EAC
INTERNATIONAL CONSULTING

CBGPF
COMPRESSED BIOGAS PRODUCER FORUM
IFGE
INDIAN FEDERATION OF GREEN ENERGY

# ENABLERS AND CHALLENGES – INDIAN COMPRESSED BIOGAS (CBG) INDUSTRY

## Identifying and removing obstacles to a potential growth story

## Is India ready for a Biogas revolution?

- *Acceptance and potential*
- *Supply chain maturity*
- *Commercial viability*
- *Ecosystem readiness*

**ISSUES TO A COMMERCIAL SUCCESS CASE REMAINS BUT EXPECTATIONS OF QUICK REDRESSAL IS LIKELY**

April 2023

# INDEX



# ABBREVIATIONS

| | |
|---|---|
| ACR | American Carbon Registry |
| ACX | Air Carbon Exchange |
| AIJ | Activities Implemented Jointly |
| BCM | Billion Cubic Meter |
| C:N ratio | Carbon Nitrogen Ratio |
| CAR | Climate Action Reserve |
| CBG | Compressed Biogas |
| CGD | City Gas Distribution |
| CBGPF | Compressed Biogas Producers Forum |
| CCC | Carbon Credit Certificate |
| C-CCC | Converted - Carbon Credit Certificate |
| CCTS | Carbon Credit Trading Scheme |
| CDM | Clean Development Mechanism |
| CIX | Climate Impact X |
| CNG | Compressed Natural Gas |
| COP | Conference Of The Parties |
| CTX | Carbon Trade Exchange |
| DAP | Di-Ammonium Phosphate |
| ETS | Emission Trading Scheme |
| FCO | Fertiliser Control Order |
| FOM | Fermented Organic Manure |
| GAIL | Gas Authority Of India Limited |
| GHG | Greenhouse Gases |
| GOBARdhan | Galvanizing Organic Bio-Agro Resources Dhan |
| GS | Gold Standards |
| ICAR | Indian Council Of Agricultural Research |
| IFGE | Indian Federation Of Green Energy |
| IOC | Indian Oil Corporation |
| KP | Kyoto Protocol |
| LNG | Liquefied Natural Gas |
| M-CCC | Mandatory - Carbon Credit Certificate |
| MDA | Market Development Assistance |
| MLPD | Million Litre Per Day |
| MMBtu | Metric Million British Thermal Units |
| MMSCMD | Million Metric Standard Cubic Meters Per Day |
| MMTPA | Million Metric Tons Per Annum |
| MSW | Municipal Solid Waste |
| NPK | Nitrogen, Phosphorus, Potassium |
| OC | Organic Carbon |
| O-CCC | Offset - Carbon Credit Certificate |
| OGMC | Oil & Gas Marketing Companies |
| OMC | Oil Marketing Company |
| OTC | Over The Counter |
| PAT | Perform, Achieve and Trade |
| PNGRB | Petroleum and Natural Gas Regulatory Board |
| PROM | Phosphate Rich Organic Manure |
| REC | Renewable Energy Certificate |
| REDD+ | Reducing Emissions From Deforestation And Forest Degradation (“Plus” refers to “Role Of Conservation, Sustainable Management of Forests And Enhancement of Forest Carbon Stocks in Developing Countries) |
| RO | Retail Outlets |
| RSP | Retail Selling Price |
| SATAT | Sustainable Alternatives Towards Affordable Transportation |
| SOC | Soil Organic Carbon |
| SSP | Single Super Phosphate |
| TPD | Tons Per Day |
| UNFCCC | United Nations Framework Convention On Climate Change |
| VCS | Verified Carbon Standards |

# INTERVIEW PARTNERS

EAC conducted interviews with 31 stakeholders from the Compressed Biogas industry (including biogas producers, OMCs, distribution network, policy makers and institutions) to collect on-ground information on industry dynamics, challenges, success factors etc.

| Serial | Company Name | Interview Partner |
|---|---|---|
| 1 | Carbon Masters | Mr. Kevin Houston |
| 2 | | Mr. Somnarayan |
| 3 | Spectrum Energy | Mr. Mohan Rao |
| 4 | Noble Exchange Environment | Mr. Nuriel Pezarkar |
| 5 | Sampurn Agri | Mr. Sanjeev Nagpal |
| 6 | Verbio | Mr. Ashish Kumar |
| 7 | | Mr. Ashish Singh |
| 8 | | Mr. Chetan Swaroop |
| 9 | | Mr. Sushil Verma |
| 10 | | Mr. Pankaj Jain |
| 11 | GPS Renewable | Mr. Varun Karad |
| 12 | Indian Oil Adani Ventures | Mr. Atul Kharate |
| 13 | Farm Gas Private Limited | Mr. Vivek Kumar |
| 14 | | Mr. Abhinay Dadwal |
| 15 | | Interviewee decided to remain anonymous |
| 16 | Atmos Power | Mr. Palaash Tarapore |
| 17 | Atlantic, Gulf & Pacific Company (AG&P) | Mr. Sanjit Suman |
| 18 | | Interviewee decided to remain anonymous |
| 19 | IO Adani Gas Private Limited | Mr. Naveen Parmar |
| 20 | South Pole | Mr. Rohit Garg |
| 21 | EVI | Mr. Rachit Verma |
| 22 | Enking | Mr. Rohit Vakkalagadda |
| 23 | Banaskantha | Mr. Priyank Mehta |
| 24 | Spectrum Energy | Mr. Mohan Rao |
| 25 | Haldia Petrochemicals | Mr. Shubham Jain |
| 26 | IOCL | Mr. Kshitij Sandhya |
| 27 | | Interviewee decided to remain anonymous |
| 28 | | Interviewee decided to remain anonymous |
| 29 | Ever Enviro | Interviewee decided to remain anonymous |
| 30 | GAIL | Interviewee decided to remain anonymous |
| 31 | | Interviewee decided to remain anonymous |

CBGPF-IFGE and EAC thanks all the interview partners for their immense contribution!

# FOREWORD

**Mr. Ramakrishna Y.B**

*Member - Working group on Bio Fuels at Ministry of Petroleum and Natural Gas Govt of India*

*India has more than 130 years of Biogas history since the first ever plant was built in Matunga, Mumbai. Biogas as cooking fuel has been known in this country ever since and in the last few decades for industrial heat and electricity generation too.*

*India considered upgraded biogas or compressed biogas (CBG) as transport fuel only under SATAT (Sustainable alternatives to Affordable Transportation) launched in Oct 2018 by the Ministry of Petroleum & Natural Gas. SATAT is a very ambitious program which aims at replacing a minimum of 35% of the total fossil gaseous fuels being consumed in the country as of today. India has the necessary resources (feedstocks), technologies, huge market and an aggressive policy framework. Despite the best efforts by all stakeholders the program is yet to gain acceleration towards achieving the potential.*

*The report attempts to identify the hurdles and challenges the sector is facing and the policy interventions needed to bridge the gap through a thorough consultative process with major stakeholders. I congratulate the EAC team as well as the IFGE CBG Producers Forum for this stupendous initiative.*

**Mr. Ketan Jadhav**

*Partner, EAC India*

*ketan.jadhav@eac-consulting.de*

*+91- 9664145856*

*Indian GDP is expected to grow at CAGR of 6%-7% during 2024-30 to become 3rd largest economy in the world by 2030. With rapid growth of infrastructure, urbanisation, and overall economy, India's energy demand is expected to grow significantly in coming years. India's future energy strategy has high emphasis on green sources including biogas as one of the major potential contributor.*

*Indian compressed biogas industry has tremendous potential to reduce import bills of natural gas and crude oil as well as to reduce government subsidy bills on chemical fertilisers. India's CBG potential is estimated around 40 to 60 MMTPA as per various studies, considering different feedstocks available across country. We expect 15% to 20% realisation of potential (8-12 MMTPA) in next 7-8 years pushed by successful implementation government policies and efforts of industry stakeholders.*

*As a knowledge partner of Compressed Biogas Producer's forum, EAC is delighted to publish the report covering CBG industry potential, key enablers, success factors and challenges of CBG industry based on-ground information collected from key stakeholders.*

