Leverage Technology Shifts in CBG to Enhance Energy Security

Presented at:
Conference on Leverage Global Innovation to Fuel CGD Growth in India
Organized by PNGRB & MNGL

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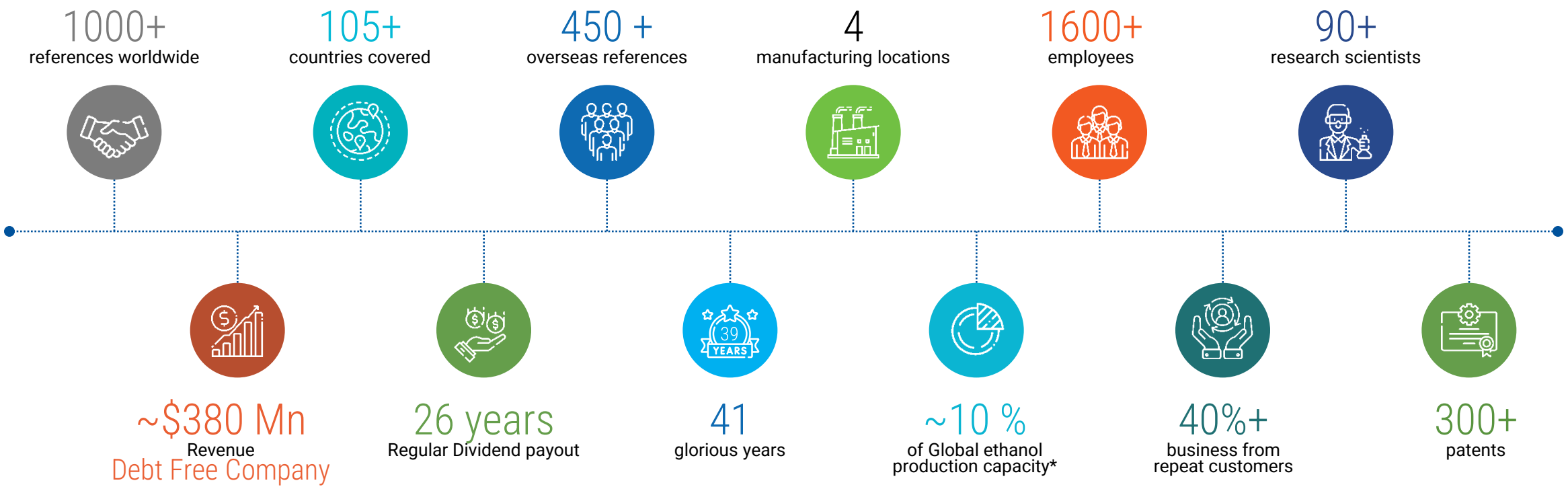
Praj Industries: Leading in Bio-processing Technology

Praj Industries is a leading bio-processing technology company with high synergies through the expertise in integrated offerings including plant, equipment and products that will enhance the quality of life.

