GGGI

Policy Recommendations to

Accelerate Implementation of BioCNG projects

under SATAT Scheme

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Abbreviations

BCM	Billion Cubic Metres
BioCNG	Biological Compressed Natural Gas
CAGR	Compounded Annual Growth Rate
CGD	City Gas Distribution
CNG	Compressed Natural Gas
EOI	Expression of Interest
FCO	Fertilizer control order
GDP	Gross Domestic Product
GGGI	Global Green Growth Institute
GMC	Gas marketing Company
GOBAR-DHAN	Galvanising Organic Bio-Agro Resources
GoI	Government in India
IEA	International Energy Agency
IIFCL	India Infrastructure Finance Company Limited
ITMO	Internationally transferred mitigation outcomes
LoC	Line of Credit
LOI	Letter of Intent
MDB	Multilateral Development Bank
MNRE	Ministry of New and Renewable Energy
MoCF	Ministry of Chemicals and Fertilizers
MoHUA	Ministry of Housing and Urban Affairs
MoPNG	Ministry of Petroleum and Natural Gas

MOU	Memorandum of Understanding
MSW	Municipal Solid Waste
MT	Metric Tonne
NAFED	National Agricultural Cooperative Marketing Federation of India Ltd.
NDC	Nationally Determined Contributions
NFIs	National Financing Institutions
OMC	Oil Marketing Company
PJ	Pico Joules
PROM	Phosphate Rich Organic Manure
PSA	Pressure Swing Adsorption
PSU	Public Sector Undertaking
RO	Retail Outlet
SATA	Sustainable Alternative Towards Affordable Transportation
SBM	Swachh Bharat Mission
SNAs	State Nodal Agencies
TPD	Tonnes Per Day
ULB	Urban Local Body
VGF	Viability gap funding

सत्यमेव जयते

Dr. Navneet Mohan Kothari, IAS
Joint Secretary

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India is the fastest-growing major economy in the world. India's economic growth, urbanization, and industrialization envision largest increase in energy demand. Currently, India imports 85% of crude oil to meet its domestic demand. Whereas, with 50% of Liquefied Natural Gas (LNG) import, on consumption basis, India is the fourth-largest importer of liquefied natural gas (LNG), globally. India's import dependence on crude oil, natural gas and large share of carbon intensive energy sources necessitates action to ensure energy security and environment sustainability.

Government of India (GoI) has set a target to reduce crude oil imports by at least 10% by 2022 and increase the share of natural gas in the energy mixto 15% by2030. However, it wasnecessary to ensure that this new energy landscape is greener and environmentally sustainable, by substituting conventional fuels with biofuels.

National Policy on Biofuels (2018) and Sustainable Alternative Towards Affordable Transportation (SATAT) initiative, was envisaged to promote the production of Biofuel (including Compressed Biogas - CBG) by realizing the potential of waste-to-energy in India. These initiatives aim to increase the substitute of fossil fuels; and contribute towards achieving national energy security, reducing carbon emission, improving air quality, and creating employment opportunities.

GoI has introduced various provisions to create an enabling ecosystem for development of CBG sector. Assured offtake of CBG, CBG-CNG blending in city or local gas distribution network, CBG projects under priority sector lending, among others are the key policy drivers provisioned for the sector. While the CBG sector is growing in India, there is a need to accelerate this growth with additional policy, regulatory, and market-based enablers.

This report entitled *"'Policy Recommendations to Accelerate Implementation of BioCNG Projects under SATAT Scheme"*has identified various challenges impeding the development of CBG sector and recommended solutions to address the issues. My congratulations to the GGGI for bring out this report. I hope that this report will be a valuable resource for various stakeholders and provide inputfor the sector development at national and sub-national level, for immediate, mid-term, and long-term actions.

[Navneet Mohan Kothari]

FOREWORD

Dr. Frank Rijsberman
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As the global economy recovers from the downturn caused by repeated waves of COVID-19, the associated growth in fossil fuel consumption highlights the urgent need to decarbonise the economy, so that the future growth can be decoupled from higher emissions. While the global economies continue to recovery, the recent geopolitical developments have also brought to spotlight the need for energy security and countries are responding by gradually moving away from established supply chain arrangements to bring in sustainability to deal with any similar future disruptions. This also provides an opportunity for countries to further harness domestically available resources which can complement the energy security needs.

India imports 85% of crude oil, 75% of liquefied petroleum gas, and 50% of liquefied natural gas on a consumption basis. Considering, India's dependence on imported oil and gas, there is a need for harnessing domestically available resources to partially offset imports have gained significance. The rising oil and gas prices have also put a strain on the India rupee which has resulted in increased prices for the end consumers. The Government of India has envisaged to reduce the energy import dependence through various national targets including initiatives such as Sustainable Alternative Towards Affordable Transportation (SATAT). While SATAT aims to contribute towards energy security, emission reduction, improved air quality, and green jobs, it also boosts the efficient utilization of organic wastes including agricultural residues among others, and promotes the production and usage of BioCNG from organic wastes.

Achieving these will however need sustained actions on addressing biomass collection and distribution challenges, developing market framework where there are long term contracts with suitable pricing mechanism etc. so that investments made in the BioCNG plants are not put to risk in the long term. Financial viability remains a key challenge, hence financing instruments will also be key as we want to build up scale.

The report entitled *'Policy Recommendations to Accelerate Implementation of BioCNG projects under SATAT Scheme'*, outlines the BioCNG landscape in India and presents recommendations specifically towards sustainable biomass supply & resource sufficiency, suitable & innovative business models, right pricing of BioCNG & Bio-manure for demand creation, and other mechanism proposed for project viability and long-term sustainability. I hope that this report will serve its purpose in providing key necessary policy, regulatory and market-based enablers to accelerate the deployment of BioCNG projects at scale.

I would like to thank the Ministry of Petroleum and Natural Gas, Government of India for providing guidance and support for the BioCNG Program. I am also thankful to the Ministry of Foreign Affairs of Denmark and the Ambassador of Denmark to India for supporting GGGI's BioCNG program in India.

Dr. Frank Rijsberman

FOREWORD

AMBASSADOR,
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Mr. Freddy Svane
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At COP26, Prime Minister of India had presented the five nectar elements, 'Panchamrit', to deal with the challenge of climate change. For India, these Panchamrit, are ambitious targets of *non-fossil energy capacity to 500 GW, meet 50 % of its energy requirements from renewable energy, reduce the total projected carbon emissions by one billion tonnes, reduce the carbon intensity of India's economy by more than 45 %,* by 2030 and achieve Net-Zero by 2070. India has achieved emission reduction of 28 % and 38 % of installed capacity from renewables, as of 2021. India's achievement highlights the impact of creating enabling ecosystem, adopting appropriate business models, and providing required policy incentives, to bring changes at scale.

Denmark is committed to contribute towards India's vision of green growth and clean energy transition. The "Green Strategic Partnership" between India and Denmark, established in 2020, has become a catalyst for enhanced cooperation and convergence of interest on climate action, green growth and energy diversification. Denmark is further strengthening the India – Denmark cooperation on cross-sectoral energy planning with a focus on biofuels, Green Hydrogen, integration of renewable energy, energy storage and decarbonisation, to reduce dependence on fossil-based energy supply and achieve energy security. The "India Green Finance Initiative" launched in Copenhagen during the May 3rd summit between Prime Minister Modi and Prime Minister Frederiksen, aims to contribute to financing green projects in India to accelerate green growth development and create many green jobs in India.

Reducing dependency on crude oil imports, tackling the problem of air & water pollution, efficient waste management, and enhancing rural economy, through the Sustainable Alternative Towards Affordable Transportation (SATAT), is a great developmental initiative envisioned by the Government of India. Various enabling provisions and policy measures exists in India to support Compressed Biogas (CBG) projects. However, incremental support on the existing provisions will be crucial to accelerate the adoption of CBG projects at large scale and achieve the SATAT target of 5000 CBG projects (potential to meet upto 32 % of Natural Gas demand in India and generate ~75,000 direct green jobs).

I would like to congratulate GGGI for preparing this insightful report entitled *'Policy Recommendations to Accelerate Implementation of BioCNG Projects under SATAT Scheme"*, for the development of the BioCNG sector in India. I am confident that this report will help policymakers, project developer, technology provider, CBG offtakers, and Financial Institutions to understand the challenges, opportunities and way forward.

I would also like to thank the Ministry of Petroleum and Natural Gas, Government of India for their guidance towards implementation of GGGI's BioCNG program in India.

Freddy Svane

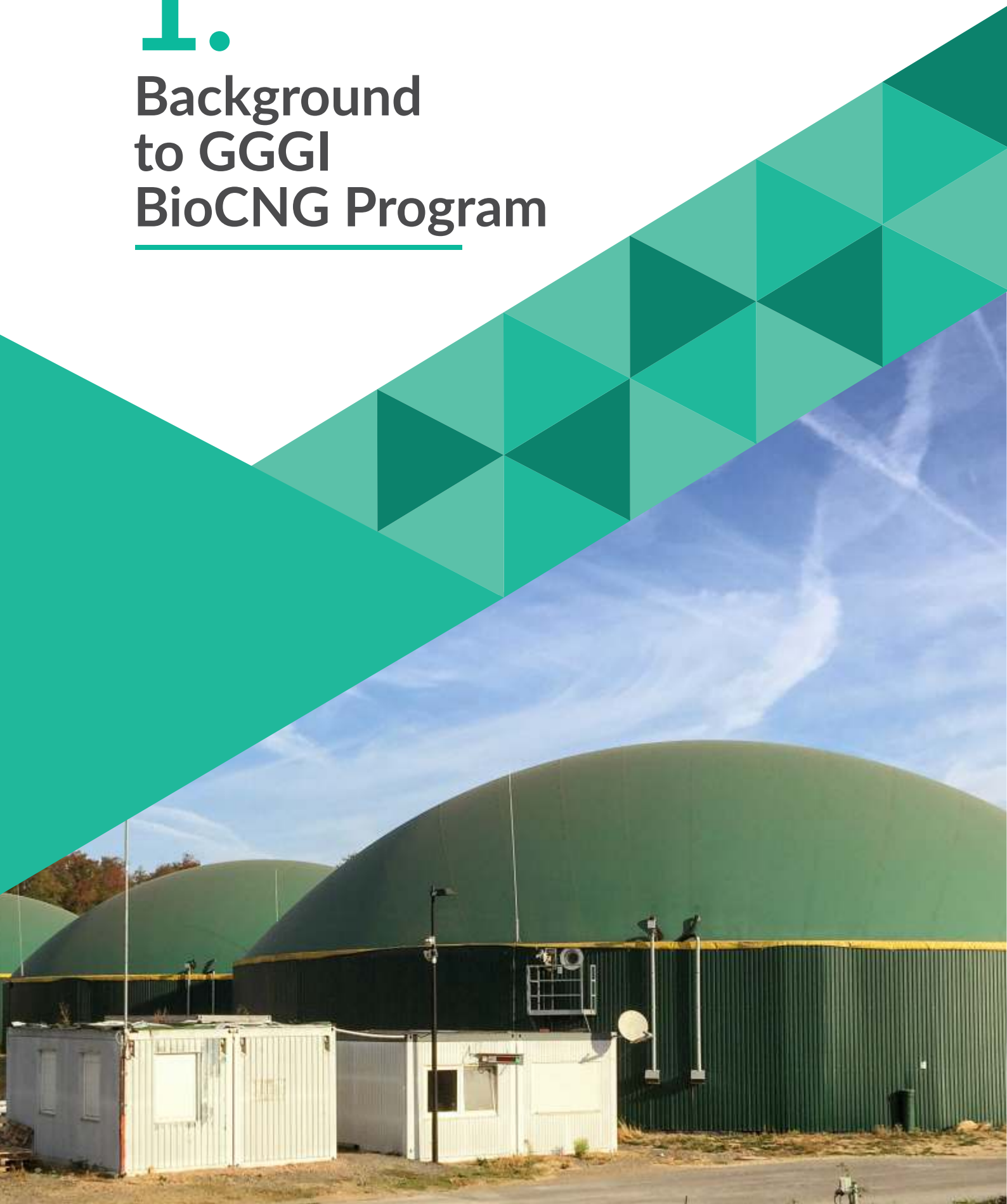
Acknowledgments

This report has been prepared by the Global Green Growth Institute (GGGI) as part of the GGGI's Biological Compressed Natural Gas (BioCNG) Program in India, which is aimed to reduce global greenhouse gas (GHG) emissions, support clean energy transition, as well as promote energy security through the use of sustainable raw material/ organic waste, improve air quality, support circular economy practices.

GGGI would like to express gratitude to the Ministry of Foreign Affairs, Denmark for providing funding support for GGGI's BioCNG program.

1.

Background to GGGI BioCNG Program



01

Background to GGGI BioCNG Program

Global Green Growth Institute (GGGI), headquartered in Seoul, Republic of Korea, is a treaty-based international intergovernmental organization dedicated to supporting and promoting strong, inclusive, and sustainable economic growth in developing countries and emerging economies. GGGI has undertaken a Biological Compressed Natural Gas (BioCNG) program in three target countries – India, Indonesia, and Thailand. The BioCNG program is supporting the governments of target countries to develop a robust demand and supply market ecosystem with innovative business models for investors and technology providers. With an increasing focus on achieving the Net-Zero commitments, the biofuels sector is rapidly gaining traction in the target countries thus increasing the potential opportunities for BioCNG implementation as a clean fuel. This multi-country program is therefore expected to witness inclusive development with respect to indigenous clean energy development and thereby, further push the learning curve upwards.

In India, GGGI has signed a Memorandum of Understanding (MOU) with the Ministry of Petroleum and Natural Gas (MoPNG) to support the Sustainable Alternative Towards Affordable Transportation (SATAT) initiative as a knowledge partner. Under this agreement, GGGI aims to assist in developing a vibrant BioCNG market and create an enabling ecosystem by reducing policy & technology barriers and creating localized sustainable & viable business models for BioCNG projects based on different waste streams including organic municipal solid waste (MSW), sugarcane press mud, wastewater/ sewage, and agricultural waste. The program is aimed towards creating innovative business models that could be scaled up and replicated in order to allow MoPNG to achieve its target of deploying 5000 BioCNG projects in the country. The program will also extend support in mobilizing green finance and enabling the adoption of innovative technologies for these projects.

2.