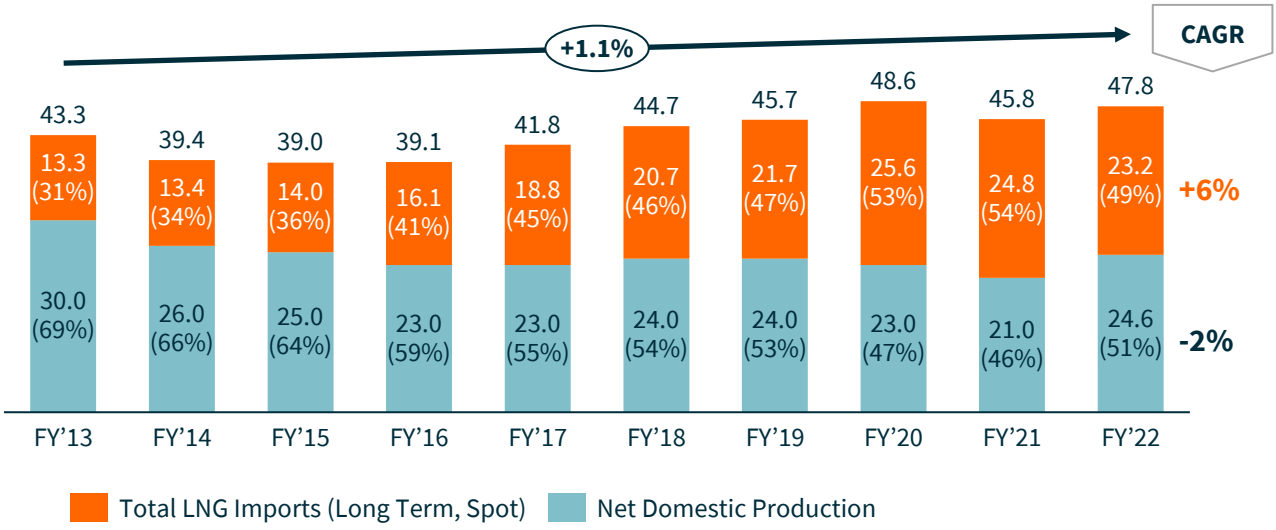
# INTRODUCTION TO CBG INDUSTRY

**Need – Potential – Enablers**

## Need: Compressed biogas (CBG) an imperative to reduce import dependence

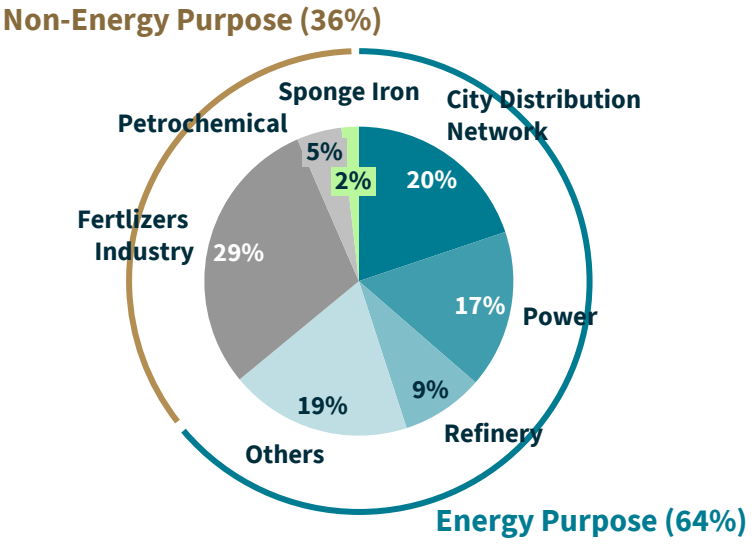
India is world's 3rd largest energy consumer, and its energy demand is expected to rise significantly in next 15-20 years. Approximately 50% of its natural gas requirements are met by imports. It spent USD 11.9 billion on import of 32 billion cubic meters of LNG in 2021-22. This compared to USD 7.9 billion spent on import of 33 bcm of gas in the previous fiscal and USD 9.5 billion on import of 33.9 bcm in 2019-20. Approx. 3x increase in LNG spot price over the last 2 years driven by supply-demand situation and geo-political reasons is mandating the use of CBG as an alternate to CNG for achieving supply and price stability.

### LNG Import vs. Domestic Natural Gas Production (MMTPA)




*Source: Ministry of Petroleum and Natural Gas*

### Sector wise Natural Gas Consumption, FY'22




Compressed biogas (CBG) is an excellent alternate to support energy requirements met by natural gas and crude oil (transport fuel).

Acknowledging its role to reduce import dependence, the Indian government announced a budget Rs 10,000 crores, for Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan) scheme. This scheme aims to install 500 new bio-CNG plants that will generate compressed biogas from organic waste.

*Source: EAC International Consulting*

# INTRODUCTION TO CBG INDUSTRY

**Need – Potential – Enablers**

**Potential: India CBG potential is estimated at ~40-60 MMTPA – Installed capacity is <1%**

**Total estimated CBG potential from various sources: ~40-60 Million Metric Tons Per Annum (MMTPA)**

- **15-28 MMTPA** — **Biomass Agriresidues** *(from residues of crops incl. rice, maize, wheat, etc.)*
- **~10-12 MMTPA** — **Cattle Dung and Livestock Waste**
- **10-12 MMTPA** — **MSW + City wastewater** *Biodegradable Municipal Solid Waste*
- **5-8 MMTPA** — **Pressmud (sugar), Spent wash (distilleries) and others**

***SATAT target is to produce 15 MMTPA of CBG and 50 MMTPA of bio-manure, to replace 2/3rd of LNG import***

***"Current installed capacity in India is <1%, moreover significant number of plants are not commercially viable due to limited utilization of capacities and are not able to realize 100% revenue (including potential revenue from FOM & carbon credit)***

***To achieve SATAT targets industry will need commercially viable business models and conducive business environment"***

Agri waste, livestock waste, MSW, and pressmud are the 4 categories of feedstock which is majorly contributing to current production and potential of CBG in India.

The efficiency of biogas production from different feedstocks depends on the substrate characteristics and process conditions. Agri waste and Napier grass have better yields of around 8-12%, however Napier grass is not majorly cultivated in India for biogas production.

The significant portion of biogas potential is being lost due to burning of agri residues and improper segregation of municipal solid waste. Also, another potential roadblock to utilize fullest potential of biomass for CBG would be other end use applications are such as co-firing at coal-based power plants.

*Agri Residue*

*MSW*

*Pressmud*

*Source: EAC International Consulting*

# INTRODUCTION TO CBG INDUSTRY

**Need – Potential – Enablers**

## Enablers

Growth of biogas market in India is pushed forward by favorable conditions including feedstock and technology availability, policy support and government focus.

### KEY ENABLERS FOR CBG IN INDIA

**PUSH TOWARDS GREENER FUEL TO REDUCE IMPORTS**

India's tryst to increase the share of renewable energy in its consumption to reduce import dependencies of natural gas

*~50% of total consumption is met by imports plus increasing pricing risk in imports*

**FEEDSTOCK AVAILABILITY AND BIOGAS POTENTIAL**

Supposedly easy availability of different feedstock including Agri waste, MSW, pressmud, cow dung, livestock waste, spent wash etc.

*Total CBG installed capacity in India is <1% of total CBG potential*

**STRONG POLICY SUPPORT AND INFRASTRUCTURE**

India has specific favorable policies for biogas production and sales – supported by existing and planned natural gas pipeline

*Natural Gas pipeline is spread across 20 thsd kms, with 333 MMSCMD capacity; additional 13 thsd kms network is under construction*

**SOIL DEPLETION – NEED FOR ORGANIC MANURE**

The Soil Organic Carbon (SOC) content in India has come down to 0.3% from 1% during 1950-2020

*FOM generated has high OC% ranging from 35%-50% which can replenish low SOC levels*

India however has not been able to scale its production and usage of CBG even with multiple positive enablers mainly because of the still shaky commercial viability of large-scale projects, and the mismatch between policies and ground reality faced by value chain stakeholders including producers, oil marketing companies (OMCs), government institutions etc. As of today, possibility of ubiquitous expansion remain distant, but speedy resolution of some of the challenges can re-jumpstart the biogas revolution in the country.

Major work needs to be done to improve the on-ground implementation of the following 4 topics:

1. ***Inconsistent and mostly unorganized feedstock supply***
2. ***Acceptance and commercial sales viability of FOM***
3. ***Limited understanding and monetization of Carbon market in India***
4. ***Implementation at ground level doesn't support policies***

*Source: EAC International Consulting*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Feedstock for CBG

### Overview

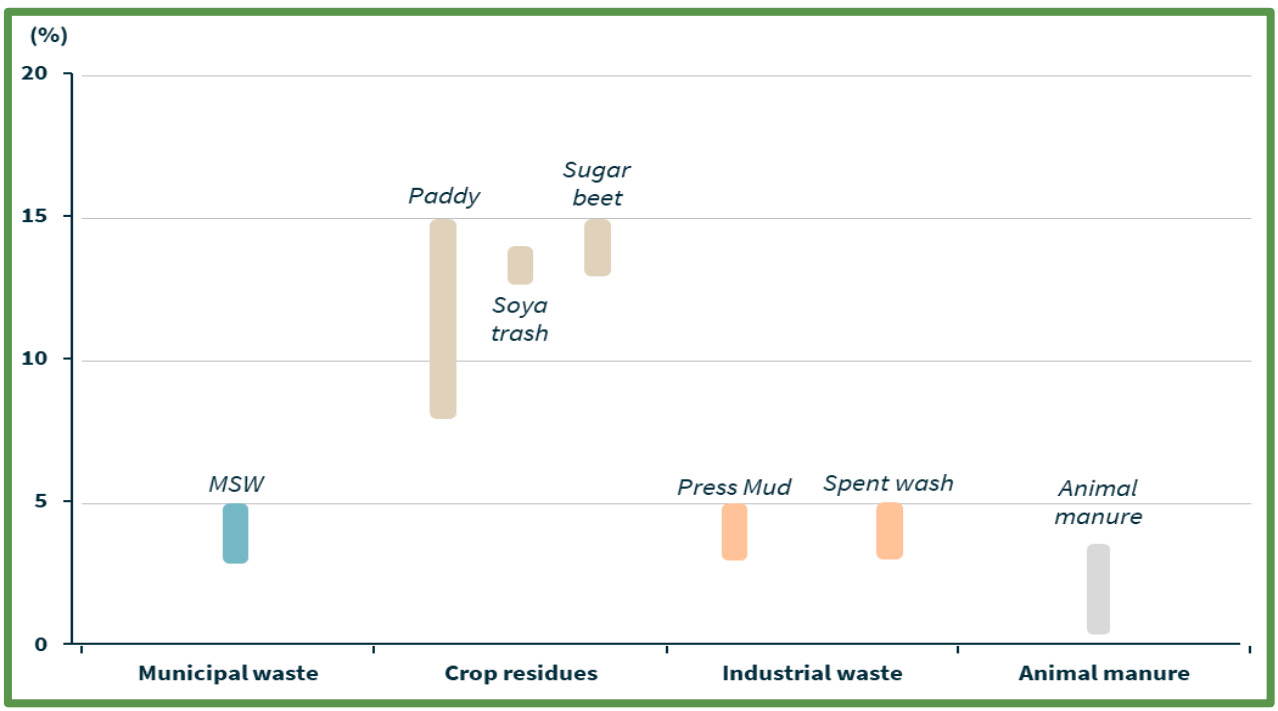
India has a wide range of feedstocks available, the most used feedstocks includes agricultural residue, municipal solid waste (MSW)/ sewage sludge and animal waste.