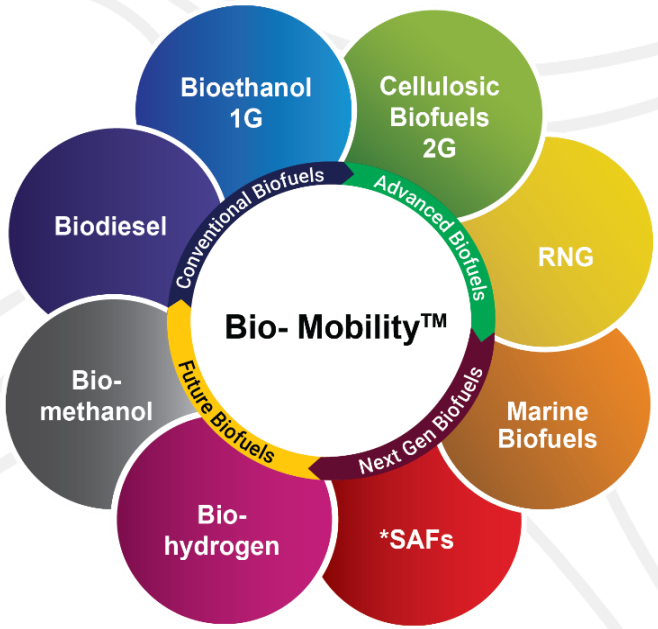


*excluding China

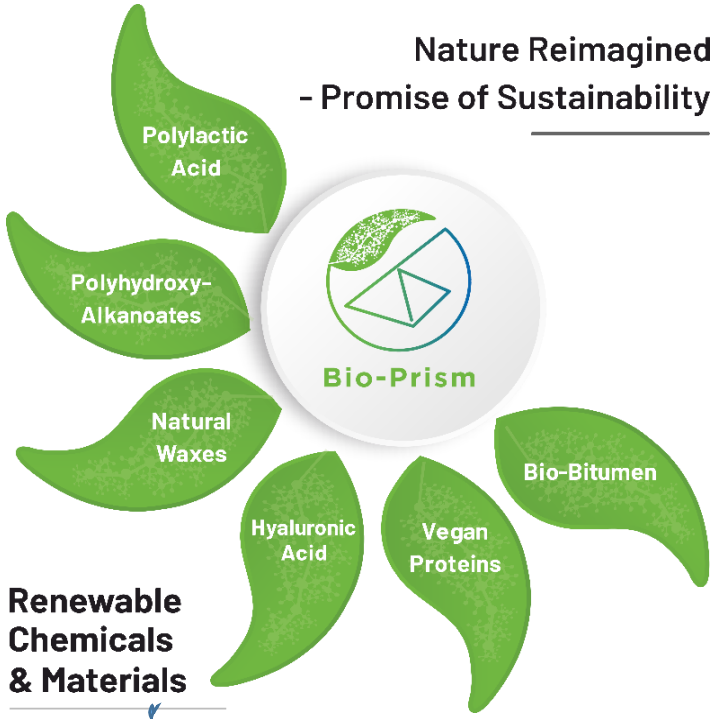
Praj's Products Portfolio in Bioeconomy

BIOECONOMY

Bio-Mobility™



Bio-Prism™

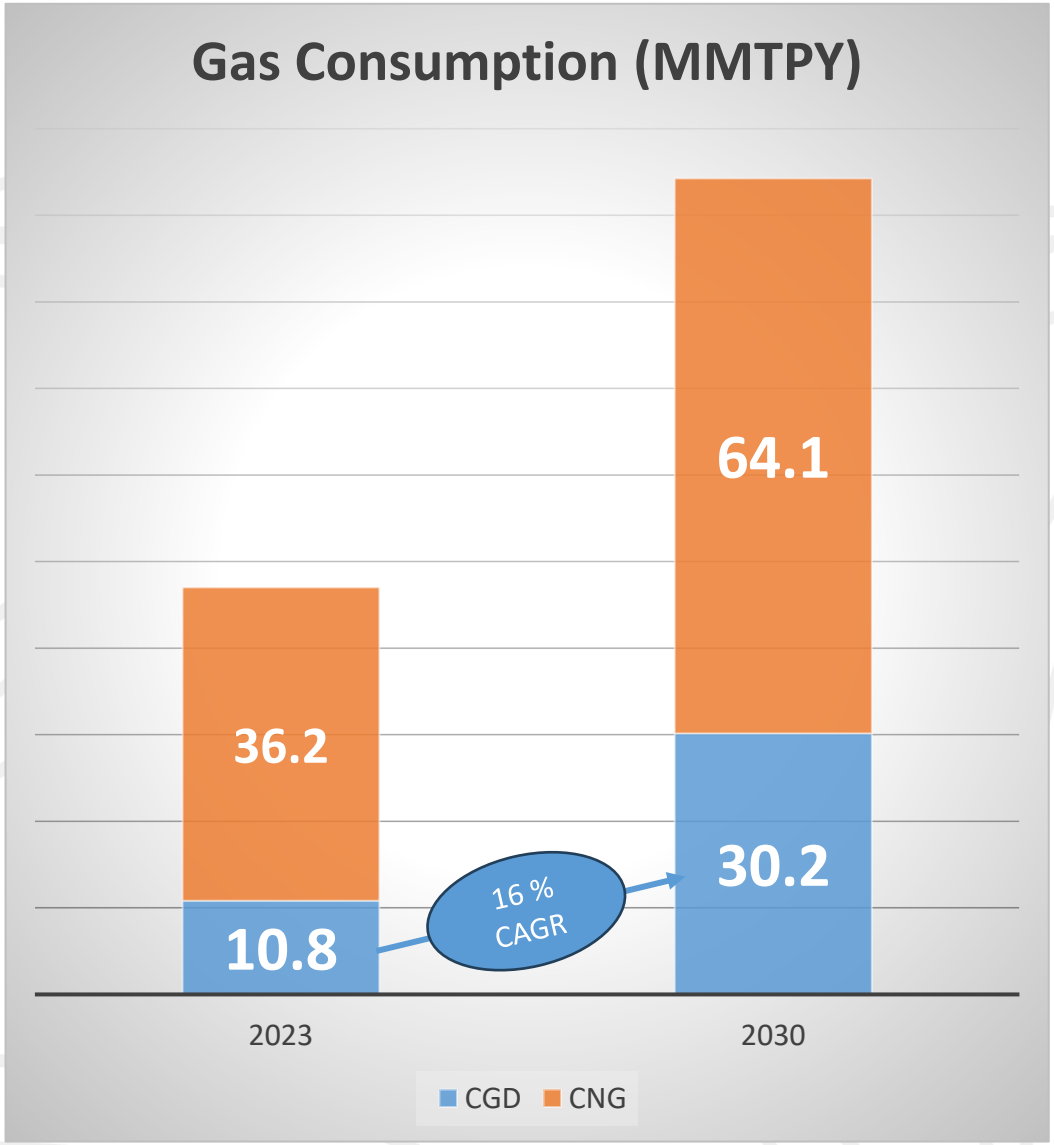


Decarbonization of Transportation and Industrial Sectors

Bio-refinery Complex

Bio-chemical Complex

Gas Consumption and Growing CGD's Share



- Targeted strategies and policy interventions could boost gas consumption beyond the forecasted trajectory to around 95 MMTPY by 2030.
- India's domestic gas production, which met 50% of demand in 2023, is expected to grow only moderately through 2030.
- India's LNG imports are set to more than double between 2023 and 2030, driven by steady demand growth and a much slower rise in domestic production.

To meet growing demand of Natural Gas, indigenous production of Compressed Biogas shall play a vital role with a **Strategic Impact on Energy Security** as below

- **Import Substitution**: Replacing just 20% of natural gas consumption with CBG could save an estimated **US$29 billion in LNG import bills** between 2025 and 2030.
- **Decentralized Power**: Unlike centralized fossil fuel systems, CBG plants provide localized energy solutions, protecting rural and industrial sectors from global price fluctuations.
- **Mandatory Blending**: India has introduced a **Compressed Biogas Obligation (CBO)**, mandating 1% blending in CNG/PNG from FY 2025-26, rising to **5% by 2028-29**. This creates a guaranteed market, de-risking long-term investments.