BioCNG Landscape and Opportunities in India

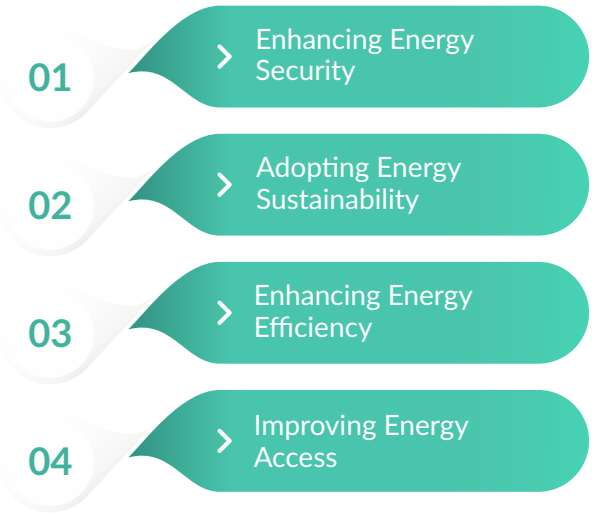
02

BioCNG Landscape and Opportunities in India

India is the third largest primary energy consumer in the world after the US and China, having recorded a Compounded Annual Growth Rate (CAGR) of 4 per cent in its energy consumption over the last decade. The country's energy demand is poised to increase further and is expected to more than double by 2040. At present, the country's energy mix has a heavy reliance on carbon-based fuels. The estimated reserves of Crude Oil in India in 2020 was 603.37 million tonnes (MT) and the estimated reserves of Natural Gas in the year 2020 was 1008.33 MT[1]. The country imported nearly 87.5 per cent of its Crude Oil requirements and about 52.8 per cent of its Natural Gas requirement in FY 2020[2]. According to IEA (India Energy Outlook 2021), India's primary energy demand is expected to nearly double to 1,123 MT of oil equivalent, as the country's gross domestic product (GDP) is expected to increase to US$ 8.6 trillion by 2040. India's annual import bill for fossil fuels is projected to triple by 2040 as the country is set to experience the largest energy demand increase in the world over the next two decades.

India's dependence on the usage of carbon-based fuels and the import of Crude Oil and Natural Gas necessitates action to ensure energy security and environment sustainability. As a result, the Government of India (GoI) has set a target of reducing this import by at least 10 per cent by 2022. Further, it has set a target of increasing the contribution of gas in India's energy mix from the existing 6.5 per cent (global average is 23.5 per cent) to 15 per cent by 2030. India has made significant commitments at the COP26 conference. The country has committed to 500 GW of non-fossil fuel capacity, and to have 50 percent of its energy requirement met by renewable energy by 2030. Additionally, India has committed to reducing its carbon emissions and intensity, before achieving Net Zero emissions by 2070. As India progresses towards a clean energy ecosystem, BioCNG (or Biogas-Compressed CBG) is expected to play an instrumental role in promoting energy security & environment sustainability. BioCNG has a calorific value and other properties similar to Compressed Natural Gas (CNG) and can be utilized as a green renewable automotive fuel. Thus, BioCNG can replace CNG in automotive, industrial, and commercial areas, given the abundance of biomass availability within the country. Replacing CNG with BioCNG will also aid in reducing the import dependence on LNG improving energy security for India. Table 1 represents the estimated potential of BioCNG production through various organic waste streams in India.

Figure 1: Four pillars of India's energy future



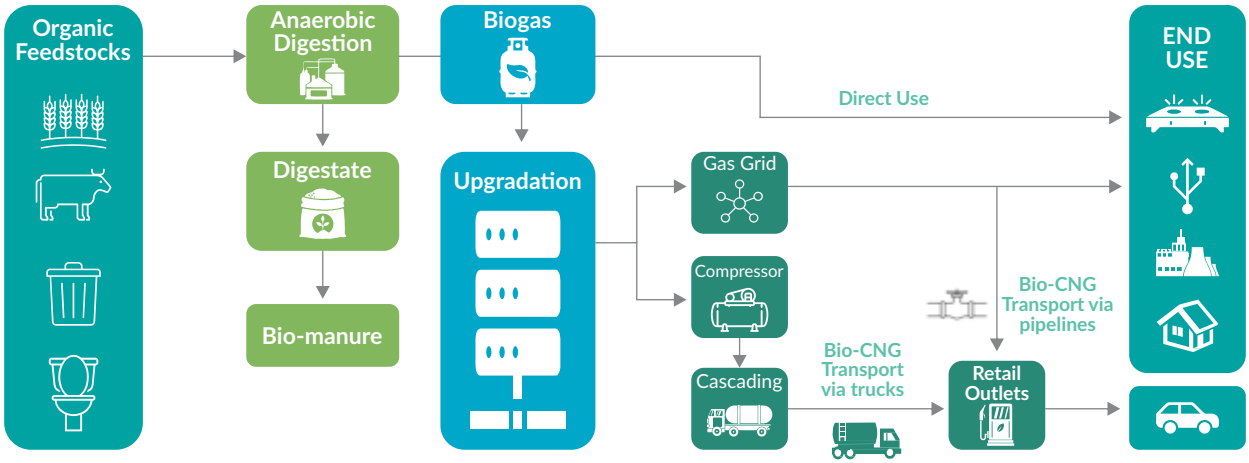
[1]https://climatepolicyinitiative.org/wp-content/uploads/2012/12/Meeting-Indias-Renewable-Targets-The-Financing-Challenge.pdf
[2]Petroleum Planning & Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India

Table 1: Estimated Potential of BioCNG Production from various Organic Waste Streams

S.No.	Categories of Organic Waste	Annual Feedstock Potential (MT)	Estimated Potential of BioCNG (MT)	%
1.	Surplus Agro-residues	150	20	32
2.	Spent wash/Press Mud	20	2	3
3.	Organic Municipal Solid Waste	62	5	8
4.	Sewage Treatment Plants	50	10	16
5.	Recoverable Cattle Dung, Chicken litter etc.	190	25	41

BioCNG is produced with the help of anaerobic digestion of biomass including cow dung, poultry wastes, organic municipal waste, agri-residue followed by upgradation. The biomass is used to produce biogas through the process of anerobic digestion. The biogas is then upgraded to remove the impurities like carbon dioxide, hydrogen sulphide and moisture. After the upgradation of the biogas, it is compressed as compressed biogas (BioCNG) which has methane content of more than 90 per cent with calorific value and other properties like natural gas and hence can be utilized as green renewable fuel for industrial, commercial, domestic, and automotive applications.

Figure 2: BioCNG production pathways

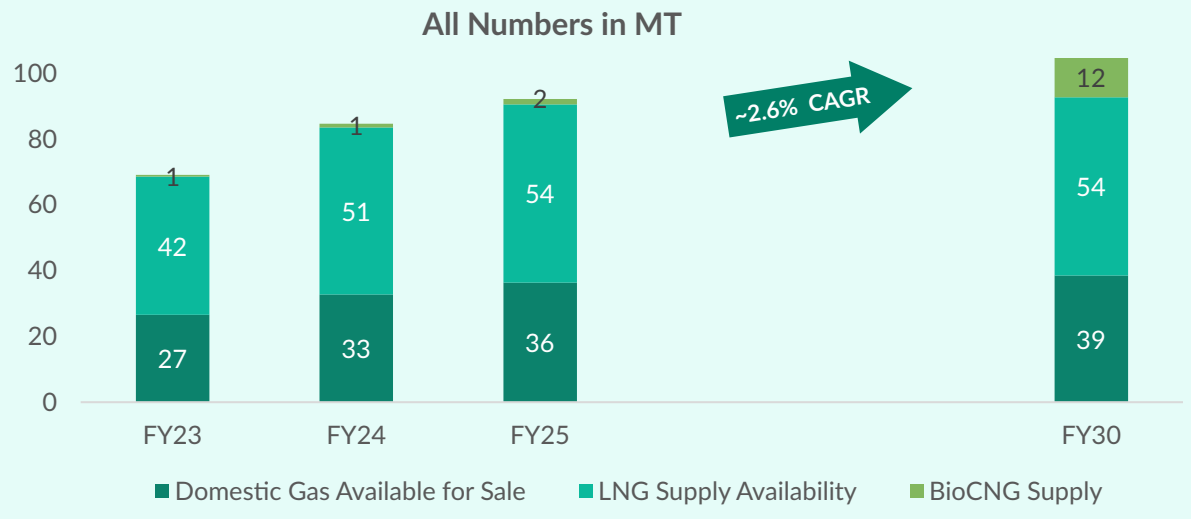


With the above in view, and in line with the national-level climate change goals, the GoI has taken necessary steps for the use of BioCNG and has introduced various schemes as an initiative towards clean energy future. The schemes initiated are aimed towards providing impetus for the development of the BioCNG sector in India while providing necessary financial and marketing support. These schemes include the Sustainable Alternative Towards Affordable Transportation" (SATAT) initiative, the National Policy on Biofuels – 2018 by Ministry of Petroleum and Natural Gas and the GOBAR-DHAN (Galvanising Organic Bio-Agro Resources) scheme which aims to produce 5 MMT (million tons) of BioCNG by 2023, from 5000 plants. Currently there are 38 plants which have been commissioned under the scheme with LOIs issued for 3694 plants.

2.1 Opportunities in BioCNG sector

With these schemes in place and strong impetus from the GoI, there is an opportunity for the country to embark on its path towards clean energy transition. Production of BioCNG, if achieved, as per the plans of GoI, could help the country two folds. On one hand, it will help reduce India's dependence on imported Liquefied Natural Gas (LNG) and on another hand it will help strengthen the rural economy through participation of various stakeholders such as farmers, village level entrepreneurs (VLEs) etc. India currently imports more than half of its natural gas requirement in the form of LNG thus posing energy security risks due to the vagaries of international LNG demand-supply and pricing. Having a structured programmatic approach towards implementation of large commercial scale BioCNG projects will help in addressing the issue of import dependency. It is estimated that production from BioCNG will constitute ~11 per cent of the overall Natural Gas basket of the country in 2029-30.

Figure 3: Estimated Production of BioCNG



Similarly, it's an opportune time for the country to scale up the non-chemical fertilizer sector in the country. Currently, there are no mechanisms or provisions for guaranteed off-take of biomass produced from BioCNG projects in India. The price and sale of solid fermented organic manure (SFOM) and liquid fermented organic manure (LFOM), if administered programmatically, could provide a massive impetus to the BioCNG program of GoI. Different products can be manufactured after enriching SFOM and LFOM with microbes into growth promoters, Phosphate-rich organic manure (PROM), fungicides etc. Similarly, the inclusion of solid fermented organic manure and liquid fermented organic manure produced from BioCNG projects under Fertilizer Control Order (FCO) approved list will aid in the replacement of chemical fertilizers. The overall potential and scale at which the bio-manure could be produced can change the paradigm of how BioCNG projects are currently being planned. A programmatic approach could lead to gradual replacement of chemical fertilizers over next 10-12 years.

In essence, by-products of bio-manure i.e., SFOM and LFOM, produced domestically have the potential of replacing chemical fertilizers being imported in by the country. Domestic BioCNG production would reduce the import demand for LNG and strengthen the rural economy increasing the participation of the farmers, VLEs, etc. If administered programmatically, the reduced imports would contribute to improvement in balance of payments while ensuring energy security for the country. This could be a massive impetus for the BioCNG Program in India. The pricing mechanism for BioCNG needs to evolve; there is a potential for creating a market pricing mechanism which can be linked to market-based indices. This will allow the project proponents to fetch prices that are akin to the market realities and in turn help make the project feasibility sustainable.

2.2 Enablers to promote BioCNG

Government of India and Ministry of Petroleum and Natural Gas (MoPNG) have provisioned various policy and regulatory enablers to promote and accelerate the adoption of BioCNG projects at scale. These provisions have the generated interest of the private sector to venture into the BioCNG sector. However, an incremental effort is required to streamline the current processes and further expand the provisions as per the requirements of the sector. Following are the key enablers provisioned for the growth of BioCNG market.

A Assured Offtake of BioCNG

Oil and Gas PSUs in India have issued number of LoIs to offtake BioCNG from the proposed projects. Oil and Gas PSUs are also executing long term commercial agreements to offtake BioCNG (IS 16087:2016 standard, compressed at 250 bar) at an assured base price of USD 0.71 and USD (INR 56.7) per kg of BioCNG (all taxes inclusive). Further, the oil and gas PSUs have notified a revised BioCNG Offtake price under SATAT scheme, in May 2022. The revised offtake prices are linked with the market price of CNG in the region. While, most of the BioCNG project developers have offtake agreements with oil and gas PSUs, there are a few projects developers who have setup BioCNG gas stations where BioCNG is directly sold to consumers like Industrial and/or Commercial Consumers amongst others.

B Offtake of Bio-manue and demand creation

To promote the bio-manure produced from BioCNG plants, fermented organic manure (FMO) and digested biogas slurry have been included under the Fertilizer Control Order (FCO) 1985. Under SATAT, oil and gas PSUs are facilitating the marketing of bio-manure produced from the BioCNG plants. In this regard, oil and gas PSUs have also entered into an agreement with National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED). A BioCNG project generates at least twice the amount of bio-manure as it produces BioCNG. The right pricing of bio-maure, policy-enabled demand, and access to market through the establishment of a fertilizer supply chain, will significantly impact the project viability.

C Synchronization of City Gas Distribution (CGD) and BioCNG

Cost effective and efficient transportation of BioCNG produced from a production point to demand points such as gas stations, CGD tap points etc. is imperative for project viability. In large number of operational BioCNG plants, BioCNG is transported through cascades (cylinders mounted on truck) at very high pressure. As a result, a significant OPEX and CAPEX is anticipated for BioCNG compression and transportation. In order to address this specific issue of BioCNG evacuation, MoPNG has formulated BioCNG-CGD synchronization scheme (CCSS), wherein, it is envisaged to blend up to 10 percent BioCNG with CNG at city or local gas distribution level by the CGD entities.

D Priority Sector Lending (PSL)

Loans for setting up of BioCNG projects have been included as a fresh category eligible for finance under the priority sector (as per the revised PSL guidelines issued by Reserve Bank of India). This is to align PSL with the emerging national priorities and to bring sharper focus on inclusive development and has been envisaged to enable the credit penetration for the setting-up of BioCNG projects. Further, to address the regional disparities in the priority sector credit flow, higher weightage has been assigned to incremental priority sector credit in identified districts where priority sector credit flow is comparatively low.

However, despite the government's support and will to promote the BioCNG industry, the implementation of BioCNG projects faces significant on-ground challenges. Although, the government, has taken initiatives to mitigate the associated challenges, there are specific interventions required to further promote the growth of the BioCNG industry. This report highlights specific challenges that are impacting the implementation of projects on ground and also provides elaboration of possible solutions to overcome these challenges.