With significant biomass quantity and better yields, agri residue contributes more than 1/3rd of the total CBG potential in India. However, the supply is seasonal and varies region to region based on crop cultivation patterns. Rice and wheat crops has higher contribution to agri residue, while other crops includes mustard, groundnut, castor, maize, soybean, gram, and tur.

Municipal solid waste is another key feedstock for biogas generation, however, to achieve higher yields segregation is done properly.

To understand the feedstock situation and its actual potential, EAC conducted interviews with select CBG producers across India using different/ mixed feedstocks. These interviews have highlighted key success factors and challenges of CBG producers to ensure regular and high-quality supply of relevant feedstocks.

**FEEDSTOCK YIELD**




With yield in the range of 8–15% (normally) and can be as high as up to 20-25%, agri residue is the most productive feedstock. MSW, spent Wash and press mud all range in between 3–5% whereas animal manure averages <3%; individual animal manure yields do vary and can go up to 7–8%

*"Use of MSW should be for CBG generation and not for power since the revenue from power is too low, even accounting for the volumetric difference between the production of the two "*

*- Somnarayan, Carbon Masters*

*Source: EAC International Consulting*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Feedstock for CBG – Aggregation, Continuity and Security

*EAC has assessed parameters related to availability, aggregation, transport and yield of the feedstock to evaluate the stability of the supply structure and the associated bottlenecks.*

| FEEDSTOCK TYPES & PARAMETERS | AGRI OR PRIMARILY AGRI | | | MSW | INDUSTRIAL | ANIMAL WASTE |
|---|---|---|---|---|---|---|
| **Type** | **Agri** | **Agri + Industrial** | **Agri + Animal waste** | **MSW incl. food waste** | **Pressmud** | **Cattle manure, Poultry etc.** |
| **CBG Producers examples** | Verbio, Farmgas, Sampoorna Agri etc. | | | Ever Enviro, Noble Ex, Carbon Masters | Spectrum | Banaskantha, Solika Energy |
| **Aggregation model** | Aggregation is a significant COST<br><br>Aggregation models<br>1. 100% Integrated, Owned & Operated<br>2. 100% Procurement via Aggregators and feedstock stored for the year<br>3. Hybrid | | | 1. Supplied by waste management companies & Municipality at No Cost Or on Revenue basis<br><br>2. Some pay annual royalty to Municipal corp. and MUST sell CBG at lower than market price | Backend integrated; Own plantation | Procures cattle dung within 10-20 km radius |
| **Aggregation CAPEX Demand** | Up to 30% of project with reinvestment every 5-6 years | None | | | | |
| **Biogas yield (%)** | 8 to 20+% | | | 4 to 5% | 4 to 6% | 1 to 2% |

*In the absence of a uniformly implemented structure, market players across feedstock type are struggling to ascertain continuous and cost-effective access to quality feedstock.*

| | | | | |
|---|---|---|---|---|
| **Input form** | Bales of size ranging between 20 kgs to 400-500 kg | Properly segregated form | Loose direct from sugar mills | Fresh Cattle dung in semi solid format |
| **Input quality** | 1. Moisture as most critical quality factor targeted <20%<br>2. Cut form direct from farms ideal to optimize pre-treatment (possible for large round / square bales only)<br>3. High compression to ensure long term & durable storage | Segregated organic content | Filtered to separate suspended matter | Requirement of feedstock free of sand and silt |
| **Supply feasibility** | Seasonal supply / Diversified crop mix<br>Needs to be stored for rest of the year<br>Continuous supply feasibility | Fairly continuous on daily basis;<br>No storage necessary | Dependent on sugar mills;<br>Inconsistent supply | Continuous daily supply |
| **Pre-treatment** | 1. Unbailing, loosening of bales<br>2. Shredding<br>3. No pre-treatment needed for pressmud | No pre-treatment required if well segregated | No pre-treatment needed | Sieving |

Uninterrupted supply of feedstock with minimal cost fluctuation and maintenance of minimum quality pose the biggest challenge to biogas producers in India irrespective of the type of feedstock utilized.

*Source: EAC's Primary Research with CBG units*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## CBG Offtake – Common models

Offtake plan through SATAT model is pragmatic and expectations of speedy implementation are high due to one party involvement; compensating biogas producers for compression would go a long way in incentivizing the acceptance further.

| | |
|---|---|
| **UNDER SATAT SCHEME** | ▪ Long term offtake agreements with the Oil & Gas marketing companies (OGMCs) to sell the CBG to them by cascades to the OGMC retail outlets (ROs) or mother station<br>▪ Availability of cascades require extra cost but the same is not compensated by the Oil & Gas companies (OMCs) so the overall enthusiasm is low |
| **CBG-CGD SYNCHRONIZATION** | ▪ Model employed by GAIL has offtakes through retails outlets as well as injection into pipelines however very few cities have completed the CBG-CGD synchronization till date<br>▪ Charges for compression is paid to the producer making it attractive to pressurize the gas up to 250 bar for injection<br>▪ PNGRB guidelines compliance is necessary in addition to IS 16087 |
| **AGREEMENT WITH MUNICIPAL CORPORATION** | ▪ Since disposal of MSW is a major problem but the responsibility of the municipal corporations, they enter into an agreement with biogas producer for the supply of segregated solid content which can be used as a feedstock for biogas. The producer might give preferential offtake to the municipal corporation/ at a concessional rate<br>▪ Segregated waste is delivered free of cost by municipal bodies; some municipal corporation though are earning royalty from the CBG producer in exchange<br>▪ Along with the municipal corporation the CBG producer can sell the CBG directly into the market |
| **STANDALONE MODEL** | ▪ CBG producer owns the captive power plant/ CBG sold to the power generation companies<br>▪ Some of the producers sell through their own retail outlets directly to the consumer and industrial customer |

*"On ground implementation of SATAT and CBG CGD Synchronization is still far away, companies are selling biogas through their own retail outlets which allows them maximum value generation"*

*- Multiple stakeholders*

*Source: EAC's Primary Research with CBG units*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## CBG Offtake – Common models

Injection to pipeline (both direct as well as decompression through cascades) hasn't been implemented on ground completely yet; biogas producers rather prefer to sell through other channels to minimize losses.

| **Offtake Scheme** | **SATAT (OMC)** | | **CBG-CGD Synchronisation (GAIL)** | | | | | |
|---|---|---|---|---|---|---|---|---|
| CBG Point of Sale | Retail Outlet | | Retail Outlet | | DCS Injection (Decompression) to Pipeline | | Direct Injection to Pipeline | |
| Commercial Implementer | OMC | | GAIL | | | | | |
| Technical/ Infra Implementer | OMC | | CGD (City Gas Distribution) Operator | | | | | |
| Unit of Sale | on Weight basis INR Per Kg | | Thermal Energy Content + Compression Energy (MMBtu) | | | | | |
| Compliance | IS 16087 | | IS 16087 + PNGRB Guideline | | | | | |
| Offtake Readiness | 5-6 Months | | Technically Immediate Existing CNG Infra utilised | | Up to 6 Months: Decompression Skid to be implemented | | 6-24 Months Dependent on Pipeline readiness | |
| Logistic precondition | Upto 250 bar compression via Cascade | | | | Up to 250 bar compression via Cascade | | 5-40 bar Compression into Pipeline | |
| Price to CBG Producer (excl. GST) | 80% of RSP as per slab | | 1470/ MMBtu + 8/ kg (250 bar-compression) | | 1470/ MMBtu + 2/ kg (250 bar-compression) | | 1470/ MMBtu + 2/ kg (5-40 bar-compression) | |
| RSP of CBG | 93 (1st April'23) | 87 (9th April'23) | 93 | 87 | 93 | 87 | 93 | 87 |
| Price Realisation to Producer (excl. GST) | 70.5 | 66.7 | 62.5 + 8 = 70.5 | | 62.5 + 2 = 64.5 | | 62.5 + 2 = 64.5 | |
| Commercial Terms | ■ Long Term<br>■ Clarity on Pricing<br>■ Prone to CNG pricing mechanism | | ■ Short Term;<br>■ Clarity on validity of pricing is missing.<br>■ Made inline to SATAT model i.e. price realization of ~80% at time of launch of scheme | | | | | |

CBG-CGD synchronization has issues of taxation as CNG falls under VAT umbrella whereas CBG is a part of GST, thus creating an accounting complication for players.

*Source: EAC's Primary Research with CBG units*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## CBG Offtake – Challenges

Implementation challenges are limiting the application of supportive policies and are needed to be fine tuned for the expected exponential growth to materialize.

### 1. Taxation

- CBG is under the purview of GST whereas CNG is under VAT. No clarity available to players how will the offset happen; compliance is difficult with two guidelines in case of synchronization

### 5. OMC's margins

- Under SATAT, profit of OMCs has been linked to the RSP of CBG, different to the model followed in CNG where it is fixed. The % margin model could be considered a bias towards OMCs against producers


### 2. Infrastructure

- Pipeline infrastructure for CBG injection is not ready; companies can meanwhile sell through ROs however 100% Offtake from medium to large CBG units is feasible ONLY via pipeline injection

### 4. Storage

- Demand variation will lead to the requirement of additional cascades for storage thus increasing the total cost

### 3. Production vs. offtake mismatch

- Multiple producers complained of erratic fluctuation in the biogas requirements from OMCs as such creating uncertainty and leading to flaring of extra gas produced

SATAT scheme and the CBG CGD synchronization plan were introduced to facilitate biogas producers who need not worry about the offtake, but the implementation is creating dissatisfaction amongst the producers who believe they have got the short end of the deal owing to erratic demand expectations and price insensitivity.