Source : iea : India Gas Market Report Outlook to 2030

Improved Techno – Commercial Viability of CBG Plant

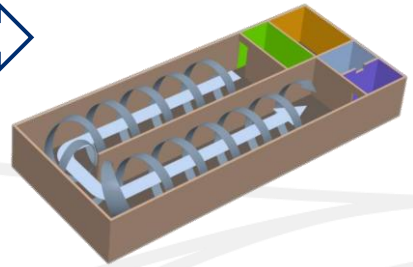
- India has seen rising interest & actual implementation of many CBG plants based on multiple feedstocks due to government drive with conducive policies.
- It is seen that plants are performing at desired output of CBG within acceptable technical norms in line with IS 16087.
- Pressmud, Spent Wash, Napier Grass & Paddy Straw have evolved as focused feedstocks
- Industry has gone through various learning cycles on technological aspects over last 2-3 years resulting in improved performance.
- Overall techno-commercial viability achieved in Pressmud, Spent Wash projects. Praj takes pride in 3 successful plants.
- Napier Grass & Rice Straw Plants have also reached closer to desired production.

CBG Process

Pressmud Pretreatment & Storage

Napier Grass Size Reduction, Pretreatment & Silaging

Agri-residue Storage & Size Reduction

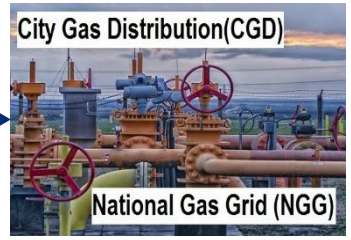


Anaerobic Digester

Biogas Cleaning

Gas Compression

Cascade



CGD Network

Solid – Liquid Separation

Bio-bitumen

Liquid Bio-Manure

Solid Bio-Manure

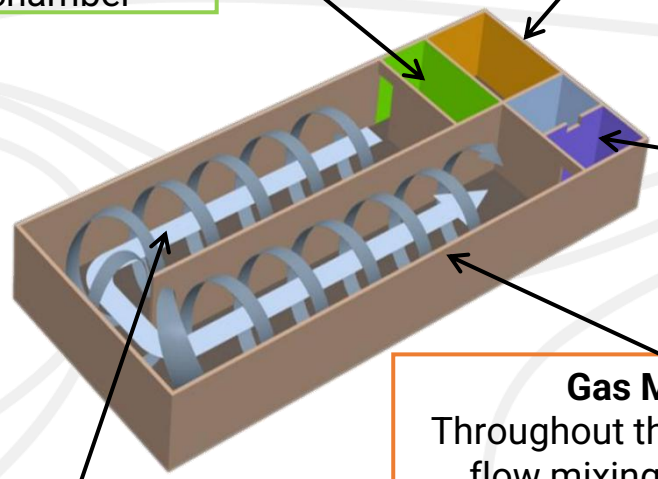
Technology Landscape

	Agri-Residue (Rice Straw)	Napier Grass	Press Mud
Front End	Material Handling Shredding Milling / Extrusion	Preservation – NG Treat Silaging Material Handling Milling / Extrusion	Preservation – PM Stab
Bio-Methanation	Wet Bio methanation via Advanced Horizontal Mixed Flow Reactor & CSTRs Dry Bio methanation is at a very nascent stage with capacity Limitation for large scale plant		
Gas Purification	H_2S Removal – Ion Chelate system CO_2 Removal – High Pressure Chilled Water system, Membrane system, PSA, VPSA		
Solid Liquid Separation	Two stage. Important for LFOM & SFOM	Two stage Important for LFOM & SFOM	Single stage Important for LFOM & SFOM
Co-Product Valorization	Solid Fertilizer Organic Manure Liquid Fertilizer Organic Manure Bio-Bitumen		

Advanced Horizontal Mixed Flow Reactor

Stage 1
Acidification chamber

Influent of fresh feed



Exit of digester effluent

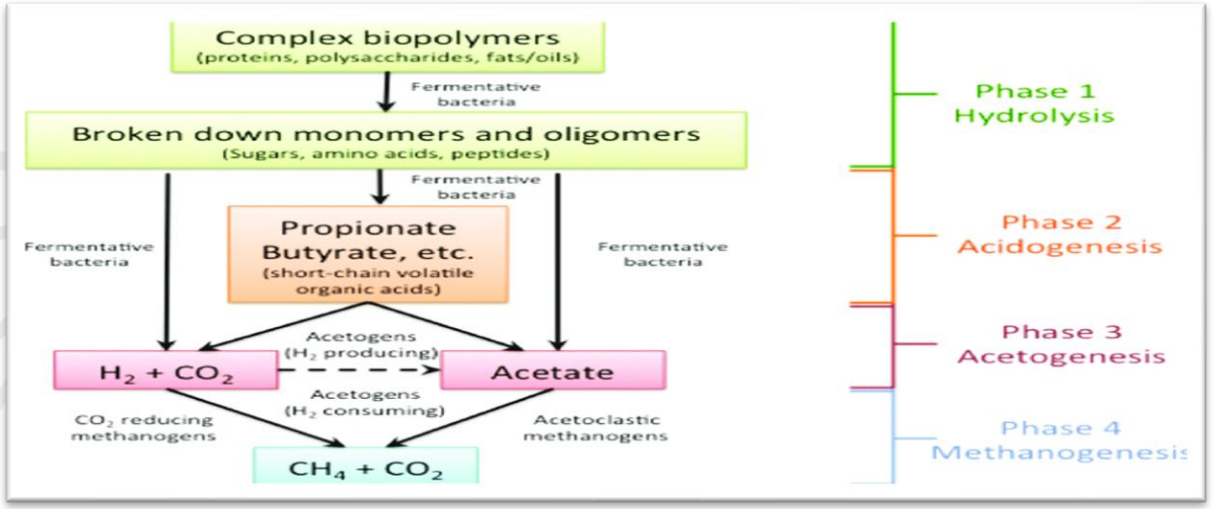
Gas Mixing
Throughout the longitudinal flow mixing occurs in a corkscrew fashion