3.
Challenges and Gaps

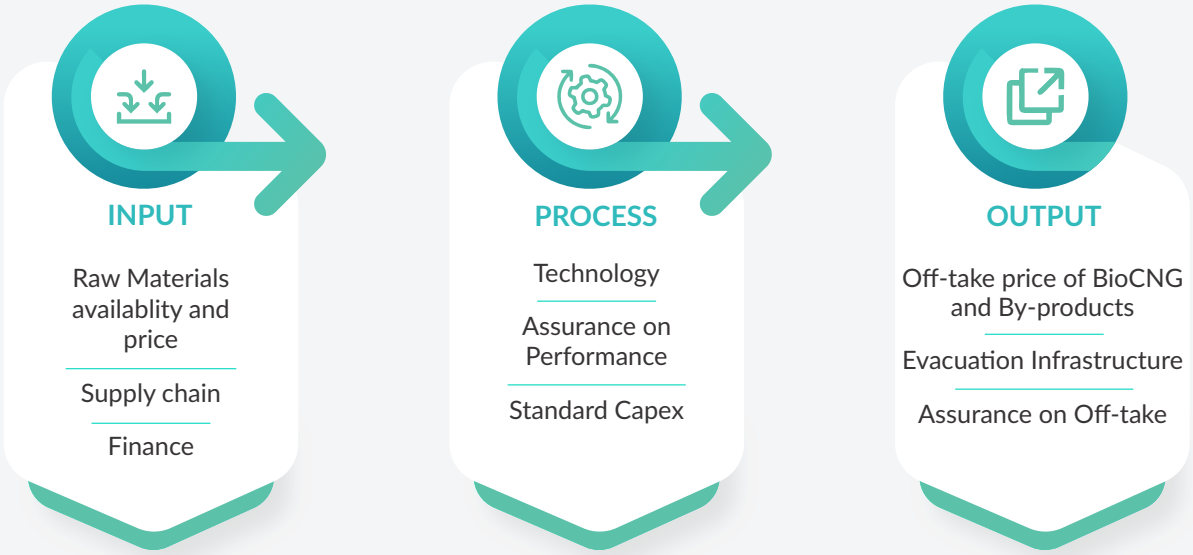
03

Challenges And Gaps

The implementation of BioCNG projects can be broadly categorized into three building blocks:

Input parameters	Raw material; its availability and pricing; and availability of cheaper finance
Processes	Technology performance and assurance of performance; capex for the technology
Output parameters	Quantity of BioCNG, byproducts and its price; assurance of evacuation

Figure 4: Building blocks of typical BioCNG project



Each of these building blocks have elements that are vital and the challenge around these elements needs to be addressed for successful implementation of the project.

a. **Land availability, raw material supply and price:** Ensuring continuous supply of quality biomass at an economical price is a challenge that needs to be addressed through enabling frameworks and infrastructure support at district level. Assess land availability within the district boundaries with relatively lower rates.

b. **Supply chain:** A robust supply chain encompassing all the key stakeholders' interests and participation from farm/waste generation source to the factory gate enhances the long-term viability of BioCNG projects and helps avoid supply shocks.

c. **Finance:** Access to low-cost finance can accelerate the growth of the sector. Absence of standardized contracts around equipments and processes hampers lenders confidence and hence needs to be addressed. Moreover, the risks associated with unorganized biomass supply adds to the performance risk, thus impacting the availability of debt.

d. **Technology:** Since the sector is in its nascent stages, there are very few technology providers present in the Indian market, mapping of various technologies to different kind of biomass feedstock needs to carried out. The business model needs to be more inclusive towards technology providers ensuring that the risk is distributed among stakeholders.

e. **Assurance on project performance:** As the sector is evolving, there are concerns related to performance of various technologies. This needs to be addressed through innovative models to foster growth in the sector. It is required to safeguard the interests of all the stakeholders involved.

f. **Standardization of BioCNG Projects:** Since there are very few projects on ground the CAPEX of a BioCNG project plant is not standardized and varies from location to location. Having standardized plant components for typical plant configuration will avoid erraticism in capex for BioCNG plants and capex can be optimized based on the various plants' configurations.

g. **Offtake price of BioCNG and by-products:** Ensuring a reasonable and assured off-take price of BioCNG and byproduct will aid in making the BioCNG projects commercially sustainable.

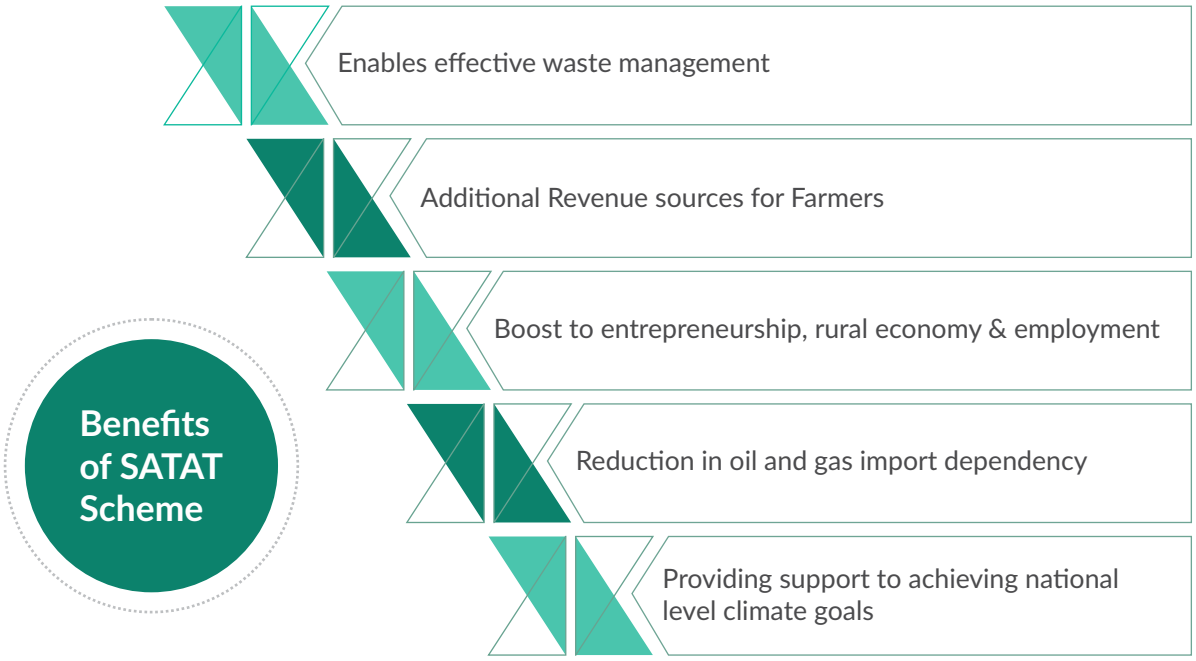
h. **Evacuation infrastructure:** Access to distribution infrastructure (Mild Steel/Medium density polyethylene gas pipeline) helps reduce the transportation cost to a greater extent. It's imperative to map access around each of the plant locations to help connect the plant to the CGD gas grid.

i. **Assurance on Off-Take:** Assurance by Oil & Gas public sector undertakings (PSUs) on the off-take quantity. This will provide confidence to the project developers and is a welcome step for the successful implementation of the SATAT program.

3.1 Existing LoI Allocation Process

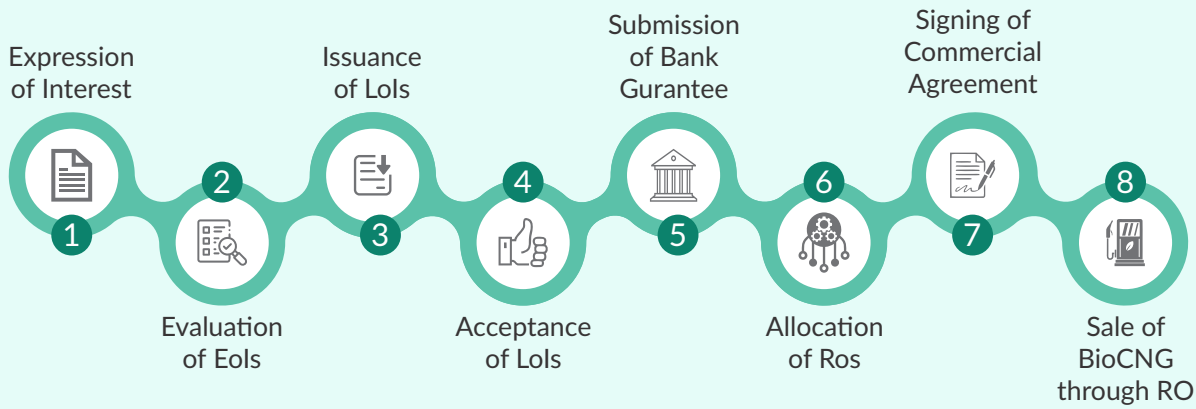
The SATAT initiative is aimed at providing a Sustainable Alternative Towards Affordable Transportation as a developmental effort that would benefit both vehicle-users as well as farmers and entrepreneurs, while tackling the problem of waste management and polluted urban air, thus reducing carbon emissions. Under the scheme, the interested developers can set up BioCNG plants and supply BioCNG to OMCs for a definitive period. OMCs will shortlist prospective developers and award LoIs through inviting Expression of Interest (EoI).

Figure 5 : Benefits of SATAT scheme



Since 2018, when SATAT initiative was introduced, over 3694 LoIs have been issued till date, but only a few 38 plants projects have been commissioned till date. States have been proactive in taking initiatives to promote BioCNG, for instance Punjab has issued LoIs for allocation of catchment area dedicated to BioCNG plants, where no other BioCNG project will be allowed. The primary reason is the process through which the LoIs are being awarded currently. The current allocation of LoIs a being carried out through an 8-step approach.

Figure 6 : Current LoI award process



The current LoI award process is not structured and lacks regular monitoring and the driving thrust which are required for ensuring the successful implementation of the project.

India's COP26 commitments:

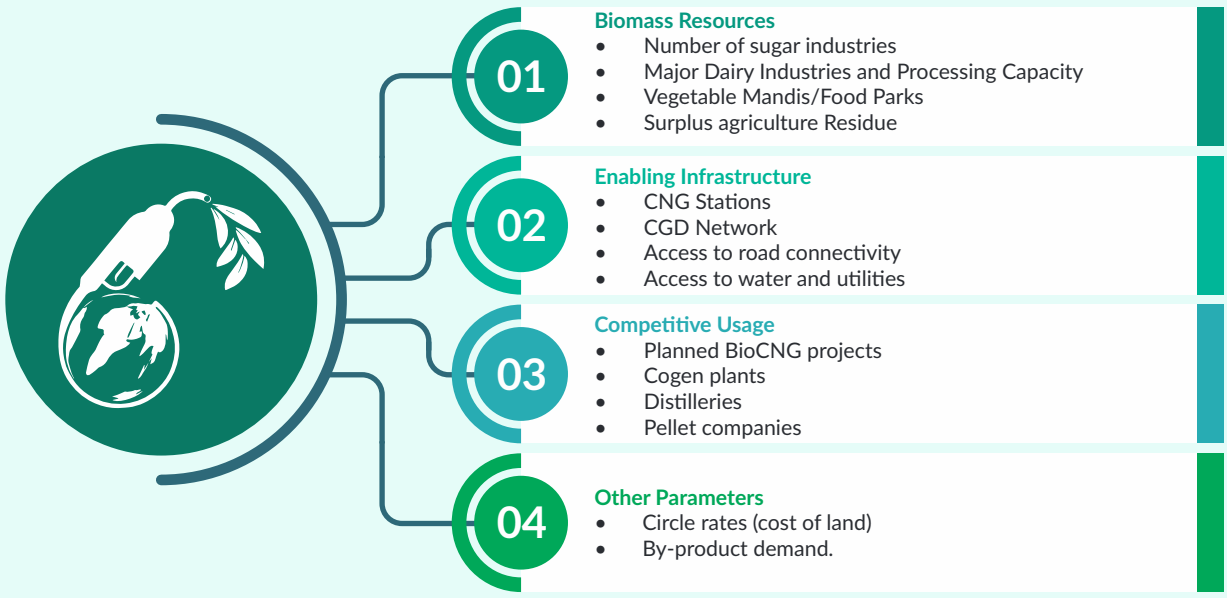
1. Name of the company
2. Directors of the company
3. Turnover of the company
4. Location of the plant
5. Details of land ownership
6. Details of water availability
7. Details of raw material availability

What is missing?

The LoI holders are required to submit general details of the land, water and raw material availability and not the specific details around the existing contracts which is typically covered in Detailed Project Report. This has led to the issuance of several LoIs without ascertaining the feasibility of the project site.

Success of any BioCNG project depends on various supply and demand side parameters. The key parameters to be assessed for identifying feasible zones for setting up BioCNG projects are highlighted in the image below:

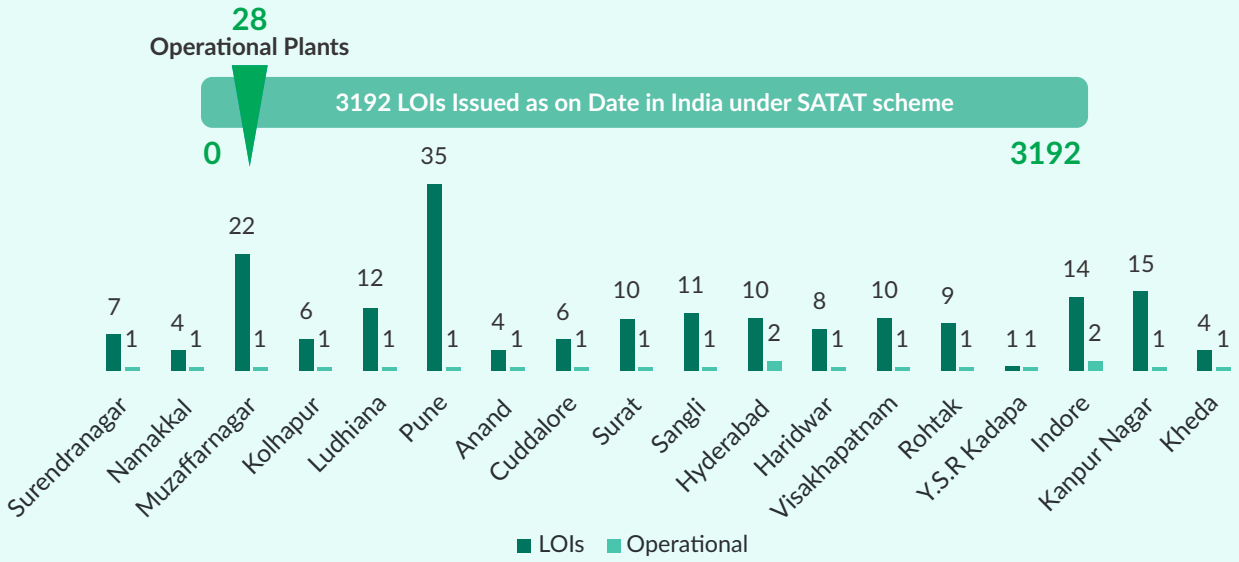
Figure 7: Key parameters for identification of feasible location



a Biomass resource mapping needs to be carried out to assess the availability of biomass throughout the year. The availability of biomass depends on the type of biomass for e.g., paddy straw is available in Kharif season and a plant which is based on paddy straw as input raw material must have either requisite storage in order to ensure continuous supply of paddy straw to the plant or have multi-feedstock system where the project can secure feedstock from other sources such as Pressmud (sugar industry) etc. Currently there is no mechanism to identify the overall availability of biomass in the district and subsequently link the LoI award based on the availability of surplus biomass and other enabling factors highlighted in Figure 7, end consumer concentration or demand for by-products. This has resulted in several LoI's being issued in a particular district. The following graph depicts the LoIs issued as well as the operational plants in these districts as of 2021[3] . Identification and mapping of biomass raw material is critical for ensuring a sustainable supply of raw material throughout the year.