> ***"SATAT scheme and the CBG-CGD synchronization plan were introduced to facilitate biogas producers who need not worry about the offtake, but the implementation is creating dissatisfaction amongst the producers who believe they have got the short end of the deal owing to erratic demand expectations and price insensitivity."***
>
> *- Multiple producer companies' stakeholders*

*Source: EAC International Consulting*

# PRIMARY INSIGHTS AND EAC ANALYSIS

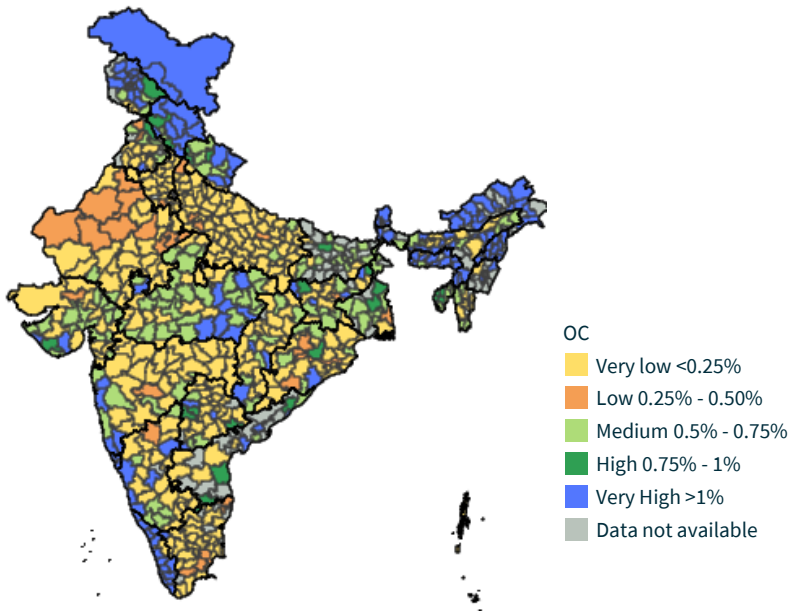
## Fermented Organic Manure – Indian Soil Status Quo

Soil health can be determined by percentage of organic carbon, macro- and micronutrients, and micro- and macro-organisms present in the soil, bulk density, water holding capacity, pH and electrical conductivity.

Disproportionate usage of NPK fertiliser, overuse of (N) fertilizer and aggressive crop cultivation has severely depleted the Indian soil of its organic carbon content.

85% of Indian soil is declared deficit in organic carbon levels falling in the categories of 'very low', 'low' or 'medium', according to 'soil health map' published during the period of 2015–16 to 2018–19 by government sources.

**SOIL HEALTH MAP FOR SOIL ORGANIC CARBON (SOC)**




- Organic carbon content, the main component of soil organic matter, has declined to 0.3% from 1% over the last 70 years
- Loss of soil organic carbon content limits soil's ability to provide nutrients for sustainable plant production. The main reasons for decline in carbon levels in Indian soil are:
  - Consumption of chemical fertilizers per hectare has been increasing in India
  - Crop pattern (wheat, rice rotation) – both crops are heavy consumers of macro- and micro-nutrients
  - Expansion of irrigation facilities – especially lifting the ground water through tube wells and pump sets

*"The overuse of chemical fertilizers and the lack of use of organic fertilizer is deluding the soil of its natural carbon and the soil can't grow crops without carbon. FOM sellers are required to persuade farmers to buy organic fertilizers, make them understand why they need to use it and ultimately price influences their decision, and they have no incentive for buying"*

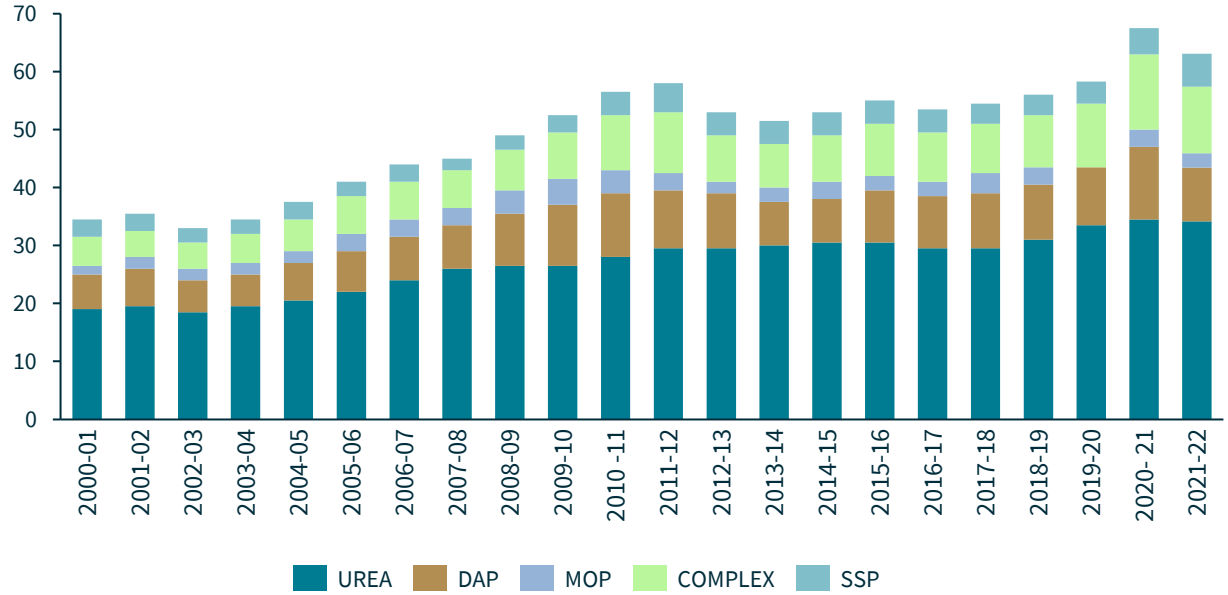
*- Kevin Houston, Carbon Masters*

*Source: Soil Health Card – 2015-16 to 2016-17, State of Biofertilizers & Organic Fertilizers in India*

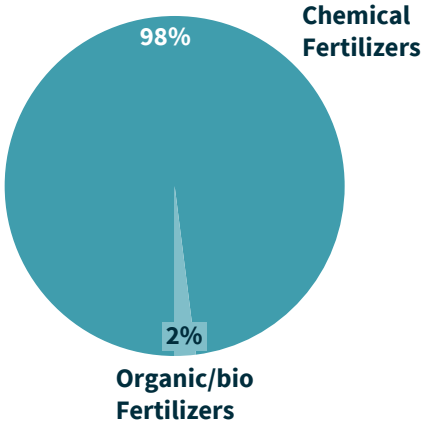
# PRIMARY INSIGHTS AND EAC ANALYSIS

## Fermented Organic Manure – Fertilizer Consumption

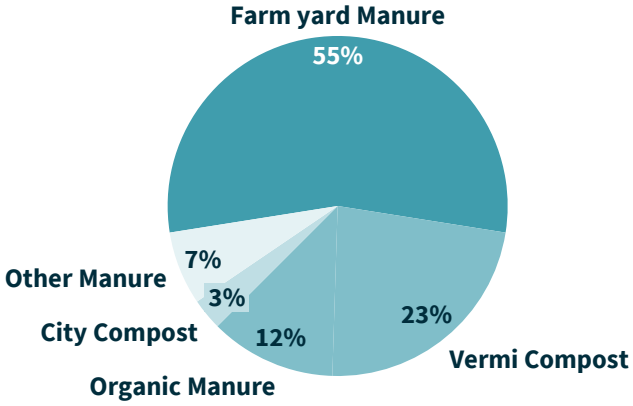
### ANNUAL CHEMICAL FERTILIZER CONSUMPTION (IN THSD TON) FROM FY'01 TO FY'22




**Indian Fertilizer Market**
65.3 MMTPA in **FY'22**




**Organic Fertilizer Market by Volume**
1-2% of overall Indian Fertilizer




- Consumption of chemical fertilizers has almost doubled to 64 MMTPA in FY'22 from 34.5 MMTPA in FY'01
  - Share of nitrogen to overall fertilizer is more than 50%
  - Over exposure of nitrogen reduces carbon content causing nutrient imbalance in the soil which ultimately impacts the soil quality resulting in lower yields
- Organic fertilizer occupies a negligible share of less than 2% of total fertilizer market share in India
  - Farmyard manure is the leading source of organic fertiliser – Karnataka and Chhattisgarh are leaders

*Source: Ministry of Agriculture and Farmers' Welfare, Government of India*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Fermented Organic Manure (FOM) – Soil Replenishment

Fermented Organic Manure (FOM) produced through CBG plants, which work on principles of circular economy, can act as potential solution to replenish low SOC levels.

Using FOM from these units, will complete the carbon cycle. currently, approx. 220 TPD of FOM is generated through the operational CBG plants in India.

Moisture, C:N ratio, and pH in solid FOM are three parameters found to deviate as per the FCO norms across various feedstock used in CBG plants.