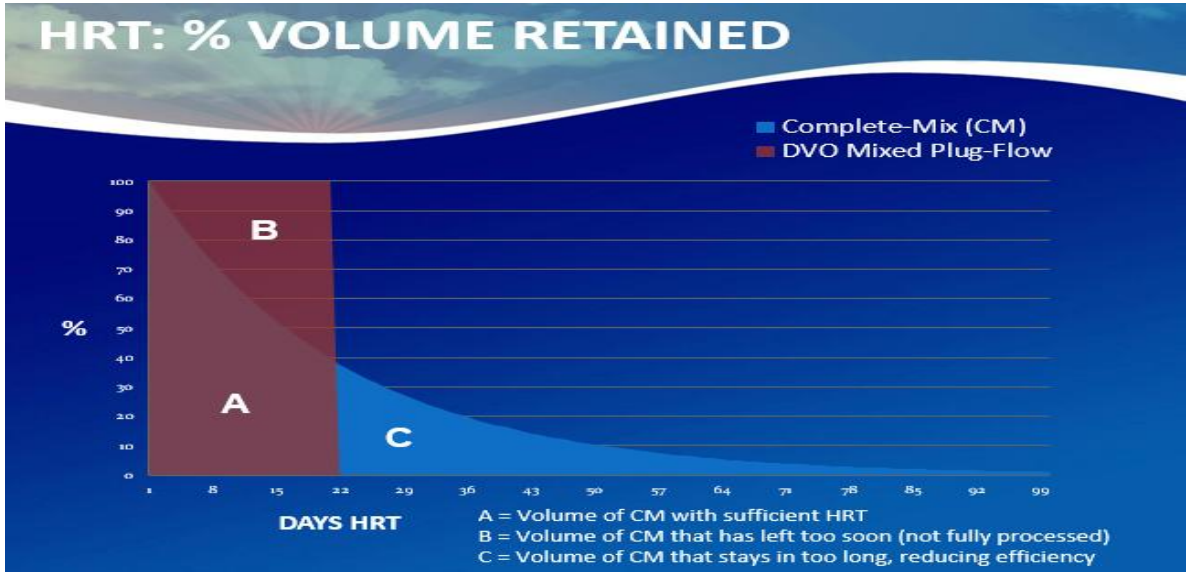
Stage 2
Methanogenic chamber with multiple stage temperature control & graded pH

Horizontal Mixed Flow Reactor

- Guaranteed retention time, high conversion
- High mass transfer with low power (Gas mixing)
- No settling / chocking – Nonstop year after year running

Bio-methanation Reaction:

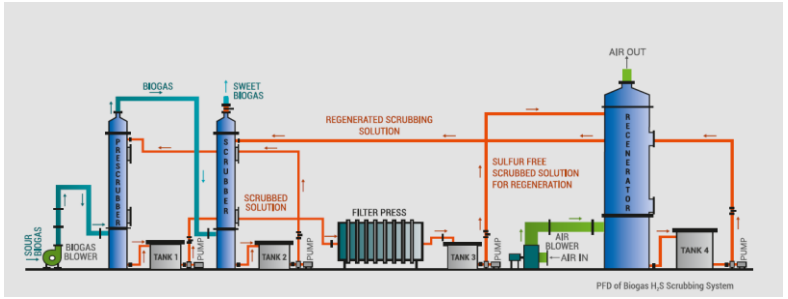




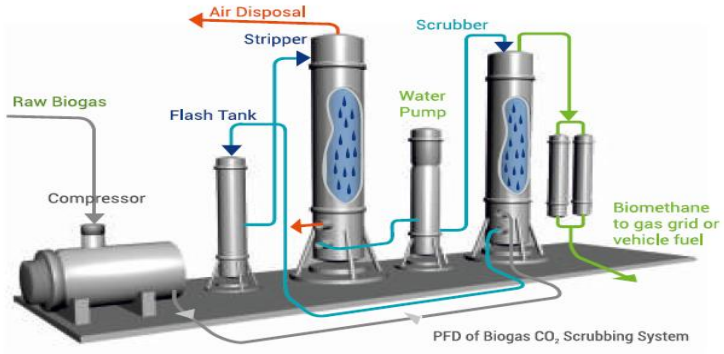
PRAJ CBG Plant design USPs: Biogas Upgradation Section