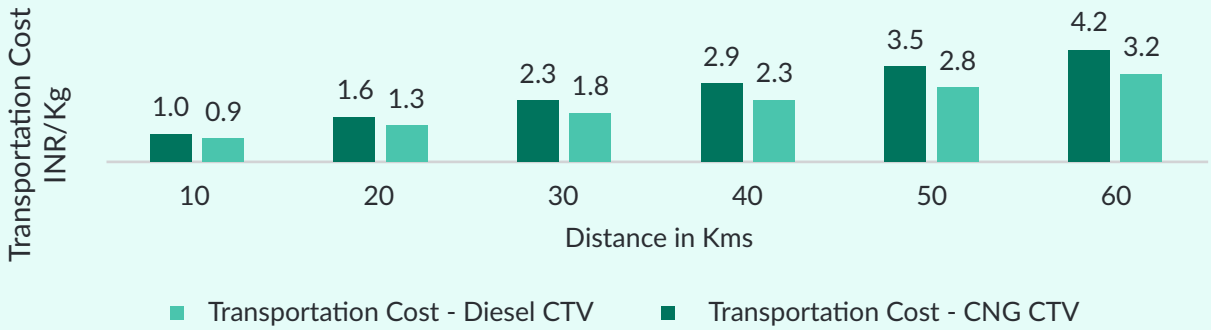
[3] Industry research

Figure 8: Current status - LoI issued VS Operational plants



(b) With regards to the off take of BioCNG, it is vital to identify the evacuation infrastructure. The ideal state would be to inject BioCNG into the grid directly, and therefore mapping of City Gas Distribution (CGD) infrastructure in the vicinity of the plant is critical while awarding LoIs. Similarly for the evacuation of BioCNG through cascades, it is imperative to study the distance of retail outlets stations from the BioCNG plants. In case of evacuation through cascades, there is an additional cost that gets added to the cost of BioCNG. The following graph depicts the increasing cost of transportation of BioCNG with respect to the increasing retail outlet distance[4]. The current mechanism of award of LoI is oblivious to this aspect.

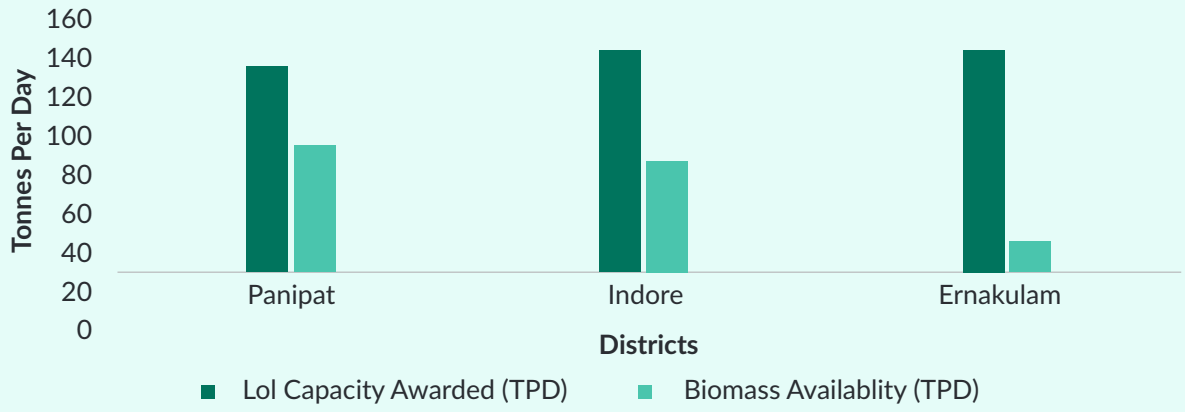
Figure 9: Transportation Cost



(c) Competitive use of biomass is another factor that impacts the availability of surplus biomass in the district. Apart from BioCNG projects, the biomass is also used for various applications including power generation and heating. Therefore, it is essential to assess the existing usage of different biomass in the respective districts to understand the surplus biomass available in the district that could be made available for proposed plant. A closer look at the cumulative LoI capacity and biomass availability indicates that there is a mismatch in terms of biomass potential that is available to support BioCNG projects. Few such examples are depicted in the table below.

[4] Average BioCNG transportation per day – 10 TPD, Diesel cost INR 97/ltr, Milage (diesel) – 3km/ ltr, CNG cost INR 72/Kg., Milage (CNG) – 3km/kg, Type of cascade -Type IV

Figure 10: LoI capacity and Biomass Availability



d. The BioCNG projects are usually located in proximity to the raw material resource. These projects generally need local approvals and clearances which are under the purview of the local administration. For faster implementation of projects, a close coordination amongst the local entities and respective state authorities is vital. A lack of coordination among various stakeholders impacts the overall progress of the project on ground. In the present scenario, it has been witnessed that the stakeholders are undertaking initiatives in the BioCNG sector on an individual basis. There is a need to establish coordination between state agencies, central agencies, oil and gas PSUs and CGD entities, among others.

e. Most infrastructure projects in the country, when awarded under a process are time bound and have strict penalty clauses in case of delays in commissioning. In case of the award of LoI for the setting up of BioCNG plants, currently there are no specific time bound clauses indicated by OMCs to the LoI holders regarding penalties in case of project delays. This has led to many frivolous players taking LoIs without an intent for developing the project.

3.2 Supply Chain Challenges

Uninterrupted and sustainable supply of feedstock is one of the key success factors for BioCNG projects. When it comes to feedstocks, Agricultural residues and MSW have the most unorganized supply chains.

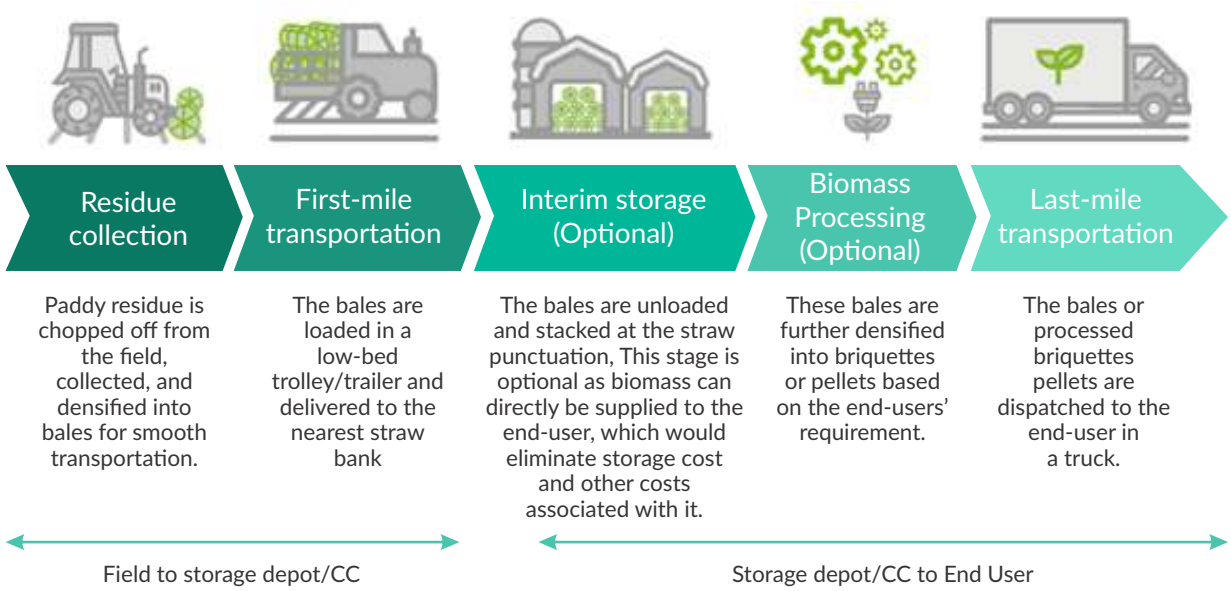
A. Agriculture residue

Supply Chain for Agricultural residue can broadly be classified into 2 categories:

i. **Simple biomass supply chain -** Refers to simple operations of shifting the biomass from field to point of consumption without involving any pre-processing at the field level.

ii. **Advanced biomass supply chains -** Refers to involvement of equipment such as balers and shredders to collect, pre-process biomass before it is shifted to consumption point.

Figure 11: Typical advanced biomass supply chain



Critical assessment of conventional system of biomass collection reveals that it is quite laborious and therefore inefficient and costlier. For example, in case of paddy straw, the conventional collection system includes shaving of stubble that remains in the harvested paddy fields. It is done with the help of a stubble shaver/ cutter. It is then followed up with a raker to form windrows of dispersed paddy straw. Then small balers are used to move over windrows and transform it into bales. These bales are then collected manually and loaded into carrier which takes it either directly to the consumption point or the intermediate storage yard/depot. Such a collection system is expensive and hence many a times farmers are not interested in using the equipment for collection.

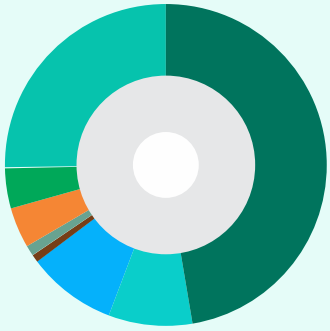
The high cost incurred in the aggregation and transportation of paddy straw owes to the low degree of mechanization in the biomass collection process. Practices across the globe clearly show the scope for improvement by replacing small balers with large balers which produces bales of 400-500 kgs and therefore entails mechanized handling which makes the entire system efficient and less labor dependent.

Another challenge faced in the supply chain of agricultural residue is their seasonally dependant pattern seasonal patterns across India. For example, the harvest periods of paddy crop in north-western region of India starts in October and lasts till mid-November. After harvest, farmers would generally start sowing preparation for the following crop which is majorly wheat. In between this period there is only about a 40-45 days break or window in order to clear away the large amount of paddy straw in the field and be ready for the next crop. And therefore, the fastest and the cheapest way that farmers adopt to get rid of bulky paddy straw is to burn it directly despite governments push not to burn paddy straw in open fields. Manpower for collection of biomass such as paddy straw is also high and hence this is also one of the reasons why crop burning is a preferred as an alternative despite the ban.

B. Organic Municipal Solid Waste

BioCNG plants based on MSW face the challenge of segregation, collection, and transportation of wastes. Typically, MSWs are composed of mixed waste including biodegradables, paper, plastic, metal, glass, rags, inerts and other materials. The following table provides the typical fractions of municipal solid waste in India.

Figure 12: Typical fractions of MSW



47.4%	Biodegradables	01%	Glass
8.1%	Paper	4.4%	Rags
9.2%	Plastic	04%	Others
0.5%	Metal	25.1%	Inerts

The generation of BioCNG from MSW requires a consistent source of biodegradable organic waste free from inert materials. While technologies are available globally to process mixed unsegregated waste as well, they are more expensive and hence not economically viable.

In theory, the total waste generated at an Urban Local Bodies (ULBs) can be represented as a function of population and the average per capita estimate of waste generation. However, the actual waste availability for BioCNG production is evaluated based on a step by step approach as shown in the figure below.

Figure 13: Availability of waste from MSW

Efficient waste collection and transportation mechanism is a key aspect that improves the availability of organic waste from MSW for BioCNG production.

Despite the mandates, including Solid Waste Management Rules 2016, among others, a major portion of the MSW is still unsegregated and uncollected. The MoEFCC estimates that only 75–80 percent of the total municipal waste gets collected and only 22–28 percent of this is processed and treated. A large portion of the collected waste is often dumped indiscriminately, clogging the drains and sewerage systems.

There is a pressing need to develop an innovative model where in the supply chain stakeholders themselves are made part of the project structuring to help build a sustainable supply chain.

3.3 Pricing for BioCNG and Allied By-products

The BioCNG prices (floor price) in India, under the SATAT scheme was fixed at INR 46/kg + applicable taxes (GST applicable at 5%) with offtake guarantee by state run PSUs. However, in May 2022, the BioCNG offtake prices werea revised and linked with the prevalent Retail Selling Price (RSP) of CNG in the market – to promote and accelerate the deployment of BioCNG projects in India. Significant increment has been observed in the BioCNG offtake price since, especially in regions/cities with very high CNG prices. Indexing of BioCNG, based on upward and downward movement in the CNG market prices has been presented in the Table below:

Table 2: Indexing of BioCNG based on upward and downward movement in the CNG market prices

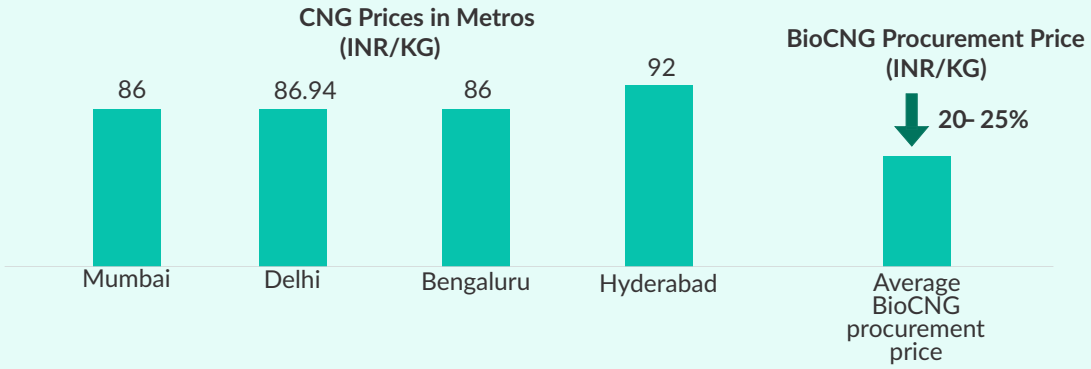
S.No.	Lower Retail selling price of CNG in Slab (including tax) (in Rs. /kg)	Higher Retail selling price of CNG in Slab (including tax) (in Rs. /kg)	Procurement price of BioCNG (without GST) (in Rs. /kg)	Procurement price of BioCNG (without GST) (in Rs. /kg)
1.	Upto 70		54.00	56.70
2.	70.01	75.00	55.25	58.01
3.	75.01	80.00	59.06	62.01
4.	80.01	85.00	62.86	66.01
5.	85.01	90.00	66.67	70.01
6.	90.01	95.00	70.48	74.01
7.	95.01	100.00	74.29	8.01

The BioCNG should be purified as per IS 16087: 2016 standards, compressed to 250 bar pressure and delivered in cascades to OMC/ GMC retail outlets that are up to 25kms in terms of one-way distance from the BioCNG plant. The transportation cost incurred is borne by the BioCNG plant. If the retail outlet linked is is located at a distance further than 25 kms from the BioCNG plant, additional transportation cost is for the extra kms at mutually discussed & agreed rates. This additional transportation cost is loaded to end consumer on cost plus basis.

GGGI has engaged with the stakeholders and made recommendations for the market linked pricing of the BioCNG. With the recent notification, the BioCNG prices are linked with the market prices, however, with a price gap (BioCNG offtake vs

market price of CNG) in the range of INR 16 per kg to INR 25 per kg. The comparison of the prices of CNG at some of the major metros in India and the expected BioCNG offtake price are as below:

Figure 14: CNG prices VS BioCNG prices



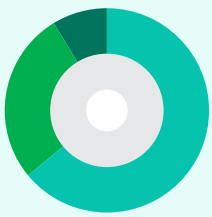
CNG prices in metro cities is almost 35 per cent – 40 per cent higher than that of BioCNG offtake price. Lower offtake prices for BioCNG (as compared to CNG prices) hinders the project viability as there is high volatility in biomass pricing since the market is highly fragmented and unorganized.