FOM generated has high OC ranging from 35-50% which can replenish low SOC Levels. Advantages include:

- Improved SOC levels can lead to soil replenishment by reducing nitrogen leaching
- Every increase of 1% soil organic carbon will reduce 100 thsd tons of $CO_2$ per acre from environment

***i) Solid FOM specifications based on feedstock used and its comparison to FOM as per FCO[1] Norms:***

| | | | Punjab | Punjab | Madhya Pradesh | Tamil Nadu | Punjab |
|---|---|---|---|---|---|---|---|
| | | | Agri-residue (Paddy straw) | Paddy straw compost | Organic fraction of MSW | Press mud & chicken litter | Press mud & paddy straw |
| Sr. No. | Parameters | FOM-FCO Norms | Results | Results | Results | Results | Results |
| (i) | Moisture% by weight | 30-40% (max.) | 65.5-78% | 61.4% | 45.1% | 41.3% | 67.7% |
| (ii) | NPK Nutrients - Total N, P2O5 and K2O nutrient should not be less than (on dry basis) | 1.2% | 2.0-3.3% | 1.3% | 4.1% | 7.2% | 2.1% |
| (iii) | Total Organic Carbon (minimum) on Dry Basis | 14% | 34-40% | 50.5% | 41.2% | 26.7% | 50.7% |
| (iv) | C:N Ratio | <20 | 36- 54 | 130:1 | 32:1 | 8:1 | 26:1 |
| (v) | Particle Size | Minimum 90% should pass through 4 mm IS Sieve | 100% pass through 3.3 mm sieve | 91% pass through 4.0 mm sieve | - | 98% material pass through 4.0 mm sieve | 100% material pass through 4.0 mm sieve |
| (vi) | pH | 6.5-8.0 | 8.7 | 8.4 | 8.4 | 7.9 | 8.4 |
| (vii) | Pathogens | NIL | - | Present | - | - | - |
| (viii) | Conductivity(as dS/m)not more than | 4 | 0.3 | 3.7 | 4.8 | 2.6 | 0.3 |
| (ix) | Arsenic as (As2O3) | 10 | Not detected | 0.5 | 1.2 | Not detected | Not detected |
| | Cadmium (as Cd) | 5 | Not detected | 0.1 | 1.1 | Not detected | Not detected |
| | Copper (as Cu) | 50 | 8.0 | 2.4 | 47.8 | 49.3 | 21 |
| | Chromium (as Cr) | 300 | 8.3 | Not detected | 14.5 | 29.6 | 2.7 |
| | Mercury (as Hg) | 0.15 | Not detected | Not detected | Not detected | 4.9 | Not detected |
| | Nickel (as Ni) | 50 | 34.3 | 0.5 | 8.6 | 98.7 | Not detected |
| | Lead (as Pb) | 100 | 133 | 0.4 | 66.5 | 9.9 | 6.5 |
| | Zinc (as Zn) | 1000 | 71.8 | 10.1 | 145.7 | 187.4 | 70.4 |

*1) Fertilizer Control Order*

*Source: EAC's Primary Research with CBG units*

pH in liquid FOM is the parameter found to have deviated as per the FCO norms across various feedstocks used in CBG plants.

***ii) Liquid FOM (Slurry) specifications for CBG plants & Liquid FOM as per FCO[1] norms***

| | | | Paddy straw | Organic fraction of MSW |
|---|---|---|---|---|
| **Sr. No.** | **Parameters** | **FOM-FCO Norms** | **Results** | **Results** |
| (i) | Moisture% by weight | 90-97% (max.) | 97.8% | 95.5% |
| (ii) | NPK Nutrients- Total N, P2O5 and K2O nutrient should not be less than (on dry basis) | 1.2% | - | 1.5% |
| (iii) | Total organic carbon (minimum) on dry basis | 14% | 0.6% | 8.2% |
| (iv) | C:N Ratio | <20 | - | - |
| (v) | pH | 6.5-8.0 | 8.9 | 7.9 |
| (vi) | Conductivity (as dSm-1) not more than | 4 | - | - |
| (vii) | Heavy metal content, (as mg/kg), maximum on dry basis | | | |
| (viii) | Arsenic as (As2O3) | 10 | 1.2 | Not tested |
| (ix) | Cadmium (as Cd) | 5 | 0.1 | Not tested |
| | Copper (as Cu) | 300 | 7.1 | Not tested |
| | Chromium (as Cr) | 50 | 1.5 | Not tested |
| | Mercury (as Hg) | 0.15 | Not detected | Not tested |
| | Lead (as Pb) | 100 | 0.91 | Not tested |
| | Zinc (as Zn) | 1000 | 34.1 | Not tested |

- Currently, majority of FOM produced by CBG producers is disbursed to farmers in the catchment area (<30 Kms) of their plants
- FOM is supplied in 'as is' form & in 'bulk & loose' form at minimal price point or free of cost
- Some CBG producers are processing their FOM as per FCO norms and marketing it through fertilizer marketing companies (FMCs) 'in bag' form but still struggling with demand & right price
- CBG producers like Verbio are further thinking of developing high value product (better price and better demand in comparison to organic manure) like PROM using FOM produced

*1) Fertilizer Control Order*

*Source: EAC's Primary Research with CBG units*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Fermented Organic Manure – Industry Takeaways

CBG producers are facing challenges in terms of FCO categorization of FOM, lack of market demand; revision in FOM categorization under FCO and, MDA and offtake support are recommendations from CBG producers.

### Redefine FOM under FCO Norms

**Challenges:**

- FOM produced in 'as is' form i.e., at high moisture doesn't comply to FCO norms Organic manures having sub standard quality are sold in market at unrealistic prices which eventually declines farmers interest for recurring demand

**Industry Takeaways:**

- Broaden/adapt existing FCO standards or amend/ create exception for inclusion of FOM in 'as-is' form from CBG units
- To include FOM as per FCO Norms in terms of NPK composition, FCO norms should be broadened in terms of moisture (60-80%), C/N ratio (<60) & pH (6.5-9) due to process and raw material involved in CBG units
- As FOM generated from CBG units is source of organic carbon and not NPK, FCO should be amended to include FOM where it should qualify on basis of its rich organic carbon content and should not contain heavy metals content over maximum limit prescribed in FCO

### Create Market Awareness for FOM

**Challenges:**

- Lack of market demand for organic manures due to:
  - Easy availability of low cost (highly subsidized) chemical fertilizers like urea
  - Gap in recommended practices and implementation at ground level
  - Lack of awareness with large section of farmers

**Industry Takeaways:**

- FMCs should be instructed for mandatory offtake of FOM generated through CBG plants in the catchment areas of these units
- ICAR should be appointed as nodal agency for mapping & validating FOM production from CBG units and on basis of the ICAR approval monetization to be established

### Promote FOM using Government Support

**Challenges:**

- Government has over the years launched several schemes to aid production of organic fertilizers however the overall impact of these attempts are overshadowed by the subsidies received for chemical fertilizers

**Industry Takeaways:**

- Provide 'Market Development Assistance' (MDA) for generated FOM till it achieves commercial market acceptance
- FOM product cost could vary from INR 3 per kg to INR 5 per kg (depending on production cost and process deployed) on an 'as-is' basis hence Indian Government should consider providing maximum relief to producers

*"ICAR is going to play the most vital role as a nodal agency in revisiting the current FOM standards across various feedstocks and providing recommendations accordingly. Furthermore, it would increase farmer and public awareness of the benefits of FOM."*

- Sanjeev Nagpal, Sampurn Agri Ventures Private Limited

*Source: EAC's Primary Research with CBG units*

# PRIMARY INSIGHTS AND EAC ANALYSIS

**Carbon Credits – India and Global climate leadership**

India has consistently made its targets more stringent to reduce its emission intensity and move towards long term goal of net zero by 2070.

**INDIA'S VOLUNTARY PLEDGE COPENHAGEN-2009**

- Voluntary target of reducing the emission intensity of our GDP growth by around 20%-25% by 2020 in comparison to 2005
- National action plan on climate change
- Improving energy efficiency by 20% by 2020 and
- Adding an additional 6 million hectares of forests over the next several years

**Copenhagen (COP 15)**

**INDIA'S FIRST NDC SUBMISSION (2016)**

- To reduce the emissions intensity of its GDP by 33 to 35% by 2030 from 2005 level
- To achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030
- To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030

**Paris Agreement (COP 21)**

**INDIA'S UPDATED NDC (2022)**

- To reduce emission intensity of GDP by 45% by 2030, from 2005 level
- To achieve about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030
- Long term goal of reaching net-zero by 2070
- Mass movement for 'LIFE'– 'Lifestyle for Environment as key to combat climate change

**Glasgow (COP 26)**

India's emission intensity of gross domestic product (GDP) has reduced by 24% between 2005 and 2016. Renewable energy has a share of 40.2% as (incl. Hydro) in the total installed generation capacity in the country.

*Source: EAC International Consulting*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Carbon Credits – An Introduction

Carbon markets are trading systems in which carbon credits are sold and bought. Compliance carbon market (e.g., CDM, Paris Agreement Article 6.4, EU-ETS) and voluntary carbon markets (Verra, GoldStandard etc.).