1. Based on plant capacity & local conditions, PRAJ offers flexible gas cleaning and compression systems
2. A Choice of Catalytic or Chemical H2S scrubbing
3. A Choice of Membrane or Chilled water based CO2 removal
4. Meeting quality norms better than IS 16087
    a. Methane > 96%
    b. CO2 < 4 %
    c. H2S < 20 PPM
    d. Water < 16 PPM
5. High Methane recovery >97%
6. Options for complete CO2 recovery – GHG reduction
7. PESO approved compression & cascade filling (250 Bar)

CATALYTIC Sulfur Removal



Water Based CO2 Removal



Pressure Swing Absorption for CO2 Removal

PRAJ's Innovative Microbial Technology – Solid & Liquid Organic Manures

Value adding Manure as co-product → **'Bio-green' NOCA certified manure**

- Praj Plants Manures are certified as Organic manures by **National Organic Certification Agency**
- Formulated Manures fetch high sales value and demand

NOCA Certification for all feedstocks	• National Organic Certification Agency approval for Bio-manure
High Performance Bio-manure	• Complete TVS degradation ensures Bio-manure with high minerals • Stable characteristics
Optional Technology for Recovering Manure with Value	• Ammonium Sulfate recovery System • Phosphrous Recovery System • Add- Back balancing for the Manure

Compressed Bio Gas (CBG)- Bio Bitumen

240 TPD Napier Grass

Ren Gas Technology

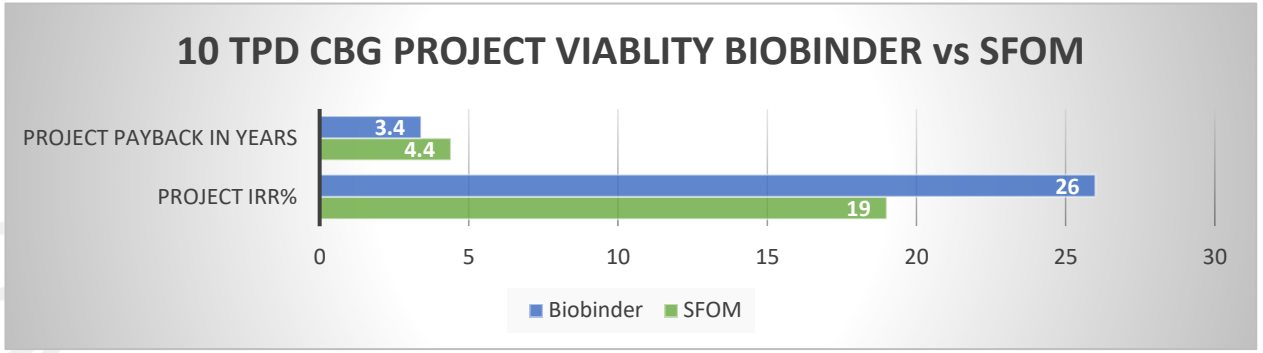
10 TPD CBG

SFOM : 35-40 TPD

25~30 TPD
Bio Bitumen

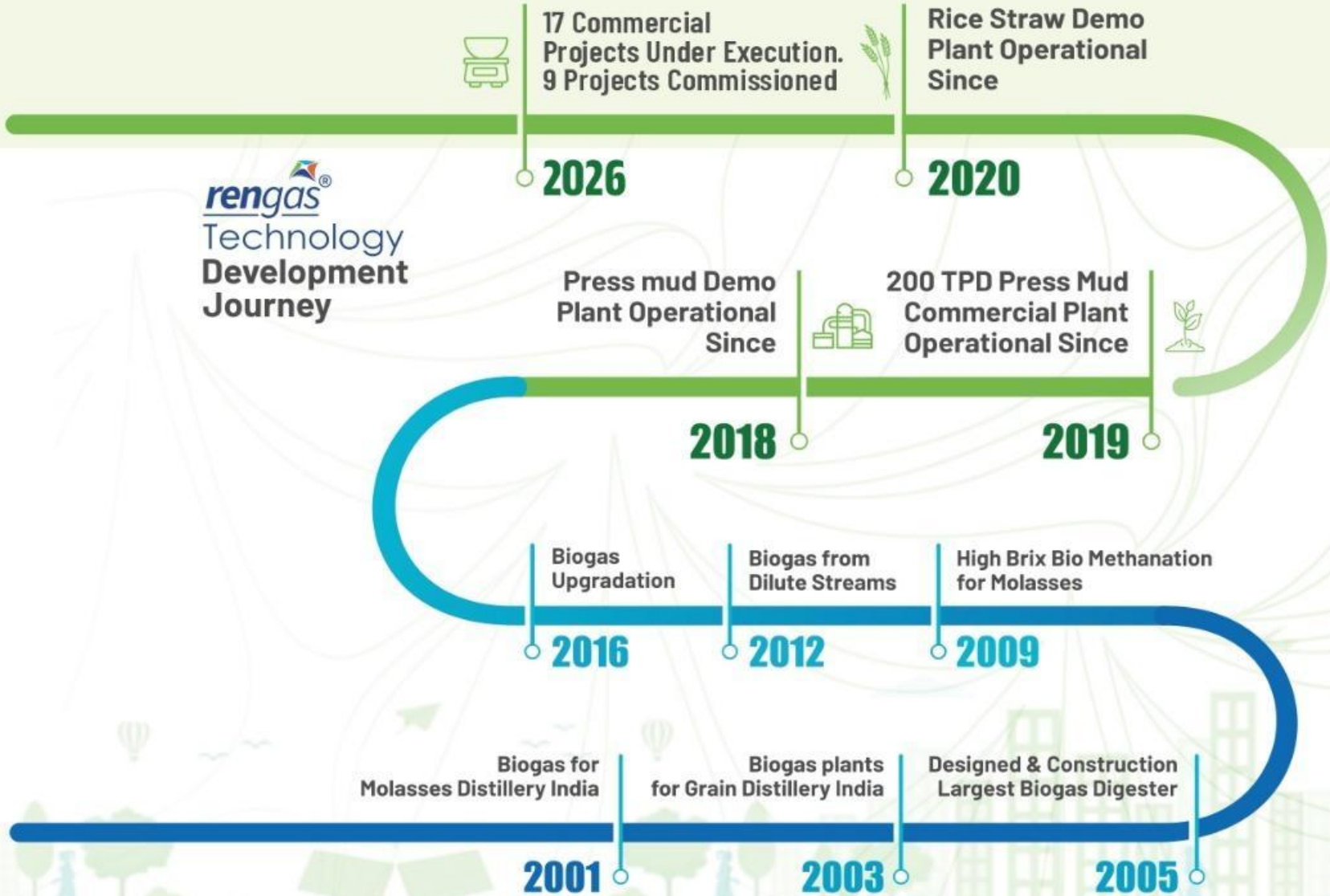
Drivers for Lignin Bio Binder used as a Bitumen substitute:

- Solution for scarcity of bitumen in near future.
- Reduction in import duty (approximately 50% Bitumen is currently imported).
- GHG reduction by approx. 50% as compared to fossil-based Bitumen.
- Addition functionality to asphalt improving high temperature and moisture resistance.
- Longer lifetime of road resulting lesser maintenance.
- Improvement in rutting resistance and thermal stability.

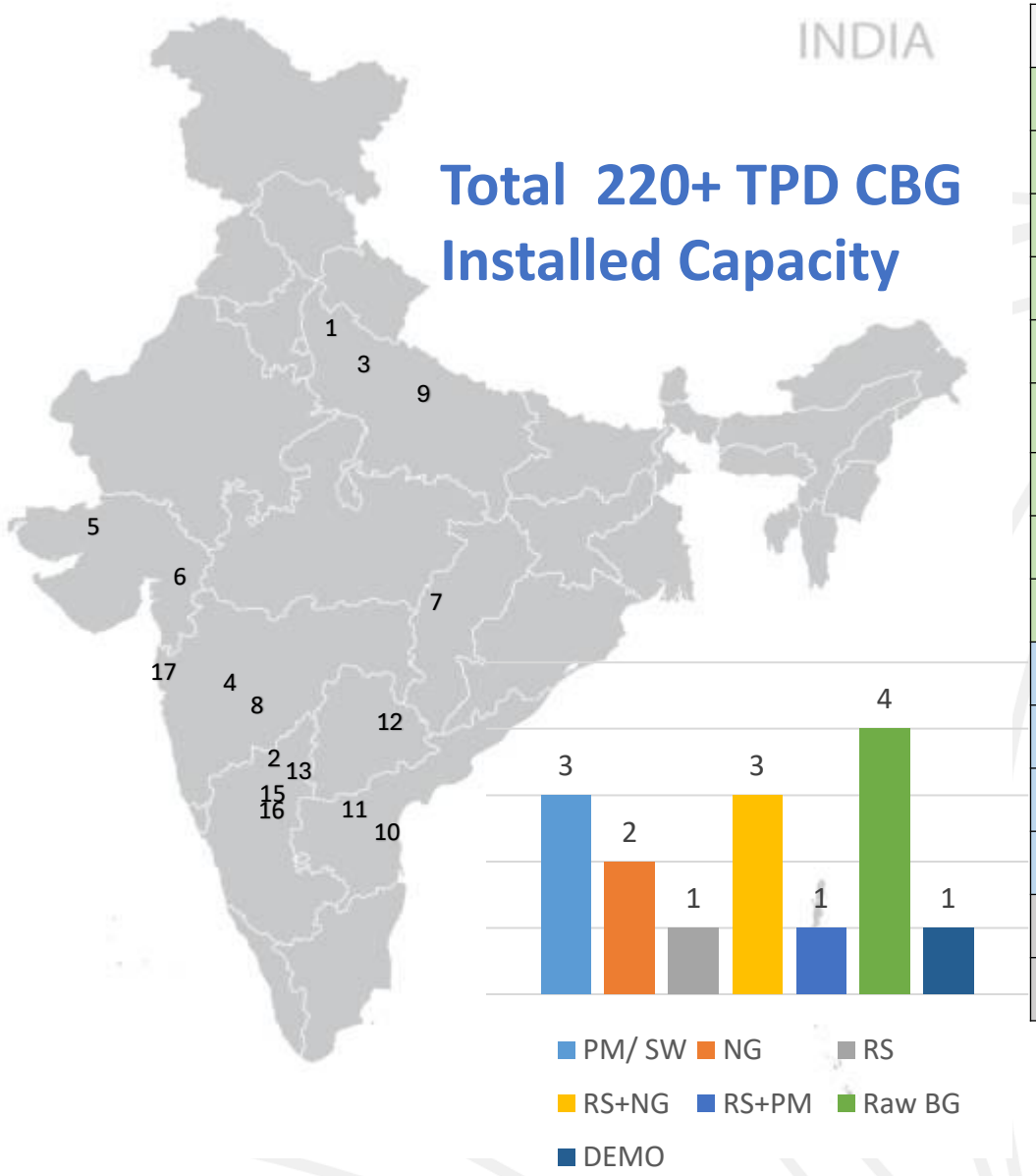


The Hon. Minister of Road Transport and Highways, Shri Nitin Gadkari, inaugurated country's first sustainable road made using lignin-based bio-bitumen at the Nagpur-Mansar Bypass project, NH 44.