Bio-manure and Bio-slurry is also produced as a by-product from the BioCNG plant. Production volume of bio-manure depends upon the raw material and the technology used for anaerobic digestion. The average yield for solid and liquid bio-manure is ~20 per cent of the total raw material consumed. Currently there are no mandates with regards to solid and liquid manure offtake. The BioCNG plant owners sell this produce in an open market where the prices are not regulated, and it competes with chemical fertilizers and hence has low market penetration. Unlike in the case of chemical fertilizers, there is no supply chain ecosystem to enable the sale of bio-manure. The primary reason is due to low quantity at this stage. The pricing for bio-manure varies from state to state and lacks standardization and linkage to the base composition. The prices for SFOM and LFOM vary from Rs. 10-25/ Kg. and Rs. 0.5-0.8/ltr. respectively.

Although, as a first step towards standardization, the bio-manure produced at the BioCNG plant is now classified as fermented organic manure, the quality of which is controlled by the Fertilizer control order (FCO). Technical specifications for bio-manure under FCO are included in the annexure 1. This is a welcome step since this will lead to co-marketing of bio-manure with conventional organic fertilizer players leading to a better pricing mechanism. Similarly, OMCs have also started to provide support for marketing activities of bio-manure. However, the support today is not sufficient enough to instill confidence amongst the BioCNG producers and needs a programmatic thrust from GoI.

The pie-chart below depicts the revenue share for a standard BioCNG plant with feedstock as paddy straw with capacity of about 100 TPD and BioCNG production of 10 TPD[5] (~10 per cent yield). Bio-manure production is ~20[6] per cent of the total raw material consumed. The estimated carbon credits earned per day are ~27 which is equivalent to 27 MT of CO_2. The average cost of carbon credits as per the compliance market in California is ~USD 30/credit.

Figure 15: Typical revenue split for a BioCNG project



- 63% Revenue from BioCNG sales
- 28% Revenue from Bio-manure and Bio-slurry sales
- 09% Value of Carbon credits earned

[5] BioCNG price considered @ INR 46/ Kg.
[6] Bio-manure price considered @ INR 10/Kg.

It is imperative to note here that 63 per cent of the revenue comes from sales of BioCNG which has assured offtake, whereas 28 per cent of the revenue comes from bio-manure sales which neither has fixed price nor offtake guarantee.

It is important to link the BioCNG off take prices to the CNG market prices through a dynamic formula which provides a reasonable price to the BioCNG plant developer. Similarly, GoI should consider notifying the prices for bio-manure and developing a mechanism for its off take.

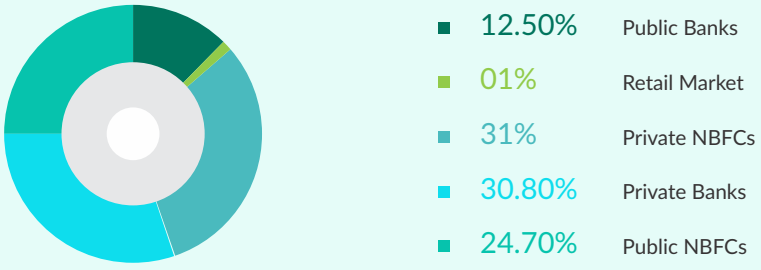
3.4 Financing Challenges

To understand the importance of financing in clean energy projects, it is vital to analyze the scale and urgency of transitioning towards clean fuels like BioCNG. India is at a critical juncture where economic growth and the wellbeing of citizens depends on the access to energy. Against the backdrop of global discourse on climate change and India's INDCs, the country energy needs depend on domestic and clean energy sources. To realize these ambitions, the availability of low cost and collateral-free project financing will play a key role. There are many channels to financing clean fuel projects. However, they are not without shortcomings in the fast-evolving sector, especially given the government's policy and regulatory priorities. Key challenges which are hindering the availability of low-cost financing for the BioCNG sector are:

A. There are no set benchmarks for technology in the BioCNG sector. This leads to unnecessary padding (gold plating) of project costs. There is a need to develop a mechanism to standardize BioCNG projects.

B. There is a need for an innovative business model which not only brings onus to the technology players but also helps create standard benchmarks for project cost to enable the financing institutes to take financing calls comfortably.

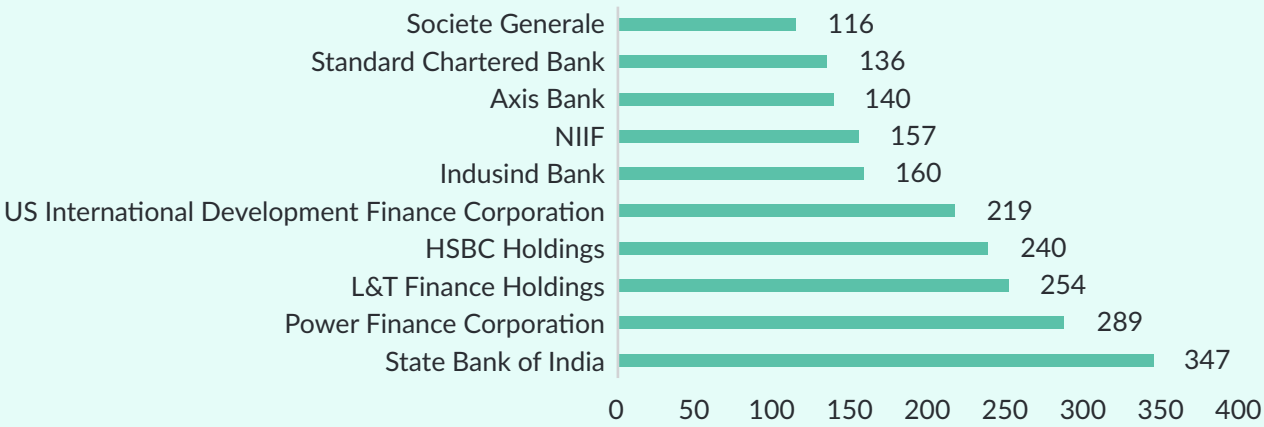
Figure 16: Clean energy market share by financing institutions



India continues to be an expensive destination for investors in the clean energy segment largely due to the high cost of debt. Loans are available at variable rather than fixed interest rates, and the average interest rates in India are in the range of 10 to 14 per cent; in comparison, interest rates in the US and Europe are in the 5 -7 per cent range[7]. Banks prefer to lend over the short term (around six to eight years), causing asset liability mismatch and making it less attractive to borrowers who are looking for longer-term loans. Insurance and pension funds are the ideal financing options, but they constitute a small fraction of financial savings in India. As the BioCNG sector is in its nascent stage, a lack of availability of low-cost project finance is one of the key challengeks hampering the sectoral growth. There is a need for concessional project financing rather than balance sheet based financing to accelerate the growth of BioCNG project development activities.

[7] https://climatepolicyinitiative.org/wp-content/uploads/2012/12/Meeting-Indias-Renewable-Targets-The-Financing-Challenge.pdf

Figure 17: Loan Disbursed by Lending Institutions in Clean Energy Sector in 2020 (USD Mn.)



The limited number of demonstrable projects and technologies and the associated guaranteed performance, is one of the major concerns for the banks and it needs to be addressed through mechanisms such as performance linked disbursements or by having the technology players showcase their technologies through demonstration projects in order to instill confidence amongst the lending community.

3.5 Technology Challenges

The GoI has set ambitious targets to achieve the non-fossil fuel powered energy capacity of 500 gigawatts (GW) by 2030, and to meet 50 per cent of its energy requirements from renewable energy by 2030 as per the climate summit in Glasgow.

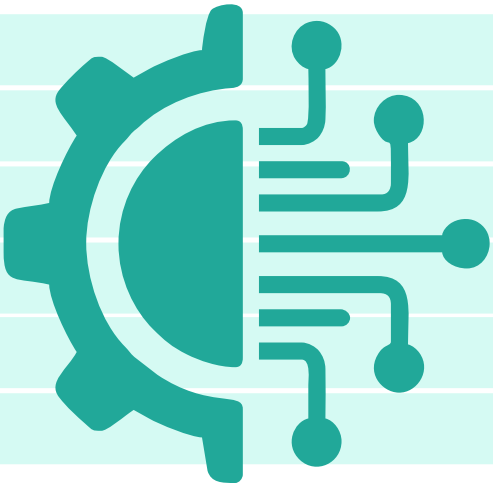
India is responding to the challenge with a mix of strategies pushing for renewables, primarily solar and wind, which will put it on an equal footing with thermal energy for a larger contributing share to the national power mix.

The next, equally important initiatives that seek to not only cut down the country's dependence on fossil fuels and its import bill, but also achieve multiple objectives along the way revolve around the development of first- and second-generation ethanol and BioCNG projects. Unlike solar and wind energy projects which don't have uncertainty in terms of resource availability and pricing, BioCNG projects are predominantly dependent on raw material availability, quality, and pricing. Similarly, technology for power generation from solar and wind energy production is well established and not complex. On the other hand, the technology for the production of BioCNG is relatively complex and entails various stages such as pre-processing and processing of raw material, upgradation, compression, and storage of biogas etc. There are various technologies available globally for biogas upgradation. Some of these technologies have been adopted in India as well. The figure 16 has the list of methods used for biogas upgradation to BioCNG.

Figure 16: Clean energy market share by financing institutions

Upgradation Technologies

- Water and Polythene Glycol Scrubbing
- Pressure Swing Adsorption
- Bio-Filter
- Chemical Absorption
- Membrane Separation
- Cryogenic Separation



Each of these upgradation technologies is associated with its own set of challenges.

(i) Water scrubbing method requires a lot of water even with regeneration.

(ii) Chemical scrubbing requires additional chemical inputs and adds to the need to treat waste chemicals from the process.

(iii) Pressure swing adsorption requires the pre-treatment of biogas for H_2S removal along with the requirement of treating the tail gas. PSA method further needs the periodic replacement of zeolites.

(iv) Membrane separation method is associated with difficulties in methane yield and, and further requires periodic membrane replacement, raising operating costs

(v) Bio-filtration requires additional nutrients for growing bacteria, and a small amount of O_2 and N_2 are also left in the treated biogas. The efficiency of the method depends on the activity of bacteria which adds to the uncertainty in output quality check punctuation

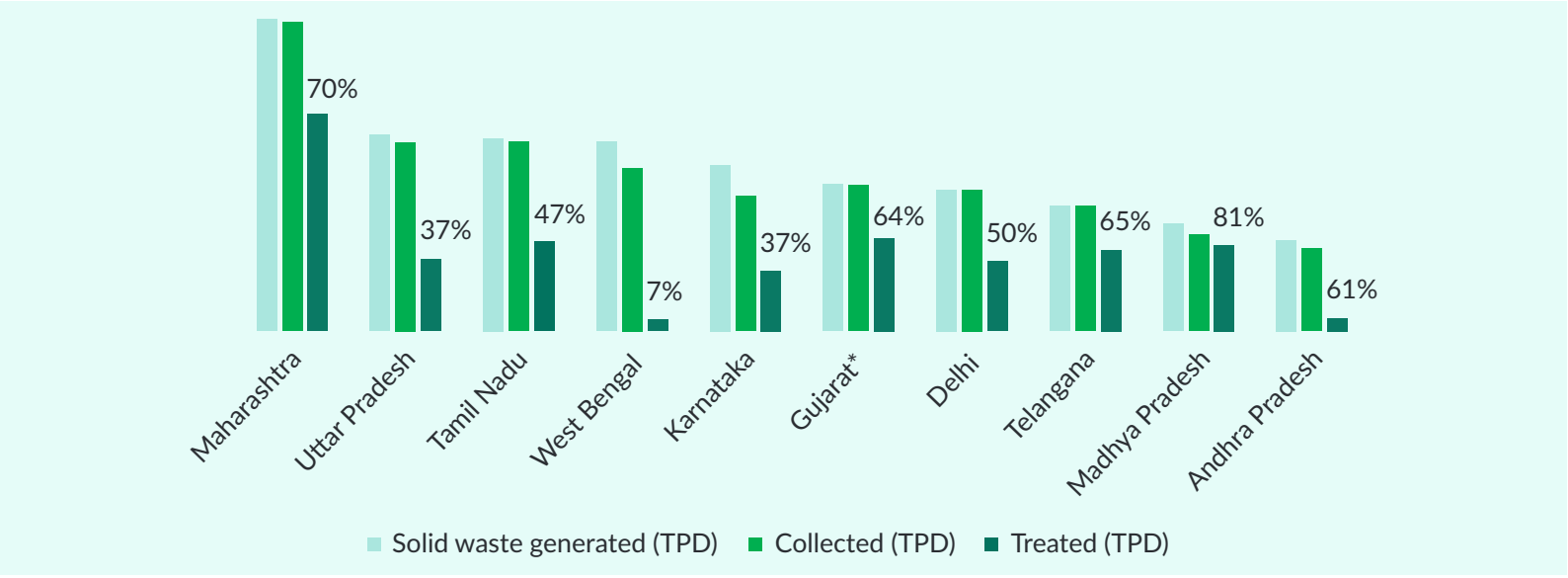
(vi) Cryogenic processes require the use of considerable process equipments, mainly compressors, turbines and heat exchangers, which adds to costs.

Pressure swing adsorption is presently the most widely used method in India. However, the technology is not well proven commercially. The efficiencies claimed by the technology providers is not achieved in certain cases. Moreover, the operational costs envisaged by technology providers is observed to be much lower than the existing costs incurred by the operating plants. For instance, the zeolites which are backbone for PSA method were expected to have an estimated life of 3-4 years, however, some of the plants have seen the need to replace the zeolites on annual basis.

Specific technical parameters including pH, CN ratio, retention time, etc. also needs to be monitored periodically, which entails the need for long term engagement with technology providers. These factors are critical for consistent BioCNG output.

In case of projects involving MSW, there is also a need for waste segregation where technology players have a major role to play. The major ULBs in India have always struggled to keep up with the need for waste segregation at source.

Figure 19: Solid waste management statistics of top 10 states for FY 20



*- Numbers are estimated for Gujarat

The national level statistics for waste treatment for FY 19 and FY 20 are as below:

Table 3: Solid waste management statistics at country level for FY 19 & FY 20

S.No.	Categories of Organic Waste	Annual Feedstock Potential (MT)	Estimated Potential of BioCNG (MT)	%
1.	Surplus Agro-residues	150	20	32
2.	Spent wash/Press Mud	20	2	3

Currently, most of the technology providers in India only treat segregated organic waste to produce BioCNG. While there are technologies available globally that utilise mixed unsegregated waste for BioCNG production, they are extremely expensive, thus directly affecting the project's financial viability. Hence, requirement of high-quality segregated waste becomes costlier.

These technical challenges mainly affect the profitability of the overall project making it unviable for operations by reducing the methane yield and increasing operational costs. These problems can be tackled by changes to the existing business model. The model currently adopted by the BioCNG plant owners entails the complete risk associated with plant operations only to oneself. The role of technology players is limited only to EPC contracting with no responsibility towards the performance of technology. Operations and maintenance of the plant is only provided as a service offering by the technology provider.