Project developers

- Design and implement carbon offset projects that generate carbon credits that represent emission reductions or removals

Standards bodies

- Organizations that certify and set the criteria for carbon credits e.g., Verra and the Gold Standard

Brokers

- Intermediaries facilitating carbon credit transactions between buyers and project developers. e.g., Carbon place, Climate Impact X (CIX), Air Carbon Exchange (ACX), Carbon Trade Exchange (CTX)

End buyers

- Entities such as individuals or corporation looking to offset their carbon emissions through purchasing carbon credits

Carbon Credit
also referred to as a carbon offset


One carbon credit

One metric ton of GHG emissions

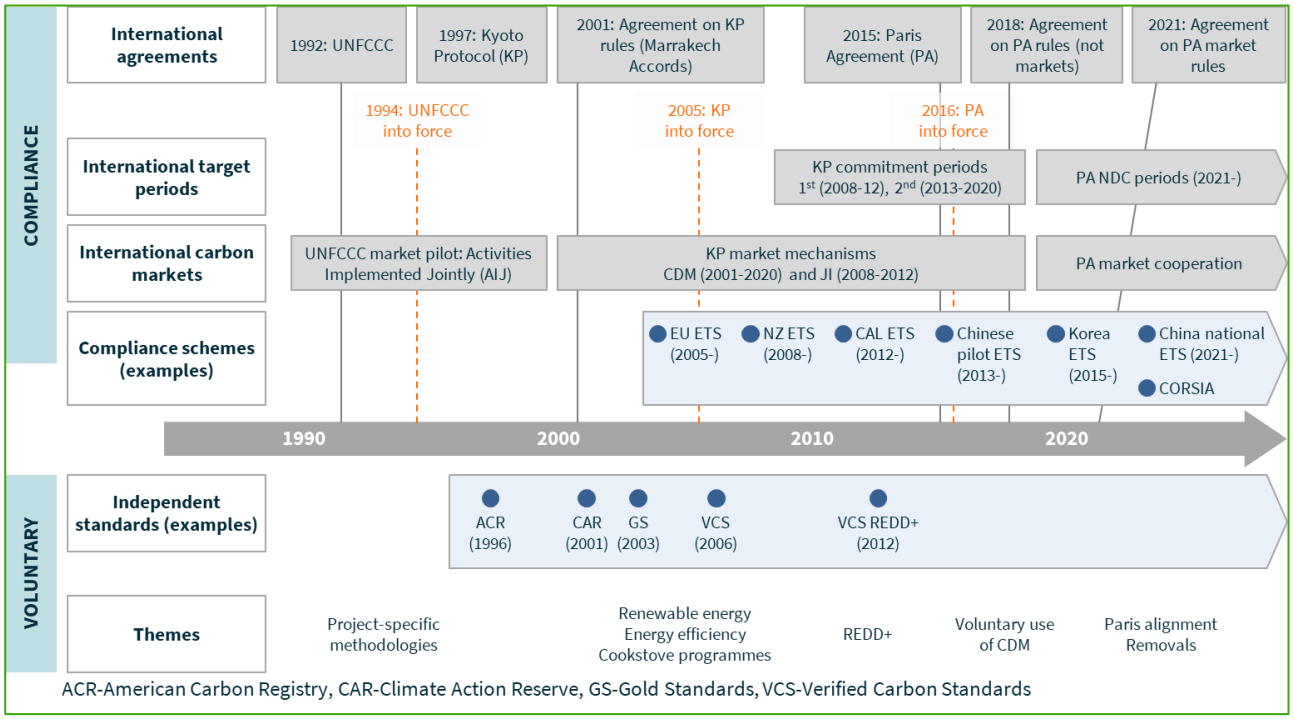
A carbon credit can be sold multiple times until it is retired by the end user that wants to claim that credit's impact

*Source: Visual Capitalist, EAC International Consulting*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Carbon Credits – Market Development

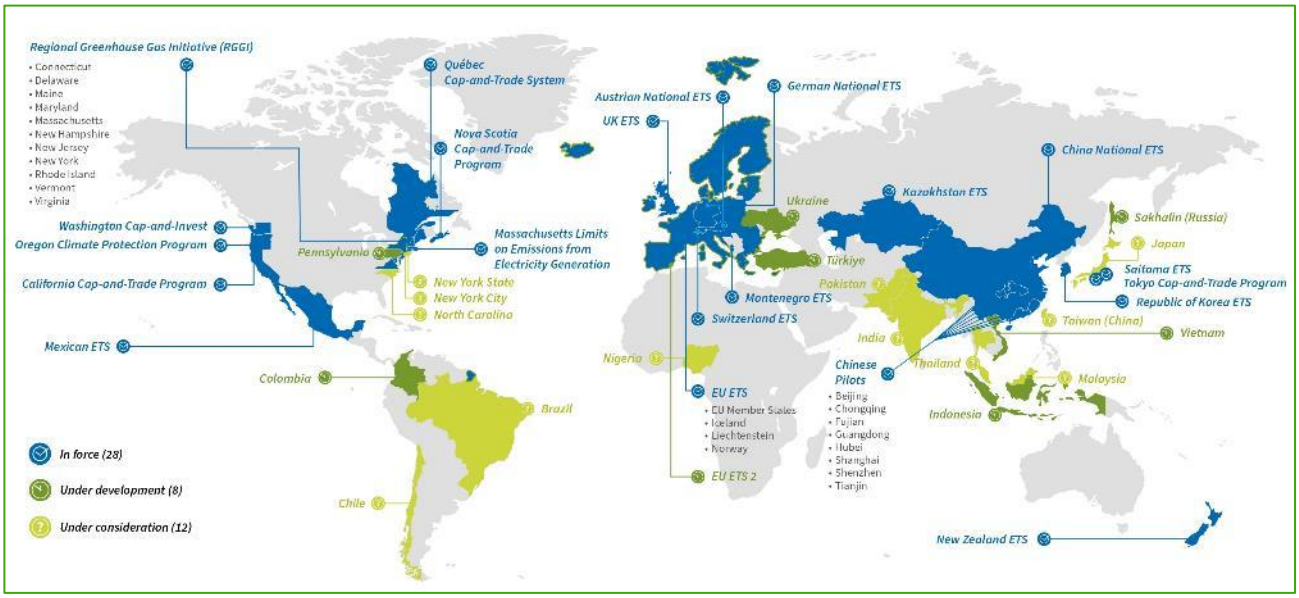
International agreements and countries/ corporations committing to carbon neutrality have spurred carbon credits/ offset market, comprising of compliance (mandatory) and voluntary markets.




ACR-American Carbon Registry, CAR-Climate Action Reserve, GS-Gold Standards, VCS-Verified Carbon Standards

## GLOBAL EMISSION TRADING SCHEME

*The number of ETS in operation has grown to 28, covering 9 GT which is 17% of global emissions, another eight are under development and expected to be in operation in the next few years.*

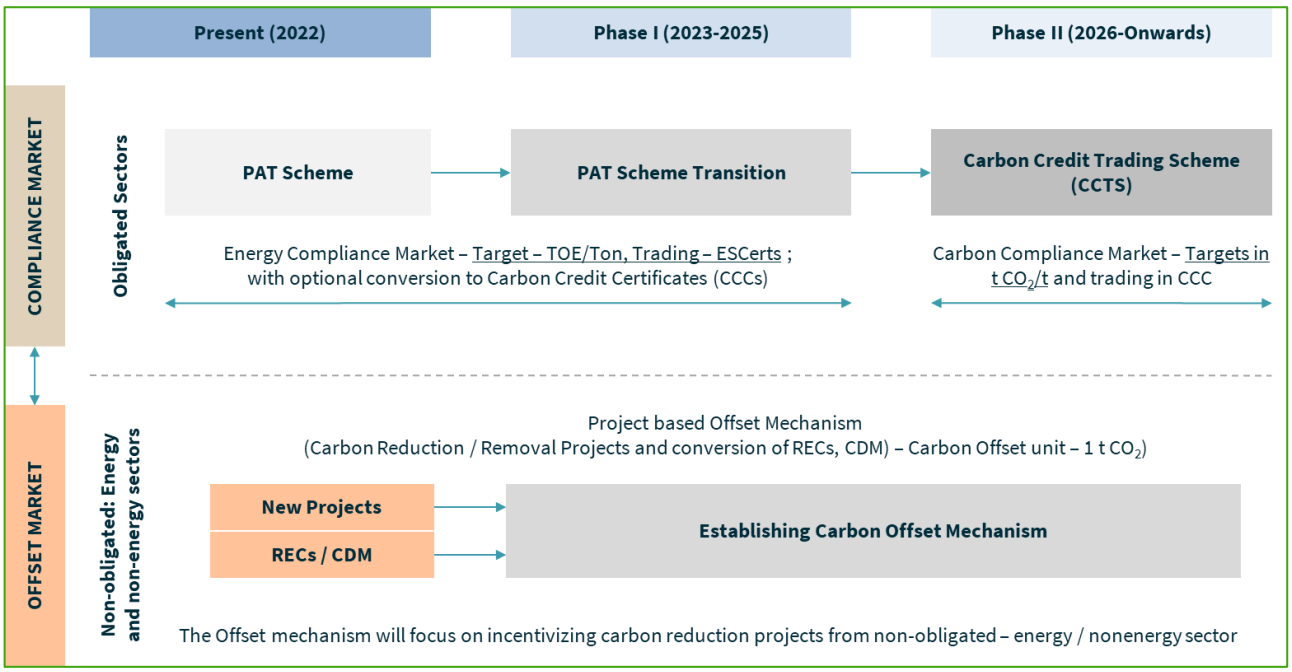



*Source: Perspective Climate group, ICAP Status Report 2023*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Carbon Credits – Trading Scheme (India)

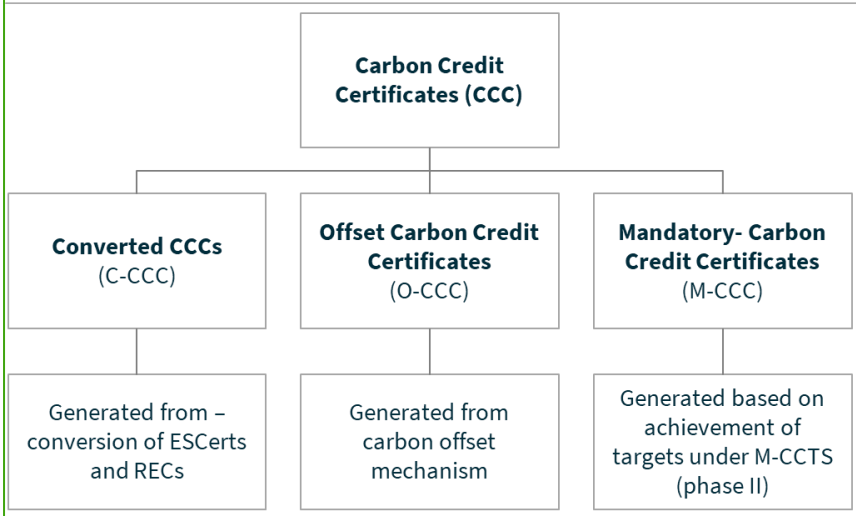
India is the world's second largest developer and supplier of Carbon Credit Transition of existing PAT scheme and REC Mechanism in Carbon Credit Trading Scheme (CCTS).