25 Years of Experience in Technology for Biogas



Reference list for CBG Projects..

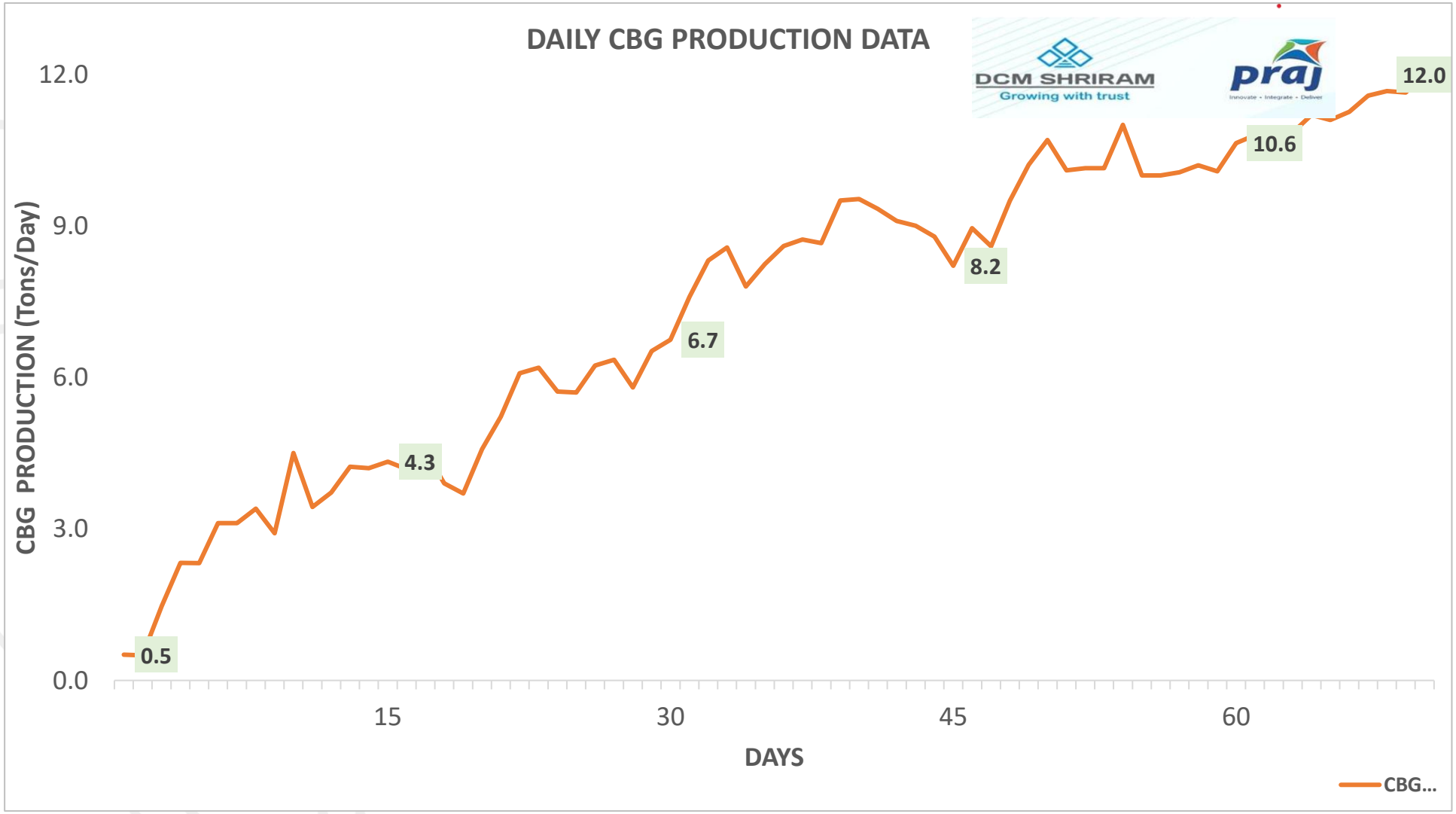


Sr. No.	Project / Client	Cap	Feed	Location	Status
1	Indian Potash Ltd.	10	PM	UP	Commissioned
2	Leafiniti Bioenergy Pvt Ltd. (TruAlt)	10	PM	KA	Commissioned
3	Hindustan Petroleum CL.	14	RS	UP	Commissioned
4	Shreenath Mhaskoba Sakhar K	10	RG	MH	Commissioned
5	New Reliance Solar Energy -	1	Mixed	GJ	Commissioned
6	Reliance Chemicals and Materials	15	RS+PM	GJ	Commissioned
7	NKJ Biofuels Pvt. Ltd.	10	RG	CG	Commissioned
8	Baramati Agro Ltd.	16	RG	MH	Commissioned
9	DCM Shriram	12	PM	UP	Commissioned
10	Reliance Nellore CBG.	21	RS+NG	AP	Under Commissioning
11	Reliance Kurnool CBG.	21	RS+NG	AP	Under Commissioning
12	Reliance Warangal CBG.	21	RS+NG	TL	Under Construction
13	IGPL, Raichur	5.5	NG	KA	Under Construction
14	URC (International)	3	RG	INT	Engineering
15	Reliance Dahanu	20	NG	MH	Engineering