Expanding the responsibility of technology providers and adding accountability in the business model has the potential to resolved the technical issues. When the technology players have their "Skin in the Game", they will have the motivation and intent to ensure the efficiency and performance of their technology.

4.
Recommendations

04

Recommendations

4.1. Mechanisms to facilitate sustainable supply of Biomass

Mitigating measures for long-term sustainable supply challenge and ensuring availability of sufficient resources

4.1.1 Biomass mapping and defining Hot Zone

Identification of sustainable and affordable biomass supply sources in a defined catchment area, has to be the starting point of determining the site/location and size/capacity of a BioCNG project. Many BioCNG producers have received the LoIs without undertaking assessment of the availability of resource/biomass and ensuring the sustainable supply. It would be prudent to undertake a broad level pre-feasibility at least at district-level/taluka level, to identify hot zones based on sources of biomass (including industrial waste, municipal organic waste, agriculture waste, etc.) available in a region. Further, a "hot zone" (geographic coverage area) maybe identified based on resource abundance, BioCNG demand assessment, CGD network availability, connectivity to road/highways etc. among other factors, to ensure the suitability of setting up a BioCNG plant.

Selecting a site for setting up BioCNG projects depends on various technical and non-technical parameters. The current process of issuing LoIs are not tagged with any possible location. Based on the consultations with various stakeholders, GGGI has devised a pre-feasibility criterion which would assist OMCs and developers in identifying the possible hot zones within a district based on GIS mapping.

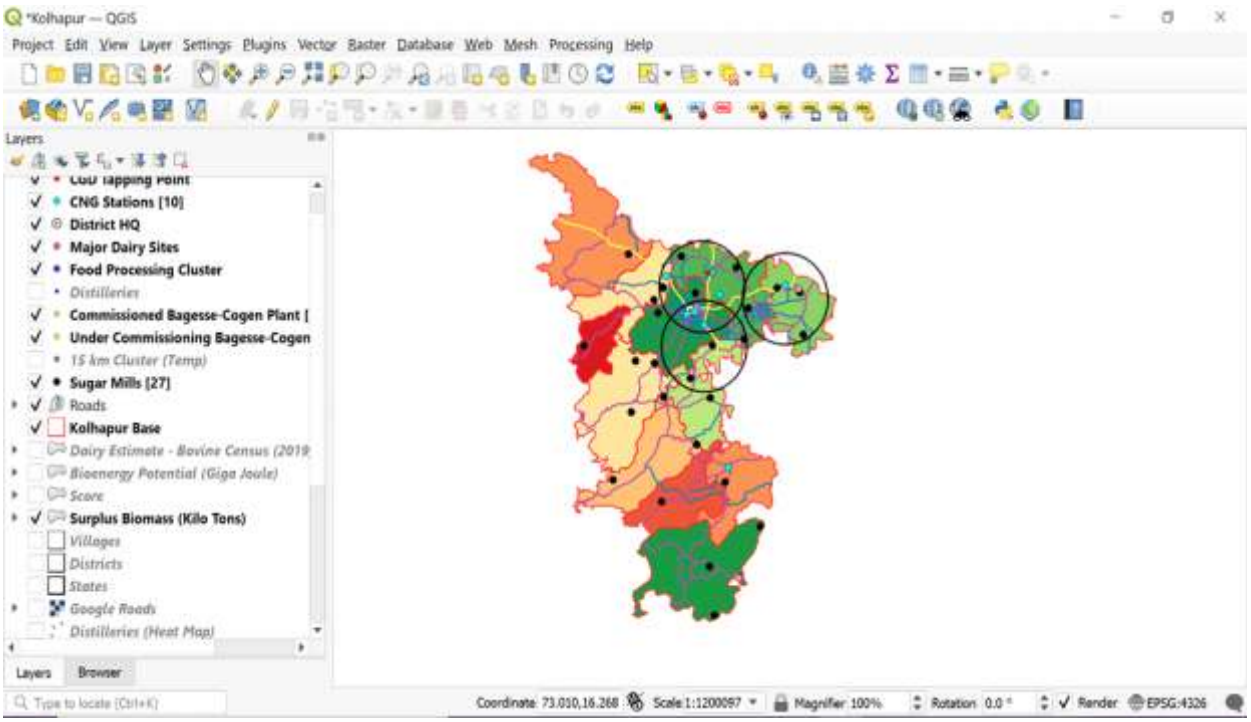
To assess the identified key parameters and test the proposed framework, two districts were shortlisted by GGGI - Kolhapur in Maharashtra and Gurdaspur in Punjab. The criteria for shortlisting the pilot districts are based on the high biomass resource potential available in the respective states. In case of Maharashtra, the primary feedstock is press mud and in case of Punjab it is paddy straw. GGGI has carried out extensive exercise of mapping various parameter for these districts.

To identify hot zones and map layers pertaining to various data points, the framework leveraged QGIS software to develop various layers on biomass resources, enabling infrastructure, competitive usage, and other critical parameters. Software snippets for Kolhapur districts are highlighted in Figure 20.

Characteristics of the proposed "Hot Zone"

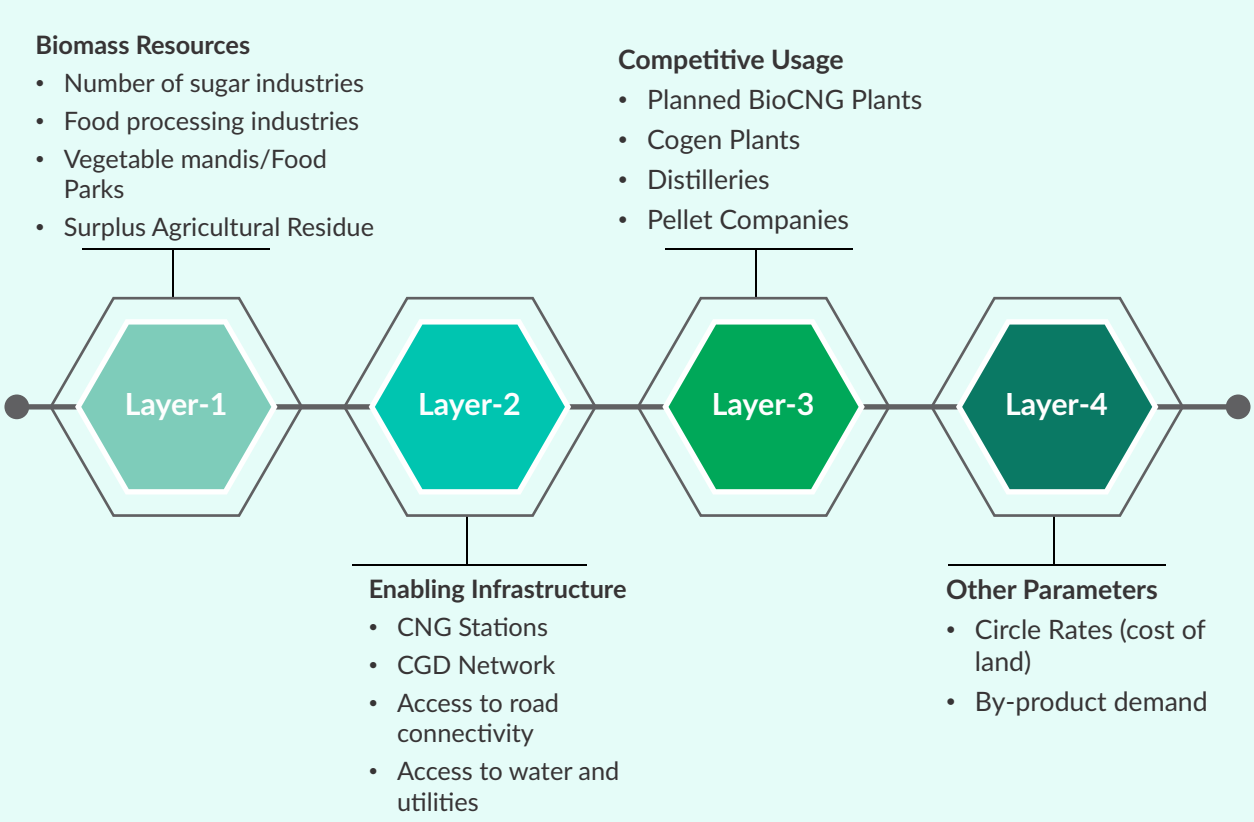
- 15 KM radius area (circle) having high biomass potential in the district
- Presence of CNG stations and access to CGD network
- Multiple sources of biomass supply including agri waste, press mud, food processing waste etc.
- Access to road network for seamless transportation of biomass and other by-products
- Out of water notified area

Figure 20: Snippets for Kolhapur



The first and foremost step is to identify the key parameters which has direct influence on operation and viability of the plants. To filter out and identify the hot zone in the respective district, a four layered approach has been followed to map and assess potential blocks across various data parameters.

Figure 21: Framework for mapping of "Hot Zones"



Layer 1: Analyzing Biomass Resources

The objective of the Layer-1 is to assess the different types of biomass availability and estimate its technical potential to understand the optimal BioCNG production potential based on the multiple resources.

The data collection was carried through secondary research and validated through consultations with various stakeholders. Agri waste data was collected by demarking blocks in the respective districts on Bhuvan portal and potential for various agri waste biomass resources was estimated. Data around district level sugar cane industries and its crushing capacity was sourced from state agriculture departments and Indian Sugar Mills Association (ISMA). For estimating vegetable waste/MSW, key municipal authorities in the respective districts were plotted and the waste available was estimated based on the population and size of mandi. Food processing industries and their waste generation inputs were sourced from state/district departments.

As part of this framework, the assessment was carried out for five different types of biomass resources including agriculture waste, sugar cane waste (press mud), MSW, Cattle Waste and STP sludge.

The outcome of Layer 1 will assist policy makers to cap the number of LoIs in a particular district based on the biomass availability.

Figure 22: Yield Conversion Factors

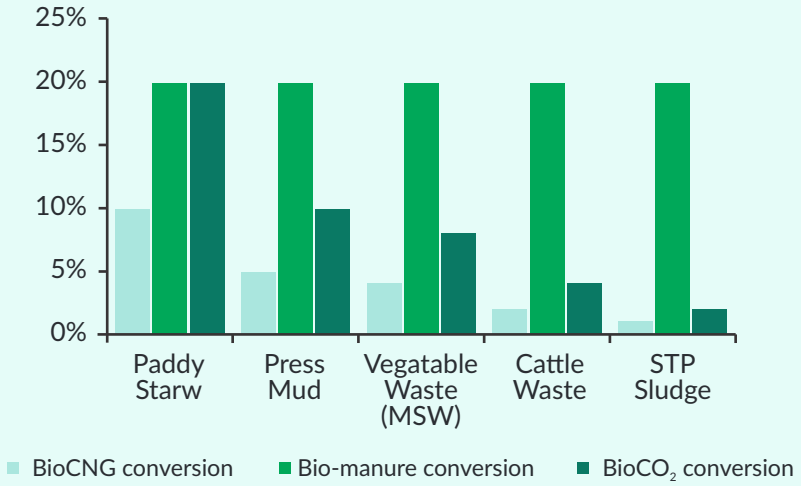
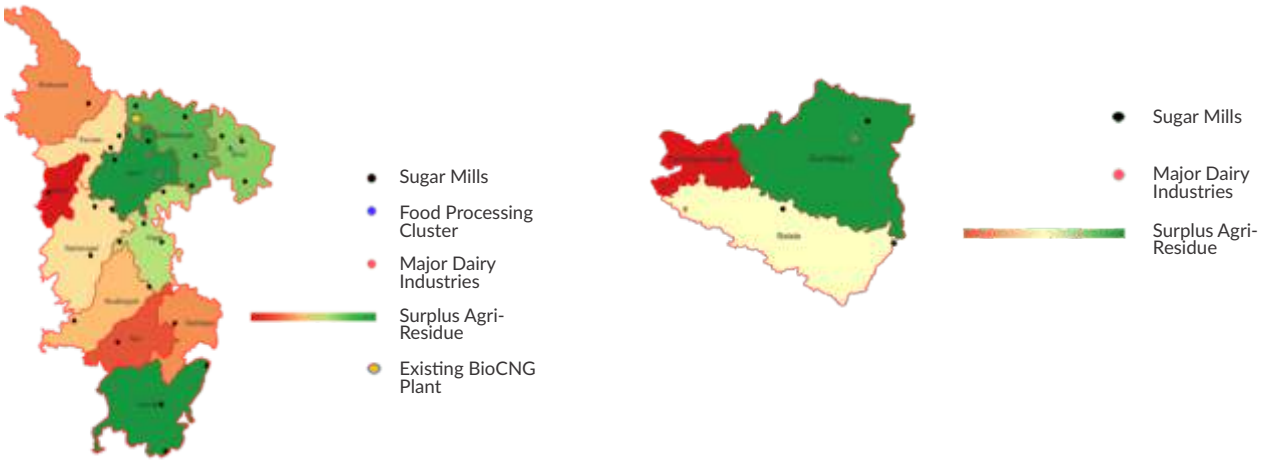


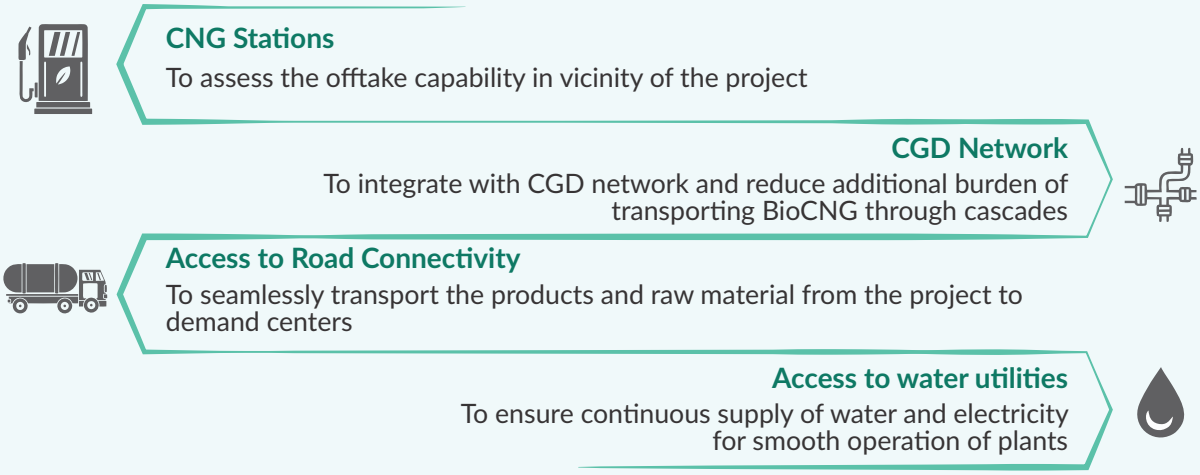
Figure 23: Layer1 outcome for sample district Kolhapur and Gurdaspur



Layer 2: Analyzing Enabling Infrastructure

Logistics and enabling infrastructure can make or break the project operations and has a direct impact on project expected returns. The layer-2 focuses on some of the key parameters which are pre-requisite for ensuring successful operation of the BioCNG plants.