### TYPES OF CERTIFICATES AVAILABLE

The voluntary (offset) market is expected to enter into force by July 2023, followed by the compliance market. According to current plans, the first compliance cycle would begin in 2024.

**TYPE OF CERTIFICATES UNDER ICM**




ICM will have a single uniform metric– 1 tonne of $CO_2$ equivalent ($tCO_2e$) as its fundamental trading unit under any ETS

- CCCs – Characteristics
  - Additional
  - Based on a realistic and credible baseline.
  - Quantified, monitored, reported, and verified.
  - Transparent chain of custody.
  - Represent permanent emissions reductions.
  - Are only counted once towards a mitigation obligation.
  - No negative externalities on environment

*Source: EAC International Consulting*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Carbon Credits – CBG producer's relevance

Availability of CBG -specific methodologies is essential for harnessing carbon markets; residue biomass based CBG production is considered for illustration purposes.

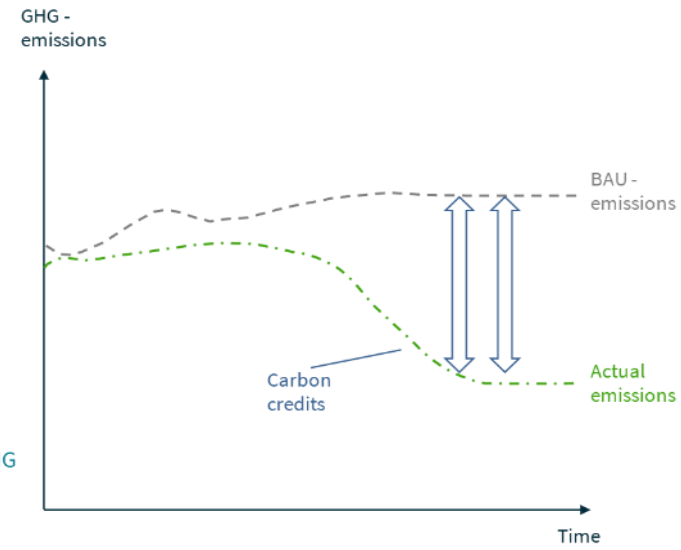
- **AMS-III.AQ under CDM** methodology outline detailed procedures for quantifying the actual GHG benefits of a project.
- It is applicable for use of Bio-CNG in transportation applications ]
- The emission reductions achieved by the project activity shall be calculated as the difference between the baseline emissions and the sum of the project emissions and leakage.

$$ER_y = BE_y - PE_y - LE_{BIOMASS,y} + LE_{PROCESS,y,FF}$$

Where:

$ER_y$ = Emission reductions in the year $y$ (t $CO_2e$)

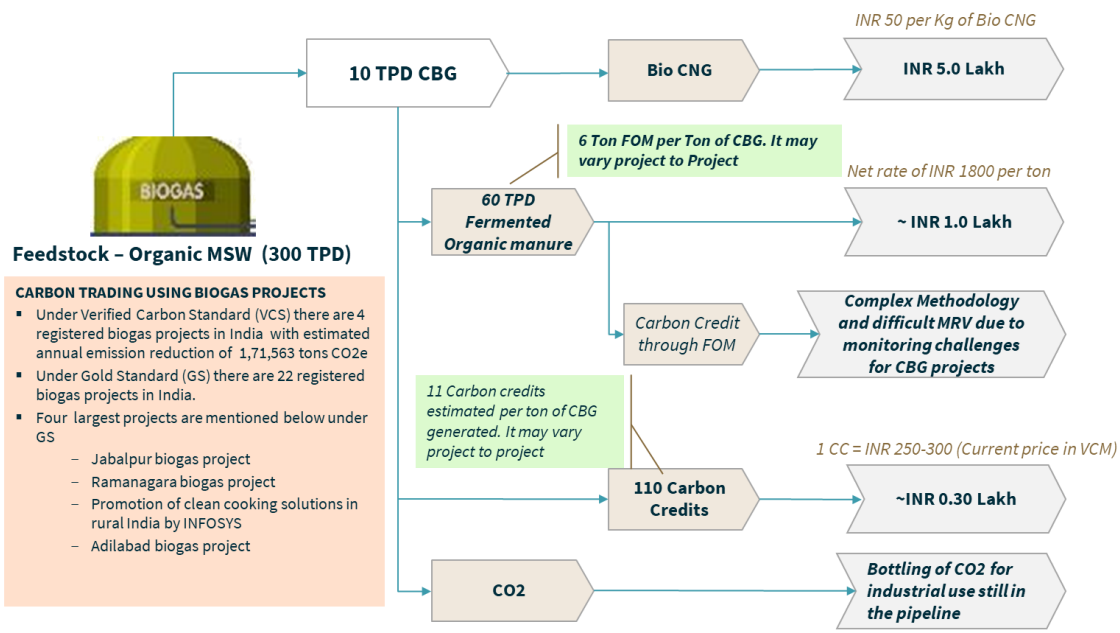
Each carbon credit can be sold if
(CAPEX + OPEX – Carbon Credit) CBG ≤ (CAPEX + OPEX) CNG




| Emission reductions | = | Baseline emissions | - | Project emissions | = | Carbon credits |
|---|---|---|---|---|---|---|

### INDICATIVE REVENUE CALCULATIONS

Carbon Credit Certificates as additional revenue streams for CBG producers. Please find below indicative revenues from organic MSW feedstock based 10 TPD CBG plant.

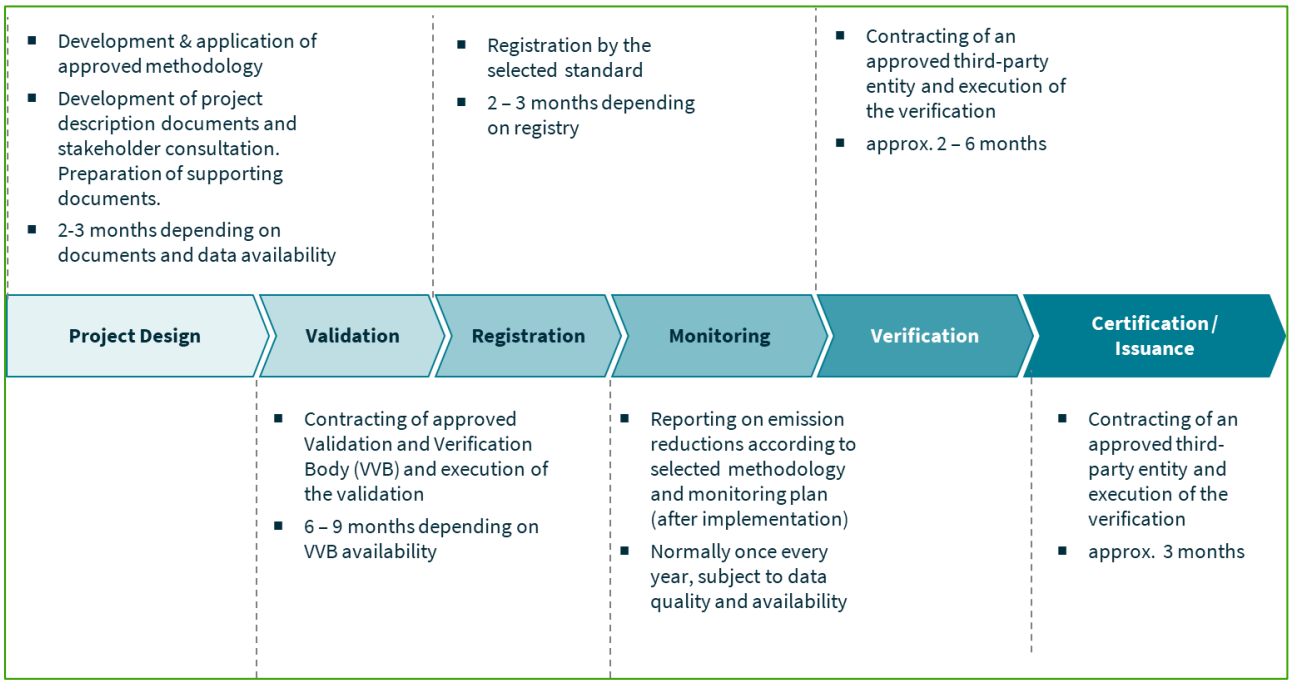



*Source: EAC International Consulting*

# PRIMARY INSIGHTS AND EAC ANALYSIS

## Carbon Credits – Normal Project Timeline

Key steps and indicative timeline from project concept design to issuance of carbon credit are detailed below. It is estimated to complete the whole carbon cycle between 12 to 18 months.




