evidenced. India's potential to produce biogas for power and heat generation and biomethane for replacing CNG, PNG and LPG are massive but require the right policy push. Some of the recent policy initiatives attempt to alleviate the key pain points for the sector. More direct government support, such as production incentives or guaranteed offtake and a policy push, could unleash the sector's potential and enable a just transition for India's expanding natural gas sector.

Policy Consolidation and Coordinated Working

An analysis of the government policies and schemes shows the disaggregated nature of government support and financial assistance provided to the biogas sector. Multiple departments and ministries have developed different schemes and packages for biogas or CBG plants, with the end use defined in some cases and feedstock availability conditions set in others. This multi-department or multi-ministry approach, with everyone working in silos, has resulted in implementation gaps for biogas schemes and the slow uptake of the sector.

Currently, different CBG plants fall under the purview of different ministries. While 48 plants have been commissioned under SATAT, 57 CBG plants are running under the MNRE and 45 under the Ministry of Housing and Urban Affairs, among others.



Multiple departments and ministries have developed different schemes and packages for biogas or CBG plants, with the end use defined in some cases and feedstock availability conditions set in others.

The Ministry of Jal Shakti's recent initiative of launching a unified registration portal for biogas or CBG projects is a step in the right direction. This points to the government's intention of treating biogas as a critical sector and making serious investments for its development. While the portal now lists the department or ministry-wise incentives directing to the originating website for details,⁴⁵ a more consolidated preliminary assistance calculator on the portal, with a possibility for application later, would be a useful next step. It would also help to have a biogas department within a central ministry, perhaps the Ministry of Finance, to consolidate funding for the sector to have a more aggregated approach to the government's support for biogas.

⁴⁵ GOBARdhan. [Unified Registration Portal For Biogas/ CBG/ Bio CNG plants.](#)

Along with policy measures, there is a need for regulatory measures to ensure that biogas plants follow proper environmental compliances in terms of feedstock use and emissions.

Increasing Market Viability for CBG and Biogas Slurry

To enable the promotion and setting up of biogas plants, it would be important to ensure markets for biogas, CBG and digested biogas slurry. Currently, efforts are being made to mandate a percentage of CBG co-mingling in the CGD pipelines and support farmers' uptake of biogas slurry with the recently announced Rs15 billion (US\$180 million) market development assistance package. These two would drastically help the viability of biogas plants and increase the implementation of biogas projects in the country.



The government needs to ensure guaranteed offtake of CBG by different natural gas-using industries to expedite meeting decarbonisation goals and enhance the market viability of CBG plants in the country.

Now, the government needs to ensure guaranteed offtake of CBG by different natural gas-using industries to expedite meeting decarbonisation goals and enhance the market viability of CBG plants in the country. Currently, India produces approximately 567 tonnes of CBG.⁴⁶ Introducing take-or-pay arrangements for SATAT and other CBG plants, similar to those provided to LNG terminals or gas-based generation for peak summer, is important. This is important as biogas plants, including anaerobic digestors, cannot meet fluctuating demands. Indian Oil Corporation has noted that there is no take-or-pay arrangement under SATAT as there is no guarantee from end users.⁴⁷ This brings the focus back to the need for the government to mandate CBG use to enable increased guaranteed demand.

Additionally, for the uptake of biogas slurry, along with proper implementation and fund disbursement of the market development assistance, it is important to enable a more streamlined offtake for using organic fertiliser, such as fixing a common price for fermented organic manure.

Enhanced Financial Access for the Development of Plants

Regarding financial assistance for biogas, the most important aspect is the enhanced clarity on the assistance available for plants like CBG, WTE etc. The bundling of different assistance under the National Bioenergy Scheme has enhanced the uptake of biogas plants. However, there is also a need to enhance the financial assistance provided to biogas plants. To make enhanced finance

⁴⁶ SBM. [Installed Capacity of Commercial CBG Plants.](#)

⁴⁷ IOCL. [Compendium Of Frequently Asked Questions \(FAQs\) On Compressed Bio Gas \(CBG\) And SATAT Scheme.](#)

available to the sector, the government should introduce various finance models like crowdfunding and commercial credit and make financing options available to plant developers and operators.

Enabling increased access to finance at more affordable rates, along with the existing priority sector allocation, would be a significant enabler for setting up biogas or CBG plants.

Feedstock Mapping and Aligned Policy Support

To ensure the viability of biogas plants in India, another key challenge that needs to be resolved is feedstock availability and aggregation. Feedstock mapping of agriculture and industrial waste needs to be done and the development of biogas or CBG plants linked to these to enable aggregation and market viability. Tools like GEF-MNRE-UNIDO mapping tool of urban and organic waste across India must be developed and utilised.⁴⁸



It is imperative to ensure that no land use conflict arises by encouraging the cultivation of energy crops over food crops in promoting biogas and only biomass and waste is used as feedstock.

Similarly, for WTE plants, Urban Local Bodies (ULBs) should be incentivised to implement waste segregation at source as it can drastically improve plant efficiency. Currently, most biogas plants in India are based on mixed waste, which increases the cost of waste segregation. This segregation cannot be done effectively and lowers the efficiency of plants. Waste segregation at source can reduce costs in the long run while improving the quality and output of biogas.

This is imperative to ensure that no land use conflict arises from promoting biogas by encouraging the cultivation of energy crops over food crops. The feedstock must comprise only genuine waste products because any biomass grown for biofuel use represents increased emissions and land use that competes with food.

Enhance Private Sector Participation

Private sector participation can drastically improve a sector's profitability and investment lucrativeness. Proper policy support, which establishes a clear market for the end product (biogas, CBG, biogas slurry) and clear supply chains, can interest the private sector.

With the government's rekindled focus on biofuels, two of the biggest industry conglomerates – Reliance Industries and Adani Group – had in July 2023 announced the setting up of 10 compressed biogas plants each with a proposed outlay of Rs 25 billion (US\$300 million) each in the next few

⁴⁸ GEF-MNRE-UNIDO Project. [Mapping the available urban and industrial organic waste in various locations in India.](#)

years.⁴⁹ Ten of these plants are proposed to come online in the next five years. Reliance Industries, after successfully setting up its first CBG plant in 10 months, updated the target to 100 CBG plants in the next five years. According to the company, these plants will consume 5.5MT of agro-residue and organic waste. This is expected to mitigate 2 million tonnes of carbon emissions, produce 2.5 million tonnes of organic manure and reduce LNG imports by 0.7 million tonnes annually.⁵⁰

Indian Oil Corporation Limited (IOCL) is collaborating with a biofuel manufacturer, Praj Industries, to enhance the biofuel capacity in India, including CBG and ethanol. More such public-private partnerships (PPPs) could help increase private participation in the sector and make it a profit-making sector for long-term viability.

PPP models can crowd in private investments and help de-risk the sector. This can help bring in green finance through blended finance from public banks and concessional finance, which can hedge risks and equilibrate risk-reward ratios, encouraging investments.

⁴⁹ Economic Times. [RIL, Adani Total Gas planning plants for compressed biogas](#). 7 July 2023.

⁵⁰ MoneyControl. [Reliance Industries AGM 2023](#). 28 August 2023.

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