Figure 24: Key elements for identifying enabling infrastructure

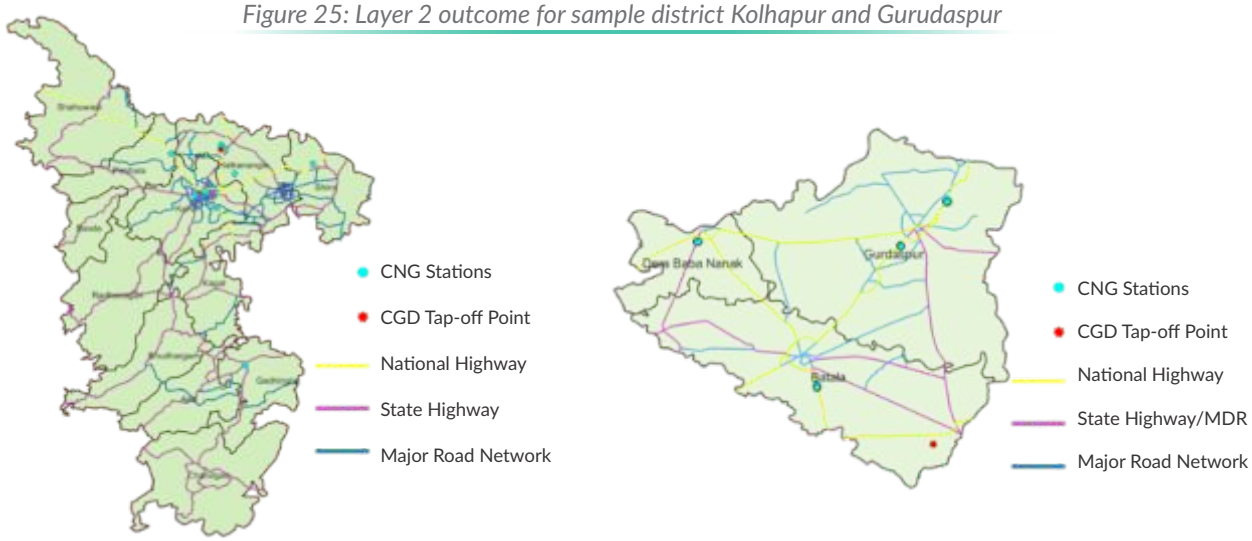


The framework considered availability of CNG stations, CGD network to integrate and supply BioCNG, access to road network for seamless transportation of raw material and end products from and to the plant, availability of utility and access to water for day-to-day operations

CNG stations demand data was sourced from respective OMCs operating in the districts. CGD tap off/ integration points were identified based on the consultations with CGD players operating in the respective districts. Access to road connectivity was verified using Google Maps and district level maps – three level connectivity modes were analyzed including local, state, and national highways. Ground water usage for industrial activities and data points of notified areas were accessed from Central Ground Water Authority (CGWA) portal.

The outcome of Layer 2 will help filter out zones which do not have access to essential infrastructure and assist policy makers to eliminate such sites.

Figure 25: Layer 2 outcome for sample district Kolhapur and Gurudaspur



Layer 3: Analyzing Competitive Usage

In the recent years, a number of policies has been introduced by the government to reduce import dependency and improve energy security which has led to an increase in usage of bioenergy and biofuels for electricity, transportation, and other end use sectors.

While the policies have greatly aided in reducing the conventional fuel imports as well as carbon emissions, the competition for the consistent supply of the existing biomass has been increased. This is because multiple bioenergy and biofuel plants utilizing biomass as feedstock have come up in close vicinity. Hence, for the successful implementation of a BioCNG project it is of utmost importance to have optimum number of plants based on available supply of biomass. The objective of the Layer - 3 is to identify the number of biomass-based plants including planned BioCNG plants, Cogen plants, distilleries and Pellet companies in a given area. This will help to assess existing demand for biomass for other competitive uses to avoid supply demand shocks in the future and unrealistic price escalations due to heavy demand in the respective districts.

The outcome of Layer 3 will be to assist policy makers to identify and avoid the locations with higher number of biomass-based plants while awarding LoIs.

Figure 26: Layer 3 outcome for sample district Kolhapur and Gurdaspur

Layer 4: Assessment of other parameters

Bio-manure, which is produced as a by-product of the BioCNG plant, is a rich source of silica that aids in the growth and yield of crops and prevents toxic material uptake by plants such as arsenic, cadmium, lead and other heavy metals. The other by-product CO_2 also has high demand for food preservation or to be used in fire extinguishers.

Revenue from sale of by-products from BioCNG plant is a vital component and hence needs to be mapped. This provides additional revenue source to the project owners and help in offsetting the production cost.

Similarly cost of land is another factor that impacts the project costs and in turn the project returns.

The objective of the Layer 4 is to assess these parameters in order identify areas within a district with maximum demand for by-products and relatively lower land rates.

Based on the assessment conducted, it has been observed that Kolhapur district has three hot zones suitable for setting up BioCNG projects. These potential hot zones have feedstock sources (viz. sugar mills, dairy farms, etc.), demand (viz. CNG stations etc.), and other favorable factors like road network etc. A catchment area of 15 km radius was defined for one hot zone. These identified zones are best suited to be awarded sustainable LOIs to setup BioCNG plants.

The outcome of this step is to assess the land prices and provide firsthand information about the circle rates so that potential project developers can consider realistic assumption while assessing the economics of the project. This will also assist lenders to validate the numbers provided by the developers in the DPRs.

The details and location of the respective hot zones are highlighted in Figure 27, below:

Figure 27: Identified Hot Zones in a sample district Kolhapur and Gurdaspur

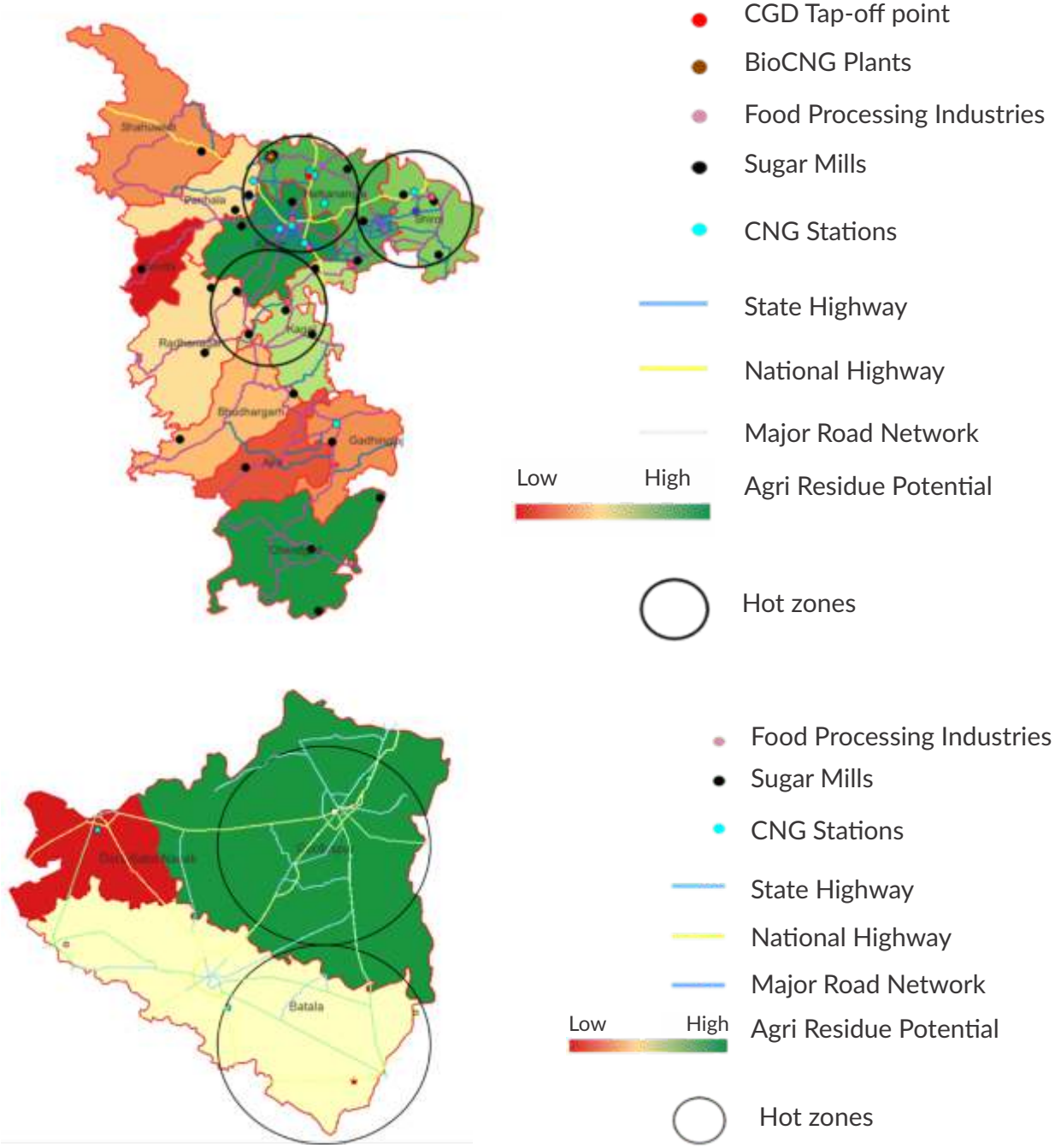


Table 4: Details of Hot Zones Identified in Kolhapur

Hot Zone	BioCNG Potential (TPD)	Details
Hot Zone 1	25	• 7 CNG stations • 4 Sugar mills of 14700 Tonnes of Crushing per Day (TCD) capacity • 3 major diary industries • 1 tap-off location • Access to State and National Highway
Hot Zone 2	20	• 1 CNG stations • 3 Sugar mills of 13000 TCD capacity • 5 major diary industries • Access to State and National Highway
Hot Zone 3	30	• 3 CNG stations • 1 Sugar mills of 17600 TCD capacity • 2 major dairy industry • Access to State Highway
Gurdaspur		
Hot Zone 1	30	• 1 CNG stations • 2 Sugar mills of 9000 TCD capacity • 1 CGD tapping point • Access to State and National Highway
Hot Zone 2	28	• 2 CNG stations • 1 Sugar mills of 2000 TCD capacity • 1 major dairy industry • Access to State and National Highway

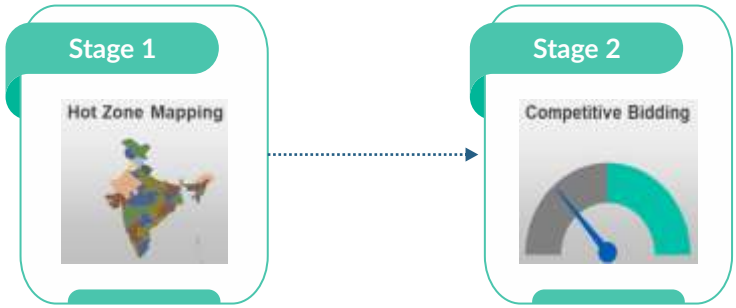
Similar pre-feasibility exercise may be carried out by a Designated Agency in the focus regions to assess the potential, jointly with oil and gas PSUs, CGD entities, state government agencies, and central government agencies, among others, prior to the allocation of LoIs to the BioCNG producers. The State Nodal Agencies (SNAs) are best suited to undertake the pre-feasibility in the respective states, the information can be shared with LoI issuers for the allocation of LoI to a potential project developer. MoPNG may issue a guidelines for SNAs to undertake the pre-feasibility exercise in their respective state and submit the same to MoPNG. SNAs should also periodically update the BioCNG project development state for the allocated LoI in their state to MoPNG or designated agency by MoPNG.

4.1.2 Process to award Letter of Intent (LoI)

Currently, over 3694 LoIs have been issued to various entities, however, only 38 plants are operational with a few under development. The low deployment/conversion rate and delays in the project implementation have put the SATAT target off-the-track.

It was observed that the lack of coordinated approach and LOI allocation without tagging it with a potential project/hot zone had majorly impeded the growth of market and accelerated deployment of BioCNG sector in India. Hence, it is imperative to develop an approach and strategy based on resource mapping and identifying hot zones, to streamline the LOI allocation mechanism and maximize project deployment rate. In this regard, GGGI recommends a two-stage LoI allocation process.

Figure 28: Proposed "Two Stage LoI Process"



In the first stage, potential hot zones may be identified by undertaking a pre-feasibility and shortlisting the possible hot zones based on the various data parameters as described in the section above. The mapping of hot zones (demarcated area) and aggregated zone-level information vis-à-vis resource, demand, and key enablers, will provide critical inputs to the market players to assess the potential and project viability. Each of the hot zones may be considered as a potential project, for which the LoI may be allocated with a concept of "One LoI in one zone", initially.

In the second stage, an auction-based mechanism for LoI allocation (for the development of BioCNG project and offtake of BioCNG produced in the potential hot zones) may be adopted to select a successful applicant based on financial, technical, and operational strength. The LoI allocation mechanism for a hot zone may be a competitive bidding process. The approach of competitive bidding and setting timeframe for various project development activities enabled through bid bonds etc. will further restrict the participation of only serious market players and in longer term help in accelerating the deployment of large-scale BioCNG projects in India.

The Competent Authorities (MoPNG) may like to propose or adopt this approach of LoI allocation (for both project development and BioCNG offtake) to initiate the large-scale uptake of BioCNG projects, as it will help market players to make informed decisions and subsequently, drive their interest towards viable, sustainable, and realistic BioCNG projects. MoPNG may issue a guideline on this and share with SNAs, oil and gas PSUs, among others to adopt the revised LoI allocation process. MoPNG may also designate either SNAs or oil and gas PSUs to undertake the LoI allocation process with support from other agencies such as municipalities, CGD companies, among others.

4.1.3 Standardization of contractual agreements

To successfully setup and sustainably operate a BioCNG project, multiple supply side and demand side contractual agreements are required. While there are model templates available for commercial agreement to offtake BioCNG, it requires certain changes for guaranteeing the off-take beyond assurance the offtake beyond assurance (in current format) to strengthen the project proposals from commercial bank's/financial institution's perspective. Whereas, the supply side of biomass/feedstock (mainly agriculture residues), would require mechanism to streamline the procurement based on contractual agreements and ensuring its enforcement/sanctity.

MoPNG may issue an indicative guidelines for SNAs to address the supply side issues in the enforcement of contractual agreements and demand side contract standardization for oil and gas PSUs. MoPNG may ask SNAs to development a detailed and structured biomass supply mechanisms through contract or agreements with potential stakeholders such as farmer producer organization, organic waste producing industries, municipalities, biomass processing companies, and other institutions. SNAs and OMCs shall develop the detailed processes, mechanisms, and guidelines in consultation with banks, project developers, biomass aggregators, among others.

4.1.4 Trading or exchange platform for the Biomass and Bio-manure

The large-scale up-take of BioCNG projects is constrained due to restricted supply of biomass, primarily due to the season production of agricultural residues, competitive use/application of biomass, supply-demand mismatch near the generation and demand locations.