***Carbon Credits can be claimed under FOM theoretically as methodologies exists for generating Carbon Credits through increase in SOC level but practically very challenging as currently monitoring the SOC level is difficult"***

***- Rachit Verma, EVI***

***If FOM is sold to different farmers having their own land, it would be difficult to monitor the verification of GHG emission reduction and is not cost-effective to get carbon credit.***

***- Rohit Vakkalagadda, Enking***

***From a plant generating 1 TPD CBG for 300 to 320 days about 3000 to 3500 Carbon Credits can be generated (based on output on the basis of input different feedstock will lead to different credit generation).***

***- Rohit Garg, South Pole***

*Source: EAC International Consulting*

# CASE STUDIES
## Business Snippets and Challenges

### Industry Case 1 – Paddy Straw feedstock

## SNIPPETS

**SUPPLY SECURITY** I
- Challenges in terms of
  - Information on collectable potential of feedstocks
  - Identification & allocation of feedstock catchment
  - Forecasting of evolving cropping pattern

**OFFTAKE MODEL - RO** II
- Non-continuous sale but continuous production so matching of production-sale curve is not realistic
- Huge logistics cost for serving multiple RO due to small volumetric demand

**OFFTAKE MODEL – LINE** III
- Risk of Supply Demand curve & Fluctuation will be eliminated with expected line implementation
- Better alternate for producers as of today is to supply through ROs but high logistics cost is involved

**CARBON CREDITS** IV
- Carbon credit can be availed for production of cleaner fuel i.e. CBG but reduction in pollution due to raw material collection cannot be claimed

**TAXATION** V
- Taxation issue in blending; there is no clarity on How documentation, GST & VAT will be offsetted
- CGD need better clarity as any taxation issue/ non-clarity will result in their hinderance on blending

## CHALLENGES AND RISKS

- Key risk related to feedstock: Ensuring continuous supply with required quality and storage risk (fire, rain etc)
- 20-50% daily fluctuation on maximum & minimum offtake volume resulting in flaring of CBG
- Average sale per Retail Outlet (RO) is 900-1200 kg per day which is non profitable for CBG producer, CGD, OMC & Dealer
- Absence of a regulated platform for Carbon credits
- Sales of FOM is miniscule, advantages against NPK fertilizers not clearly passed down to the customers
- Taxation structure – GST and VAT applicability and offset

*Supply is not continuous for agri feedstock-based biogas producers. The raw material/feedstock is sourced based on the seasonality (different crops over year) and needs to be stored for the rest of the year*

*Source: EAC's Primary Research with CBG units*

# CASE STUDIES
## Business Snippets and Challenges

### Industry Case 2 – Straw + Pressmud feedstock

## SNIPPETS

**SUPPLY SECURITY** I
- Press mud and paddy straw is used as per availability
- Feedstock is collected in the window of October and March must be stored for the rest of the year

**STORAGE** II
- Storing of press mud and paddy straw poses a challenge since it can decay easily
- Challenge of storing the feedstock away from moisture

**OFFTAKE MODEL - RO** III
- Sales through own retail outlet ~ 3- 5 MT CBG/ day
- Excess gas is supplied to sister concern since it must otherwise be flared due to storage constraints

**CUSTOMER** IV
- Currently operating through own RO, sold to consumers directly
- Sister concern sells excess gas to industrial customers

**FOM** V
- FOM is given in loose form to nearby farmers for free
- Dryer/ Sundrying is not implemented since it's a cost and cannot be compensated by the current acceptability of FOM

## CHALLENGES AND RISKS

- Performance issues are faced due to variation in the feedstock quality
- Supply and storage risk
  - Collection happens through the company and is a cost
  - Window for feedstock collection is small thus everything needs to be stored for the rest of the year
- Selling of biofertilizers is a challenge as the digestate gets decomposed in 20 days
- Paddy straw is very corrosive to the machinery
- Land maintenance cost is too high

*Aggregation is done through balers; farmers are not directly contacted in most cases procurement of straw is done in form of bales. Small size tractor trailers used to transport the feedstock within 10 km range.*

*Source: EAC's Primary Research with CBG units*

# CASE STUDIES
## Business Snippets and Challenges

### Industry Case 3 – Cow dung feedstock

## SNIPPETS

**SUPPLY SECURITY** (I)
- Procures the cattle dung from the farmers living in 10 km radius of the plant
- Feedstock supply is continuous

**FEEDTSOCK QUALITY** (II)
- Sand and silt in the feedstock is a challenge
- No storage involved - entire quantity of feedstock is utilized on daily basis

**OFFTAKE MODEL** (III)
- Sales through own ROs
  - better revenue and autonomy
- Produced quantity from existing plant gets completely sold

**DEMAND OUTLOOK** (IV)
- Plans to set up additional plants; will have issues of demand stability vs. production

**CARBON CREDITS** (V)
- Not a focus in the immediate short term
- Financial evaluation is ongoing

## CHALLENGES AND RISKS

- Quality of feedstock
  - Presence of excess Sand and silt
- Maintaining pressure while transporting CBG to RO through pipeline
- Average sale per Retail Outlet (RO) is 750-800 kg per day which is non profitable for CBG producer, CGD, OMC & Dealer

*Most companies EAC talked with are aware of the concept of Carbon Credits and have done rough calculations on possibilities and amount of credit that can be claimed but are wary of the investment they will need to make, especially for smaller sized players*

*Source: EAC's Primary Research with CBG units*

# CASE STUDIES
## Business Snippets and Challenges

### Industry Case 4 – Pressmud and Chicken Litter feedstock

## SNIPPETS

| | |
|---|---|
| ***SUPPLY SECURITY*** I | ▪ Press mud is collected from sugar mills up to 150 km radius<br>▪ Chicken litter collected from nearby areas<br>▪ Consistent supply of feedstock |
| ***FEEDTSOCK QUALITY*** II | ▪ No influence over aggregating point therefore the quality of feedstock procured depends upon supplier side<br>▪ Fresh feedstock gives higher yield of CBG |
| ***OPERATION CONTINUITY*** III | ▪ Plant is operating consistently and has stopped only for maintenance<br>▪ No pre-treatment needed for pressmud |
| ***OFFTAKE*** IV | ▪ Contract with IOC<br>▪ Contract with local restaurants |
| ***FOM*** V | ▪ FOM is supplied to large fertilizer companies, large distributors and nearby farmers<br>▪ FOM generated needs to be processed further to meet FCO standard |

## CHALLENGES AND RISKS

- Unforeseen climatic conditions such as heavier rains than expected can delay operation of sugar mills
- To meet the FCO standards the company has to incur costs to process the FOM thus keeps the costs sometimes higher than the selling price of FOM
- Operations are loss making with current yield and in the absence of Carbon credits revenues

*Tamil Nadu has two seasons for sugarcane which starts from Nov to March and short second one from July to August due to which storage is only required for couple of months and the feedstock continuity is much better*

*Source: EAC's Primary Research with CBG units*

# CASE STUDIES
## Business Snippets and Challenges

### Industry Case 5 – Agri residue and Animal Waste feedstock

## SNIPPETS

**SOURCING** I

- Feedstock collection window
  - October to March for Agri residue
  - Animal waste throughout the year
- Aggregation is outsourced; feedstock is stored for the year

**CAPACITY** II

- 2.5X of current production can be achieved with existing capacity

**PRICING** III

- Slurry is sold at 50 INR/ litre or 40 INR/ kg in Punjab
- Similar slurry can be given away at 100 INR / 5000 litres in Southern Maharashtra because of storage issues

**OFFTAKE** IV

- Company uses biogas to produce power that they sell to the local power distribution company

**FOM** V

- Marketing of FOM can be carried out by educating user about the long–term benefits of FOM on crop heath & availability of earning credits by increasing SOC levels
- Market expansion to urban areas

## CHALLENGES AND RISKS

- Growth and acceptance amongst farmers for FOM is low
  - Clarity on the performance of FOM against chemical fertilizers is still unclear to the users
- Sales of FOM are affected, as marketing is difficult due to involvement of multiple agencies and non-uniform FOM composition compared to chemical fertilizers
- Forced to give away to nearby farmers almost free of cost

*Most biogas and CBG plants are struggling to dispose of their bio-manure. These plants are forced to store bio-manure for long periods, unless they are sold, leading to storage issues and cost*

*Source: EAC's Primary Research with CBG units*

# EAC SUPPORT OPTIONS

**Bridging the gap between your biogas plans and reality**

- ***Policy transparency and the impact of the changes*** *onto the business environment of a company in Indian biogas sector*
- ***Opportunity sizing*** *including* ***addressable market quantification*** *for CBG, FOM and Carbon credits and the offtake segments dynamics*
- ***Location identification & facility setup for CBG plant setup*** *in India and* ***facilitation of incentives discussions with government***
- ***Access support to technology partnerships and M&A*** *including target screening, due diligence, and deal finalization*
- ***Evaluation and supply network development for cost competitive feedstock sourcing***
- ***Business plan development and support*** *including assessment of Investment required, RoI, partners and cost and revenue streams*

## WANT TO KNOW MORE? CONTACT OUR EXPERTS


**Ketan Jadhav**
**+91- 96641 45856**

**Anup Barapatre**
**+91- 99670 29339**

**Rituraj Shailendra**
**+91- 79708 83049**


*Source: EAC International Consulting*

# WHERE YOU CAN FIND US – EAC AROUND THE GLOBE

## EAC MUNICH

**EAC - Euro Asia Consulting PartG**
Widenmayerstraße 29
80538 München

Phone +49 89 92 29 93-0
eac-muc@eac-consulting.de

## EAC SHANGHAI

**EAC - Euro Asia Consulting**
Sunyoung Centre, Rm. 801
398 Jiangsu Road
200050 Shanghai/ China

Phone +86 21 63 50 81 50
eac-sha@eac-consulting.de

## EAC MUMBAI

**EAC - Euro Asia Consulting Pvt. Ltd.**
704, Leela Business Park,
Andheri Kurla Road, Andheri (East),
Mumbai -400 059/ India

Phone +91 77 18 96 71 26/ 27
eac-mum@eac-consulting.de

## EAC Kuala Lumpur

**EAC - Euro Asia Consulting**
GBC Menara Hap Seng 2
Plaza Hap Seng, No. 1 Jalan P. Ramlee
50250 Kuala Lumpur

Phone: +60 43 9235 1800
eac-sea@eac-consulting.de

Find out more about EAC - www.eac-consulting.de