DCM Shriram – Robust Digester for Press mud to CBG Plant

Anaerobic Digester

Biogas upgradation



Record Commissioned in just 60 days

Quick commissioning means Revenue ~ 2.5 Cr / Month

IPL, Muzaffarnagar

RIL Vadodara Project

Gas Holder

Anaerobic Digestor

HPCL BADAUN-RICE STRAW TO CBG PLANT

Baramati Agro Raw Biogas to CBG project

Gas Purification Section

Reliance Nellore CBG Project

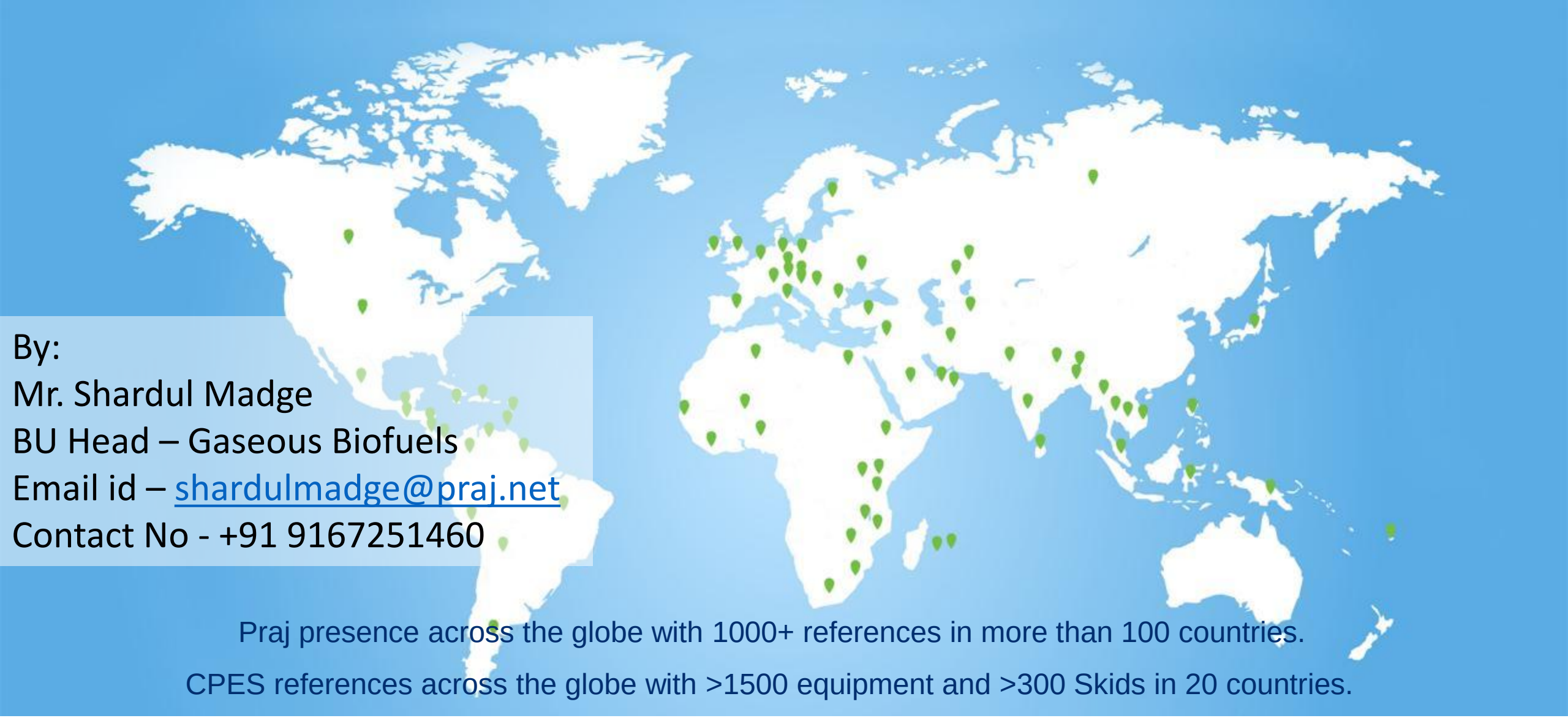
Conclusion:

Various technology innovations have been undertaken by Praj & its vendors which have improved the techno-commercial viability of CBG plant.

- Preservation of feedstock using stabilizing agent to prevent degradation of volatile solids with Praj's PM Stab technology for Pressmud, NG Treat technology for Napier Grass.
- BM - Solve technology helps in improved digestion of cellulosic biomass.
- Advanced Horizontal Mixed Flow Reactor design helps ensures enhanced performance, seamless operations & minimal wear & tear.
- Improvements in size reduction system such as Hammer Mills & Bio-Extruders, bio grinders.
- Ion-Chelate Solution for effective H2S removal from biogas.
- CO2 removal technologies such as Chilled Water Scrubbing, PSA & Membrane.
- Co-Product Valorization – Bio bitumen, LFOM, SFOM.

Take Away:

- **Due to improved technology and overall techno-commercial viability customers are taking keen interest in setting up plants.**
- **Plants have started operating close to rated capacity with desired gas specification.**
- **Domestic CBG production shows strong potential in ensuring energy security for India**



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Praj presence across the globe with 1000+ references in more than 100 countries.

CPES references across the globe with >1500 equipment and >300 Skids in 20 countries.

THANK YOU