Establishing a formal and regulated market for biomass through biomass trading platforms, would ensure a balance between its demand and supply at a guaranteed quantity and price. The market would provide a better renumeration price to farmers for their agricultural residue leading to an increase in the income potentials. Akin to 'Customer Hiring Centers' adopted in Haryana state, where farmers and small-scale entrepreneurs will be assisted in getting machinery for crop residue management, which would further help in aggregating the biomass in a structured way.

The biomass trading platform would also ensure for scaling up of various ongoing as well as upcoming BioCNG projects based on the sustainable business model. The same platform may also be used to exchange/trade bio-manure.

The Competent Authority (Ministry of New and Renewable Energy) may propose to act towards establishing the biomass trading/exchange platform, jointly with Ministry of Housing and Urban Affairs, Ministry of Agriculture and Farmer Welfare, Ministry of Chemicals and Fertilizers, among others. This will lead to development of biomass, bio-manure processing and storage facilities (bio-special economic zone – BIO-SEZ) in strategic locations, strengthen biomass supply chain, and contribute to accelerated scaling-up and ensure the viability of BioCNG projects. Revisions in the Solid Waste Management rules 2016 may also be considered to streamline the process of collection, transportation and supply of organic waste to the BioCNG projects.

4.2. Policy and Regulatory enablers

To ensure sustainability and viability of BioCNG projects, policy and regulatory incentives are imperative

The BioCNG market is still in very nascent stage which require various policy, regulatory and market support. Enabling ecosystem may be developed by introducing various policy, regulatory and market-based mechanisms to improve the viability and long-term sustainability of BioCNG projects.

4.2.1 BioCNG proposed Pricing Mechanism

The ecosystem for BioCNG in India is still evolving and have uncertainties around various project development and operational aspects, which directly affects the project viability. The key constituents to the cost of BioCNG production are biomass/feedstock price, technology cost, and cost of financing. Hence, the volatility in the biomass market (both in terms of availability and affordability), high technology cost, and low access to affordable finance, further increase the risk of project viability in long run. It is imperative to account the risks to ensure the viability and long-term sustainability of the projects. The high volatility in the price of biomass is required to be appropriately accounted with the BioCNG offtake price.

Table 5 lists out the project returns for various scenarios considering the BioCNG offtake price and biomass price. The plant considered is assumed to be based on mixed feedstock of 300 tonnes per day with average BioCNG yield at 3.35 percent and bio-manure yield at 20 percent (at offtake price of INR 3,000 per ton).

Table 5: Sensitivity on project returns based on various BioCNG and Bio-manure pricing

BioCNG (INR per kg)	Biomass Price INR per ton					
	1500		1800		2000	
	IRR	Payback (in years)	IRR	Payback (in years)	IRR	Payback (in years)
55	12.5%	9.3	7.9%	11.7	4.0%	15.3
60	14.5%	8.5	10.3%	10.4	7.0%	12.3
65	16.3%	7.8	12.5%	9.3	9.5%	10.9
70	18.1%	7.27	14.4%	8.5	11.7%	9.67

With the above in view, in addition to the floor price (i.e., INR 54 per kg of BioCNG, where the CNG market price is INR 75 per kg)[8], the variability in the biomass pricing may also be accounted and reflected in the BioCNG offtake price. It is evident from the sensitivity analysis; the viability of the projects is closely linked to the biomass market prices. Increase of biomass price from INR 1500 per ton to INR 2000 per ton will have an impact on IRR dropping down to 4% from 12%. It is a welcoming move by the government to link the off-take price with CNG prices, but the viability of the projects has a direct bearing on biomass price, so it is recommended to have linkage with price of biomass as well to ensure the sustenance of the BioCNG sector. The proposed approach will improve the viability of BioCNG projects while generating enough interest amongst the key market forces who can accelerate the growth of BioCNG sector.

The Competent Authorities (MoPNG/oil and gas PSUs) may review the current framework and revise it accounting biomass market price trends in India, which has witnessed an increment in the recent times due to increase in demand due to upcoming BioCNG projects. The guidelines shall also cover the aspects of payment security mechanism. State or Central governments may also provide generation-based incentives to the BioCNG producers.

4.2.2 Creating regulated market for Bio-manure

BioCNG projects generate a large quantity of Bio-manure (SFOM and LFOM) (almost 20 per cent of the input feedstock) and is an important revenue stream for these projects. To achieve the viability of BioCNG projects, there is a need to develop a incentives for the bio-manure.

The Competent Authorities (Ministry of Chemical and Fertilizer MoC&F) may notify guidelines or mandates for the fertilizer companies with indicative percentage of bio-manure purchase and sell obligation. Such an initiative will create the long-term demand and market-based pricing for bio-manure in India. MoC&F shall also devise a mechanism to determine the fair price of bio-manure, considering the environmental cost of chemical-based fertilizer, subsidy applicable for chemical-based fertilizer, among others, to promote adoption of bio-manure. State or Central governments may also provide generation based incentives to the bio-manure producers.

[8] https://satat.co.in/satat/pages/assets/download/CBG%20Pricing%20Circular%20-%20Stakeholders.pdf

4.2.3 Policy incentives/ Taxation

Upfront investment in the BioCNG projects is generally high due to high plant and machinery costs. The reduction in the total plant cost will have impact on BioCNG production cost and will significantly improve the project viability and economics. It is understood there is a discussion GST council recently notified the escalation of GST slab from 5 per cent to 12 percent for BioCNG plant related equipment and its parts. If so, this can be a major contributor hindering the growth potential for the sector through increased project cost and limited expansion capability.

MoPNG may recommend the GST council to take cognizance of the overall objective of GoI - enhahncing the growth of the BioCNG sector. The Ministry could also propose a concessional GST rate across the value chain of the BioCNG sector and recommend the GST Council to provide a rebate/wavier on GST applicable on BioCNG sale and purchase.

4.2.4 Eligibility of projects for Carbon Finance under Article 6

Conversion of biomass/organic waste to BioCNG, will significantly mitigate the carbon (or equivalent carbon) emission across the value chain, through avoided emissions from untreated/mismanaged organic waste & open burning of agriculture residues, replacement of fossil fuel with BioCNG, and replacement of synthetic fertilizer with Bio-manure. Furthermore, the CO_2 mitigation potential from a BioCNG project will depend upon various factors including biomass/organic waste treated, quantity & quality of output products, and process & operations of the plant. As per an estimate, a BioCNG plant with processing capacity of 300 tons of municipal organic waste per day, has a potential to mitigate ~ 75,000 tons of CO_2 annually.

The carbon mitigated from the BioCNG projects may be leveraged and monetized under Article 6 of the Paris Agreement as Internationally Transferred Mitigation Outcomes (ITMOs). However, the modalities, procedures, and guidelines for the ITMOs exchange and crediting mechanism under Article 6 are yet to be finalized/implemented.

In the absence of availability of any Viability Gap Funding (VGF) or subsidies for the BioCNG projects, it is imperative that the BioCNG projects may be allowed to explore the carbon finance market to generate financial resources.

To promote BioCNG sector and achieve project viability, the Competent Authorities (Ministry of Environment, Forest and Climate Chang, MoEF&CC) may agree to waive-off the ITMOs accrued from BioCNG projects to meet India's NDC commitment and allow the projects to trade ITMOs (as and when the modalities, procedures, and guidelines are finalized/ implemented).

4.2.5 CGD network access to the BioCNG projects

The mode of transporting BioCNG from production point to the demand/distribution point, significantly impacts the viability of a BioCNG projects (contributing substantially to both th CAPEX and OPEX of the project). To address this challenge, MoPNG formulated a BioCNG-CGD synchronization scheme (CCSS). The MoPNG guidelines on CCSS suggests establishing connectively for injection of BioCNG in CGD network, where the distance is below 10 kms. However, the responsibility of establishing the connectivity between the BioCNG plant and CGD network lie with BioCNG producers or the LoI issuers.

From the operation and execution perspective (including right of way acquisition, securing clearances, design, safety, and installation of the network infrastructure, among others), CGD entities would be best suited for their roles as infrastructure developers.

To further promote the uptake of BioCNG projects integrating with the CCSS, MoPNG may issue guidelines for oil and gas PSUs, CGD entities, among others to provide network infrastructure from the city gate station (CGS)/ CGD tap point upto 10 km tap point situated up to 10 KM or BioCNG plant location (whichever is less) at zero cost to BioCNG producer. Whereas, for the development of additional infrastructure (after 10 km), BioCNG producer can bear the appropriate development/ utilization cost, in the form of development charges or infrastructure utilization cost on per unit of BioCNG transportation basis or balance of both. However, the infrastructure shall be developed, operated and maintained by authorized/ relevant CGD entity.

4.3 Innovative business model to support the development of a scaled BioCNG market

Need to bring together key stakeholders based on shared risk-return approach

Under SATAT, many enablers are provisioned for the promotion of BioCNG projects. There is a need to appropriately integrate various policy & regulatory levers with the suitable market-based mechanisms - to create ecosystem for accelerated and sustainable growth of BioCNG sector.

Considering the current market scenario and business development practices, it is imperative to bring together key stakeholders (including Investor, Technology Provider, Biomass Supplier, OGMCs, among others) in a coordinated manner and demonstrate a few large-scale projects with viable business models.

4.3.1 Risk-Return sharing based Business Model

Innovative business model needs to be developed to create replicable template and enabling ecosystem for scaling up. As per the structure of the proposed "Shared Risk-Return Business Model", an investor makes upfront investment to cover the 100% project development cost and own the project/asset. Investor shall select a technology/service provider based on its technical & financial capabilities and/or competitive bidding process. The technology/service provider (T/SP) shall commission the project and also operate & maintain of the project. T/SP shall furnish a bank guarantee to cover the technology performance risks of the project, till the investment payback period. T/SP shall ensure the sustainable biomass supply and optimal projects operation to maximize project profit and earliest payback of investment. Post equity payback for the remaining project life, the profit sharing between Investor and T/SP shall be based on a pre-agreed formula (including factors such as the extent of investment risk covered through bank guarantee).

The proposed model has been appropriately balanced with the Risk-Return profile of the Investor and the T/SP and hence, creating a win-win scenario for all. Furthermore, the business model will help in create an enabling ecosystem of services for BioCNG in India through key development factors including establishing trust amongst the key stakeholders, ensuring project suitability, mitigating project investment risks, and building confidence of commercial banks/ financing institutions towards BioCNG Projects. The projects developed and deployed using the business model will also help in creating replicable template for the BioCNG projects in India, benchmarking technology performance and its cost, identifying technologies which are best suited for Indian agroclimatic conditions, building institutional capacities, enable access to affordable finance, and increase private sector participation in BioCNG space. Once the ecosystem is established and sufficient understanding is developed on various BioCNG technologies, the investment risk coverage through bank guarantee commitment may be reduced or gradually waived off.

4.3.2 Role of OGMCs in creating market using the proposed business model

Oil & Gas PSUs as coordinating agencies for BioCNG off taker and BioCNG-CGD synchronization (downstream), are key partners who can leverage their existing infrastructure and consumer reach to create market for BioCNG. However, oil & gas PSUs shall also play key role in upstream of the BioCNG ecosystem to kickstart the sustainable growth and establish right template and business models for the sector. The deployment of initial 25 to 30 BioCNG projects for various organic waste streams - including agriculture, vegetable market, municipal, industrial wastes, etc. shall provide much needed impetus and create a domino effect in the sector.

It is recommended that for effective execution, PSUs as investors shall identify and implement potential projects based on appropriate business models. Successful demonstration and operation of initial 25 to 30 BioCNG projects – would de-risk the sector, improve the participation of private sector & commercial banks, and accelerate scaling-up of BioCNG projects. PSUs may choose to exit from the BioCNG projects at appropriate time, after generating enough returns from the projects.

4.4 Access to Affordable Finance

Capacity building of banks and innovative financing instruments to optimally utilize line of credit from multilateral development banks

Aligning with the emerging national priority, Reserve Bank of India had revised the Priority Sector Lending guidelines to enable better credit penetration to BioCNG projects/sector. Commercial banks also have schemes to finance BioCNG projects, however, perceived sectoral risks substantially increase the lending rates due to high credit risk premium (up to 5.4 per cent in some cases) for the sector. However, seamless mobilization of concessional finance through a line of credit to deserving projects needs to be done at a programmatic level and requires interventions from competing authorities. The commercial banks are already overburdened by their exposure to other infrastructure projects and need to evaluate their strategy for financing projects in the evolving sector. There is a need to bring concessional finance for the BioCNG sector through national financing institutions (NFIs), sovereign loans, or loan to PSUs.

4.4.1 Line of Credit from Multilateral Development Banks (MDBs)

Mobilizing long-term concessional finance to support and fund the large-scale BioCNG projects will significantly contribute towards the growth of the sector. Various Multilateral Development Banks (MDBs) such as the World Bank, Asian Development Bank, amongst others can provide line of credit (LoC) to NFIs such as State Bank of India (SBI), India, Infrastructure Finance Company Limited (IIFCL). The LoC would be used to disburse loan to BioCNG projects at much lower rates by compensating for the higher risk premium in the current market. MDBs may also provide sovereign loans to either state or central government, the loan can be disbursed to BioCNG project proposals through nodal agency/ department/ministry at state or central level.

MoPNG may ask the development sector organization to engage with Commercial Banks, Financial Institutions (FIs) and OMCs to develop an effective mechanism for mobilization of investment for the BioCNG projects using various financial instruments. Development sector organizations shall focus on interest rate subvention, loss/risk guarantee, among other instruments, to mobilize debt financing.

4.4.2 Training and Capacity Building of Commercial Banks

Since the inception of SATAT initiative in 2018, around 28 BioCNG projects are commissioned and very few are under development. The limited evidence regarding the suitability of BioCNG technology and guaranteed performance, is an economical risk to the bank's investment. These risks can be mitigated by - adopting standard project appraisal template, developing technology evaluation/ benchmark mechanism, and demonstrating projects using appropriate business models. Undertaking these mitigating measures in coordination with banks would not only standardize the project appraisal template but also build the institutional capacity of banks in the sector and reduce the credit risk.

MoPNG may ask the development sector organization to work in close coordination with commercial banks, and Financial Institutions (FIs) to develop their capacities on BioCNG projects through focused training and workshops.

Annexure - 1

Annexure - 1

No	Characteristic	SFOM	LFOM (Bio-slurry)
1.	Moisture% by weight, maximum	30-40%	90-97%
2.	NPK Nutrients- Total N, P2O5 and K2O nutrient should not be less than	1.2%	
3.	Total Organic Carbon (minimum)	14%	
4.	C:N Ratio	<20	N.A
5.	Practical Size	Minimum 90% material should pass through 4.0 mm IS Sieve	
6.	pH	6.5-8.0	
7.	Pathogens	NIL	N.A.
8.	Conductivity (as dSm-1) not more than	4	
9.	Heavy metal content, (as mg/kg), maximum Arsenic as (As2O3) Cadmium (as Cd) Copper (as Cu) Chromium (as Cr) Mercury (as Hg) Nickel (as Ni) Lead (as Pb) Zinc (as Zn)	 10.0 5.0 50.0 300.0 0.15 50.0 100.0 1000.0	

Notes

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