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Ensuring Biogas Plant Success: Lessons Learned from India's Bio-Compressed Natural Gas (Bio-CNG) Projects

Dr. Nimmi Damodaran, Independent Consultant
On behalf of the Global Methane Initiative and the U.S. Environmental Protection Agency

Overview of Presentation

- Global Methane Initiative
- Overview of biogas and bio-CNG
- Insights from 11 Bio-CNG plants
- Successes, Challenges and Recommendations

Global Methane Initiative (GMI)

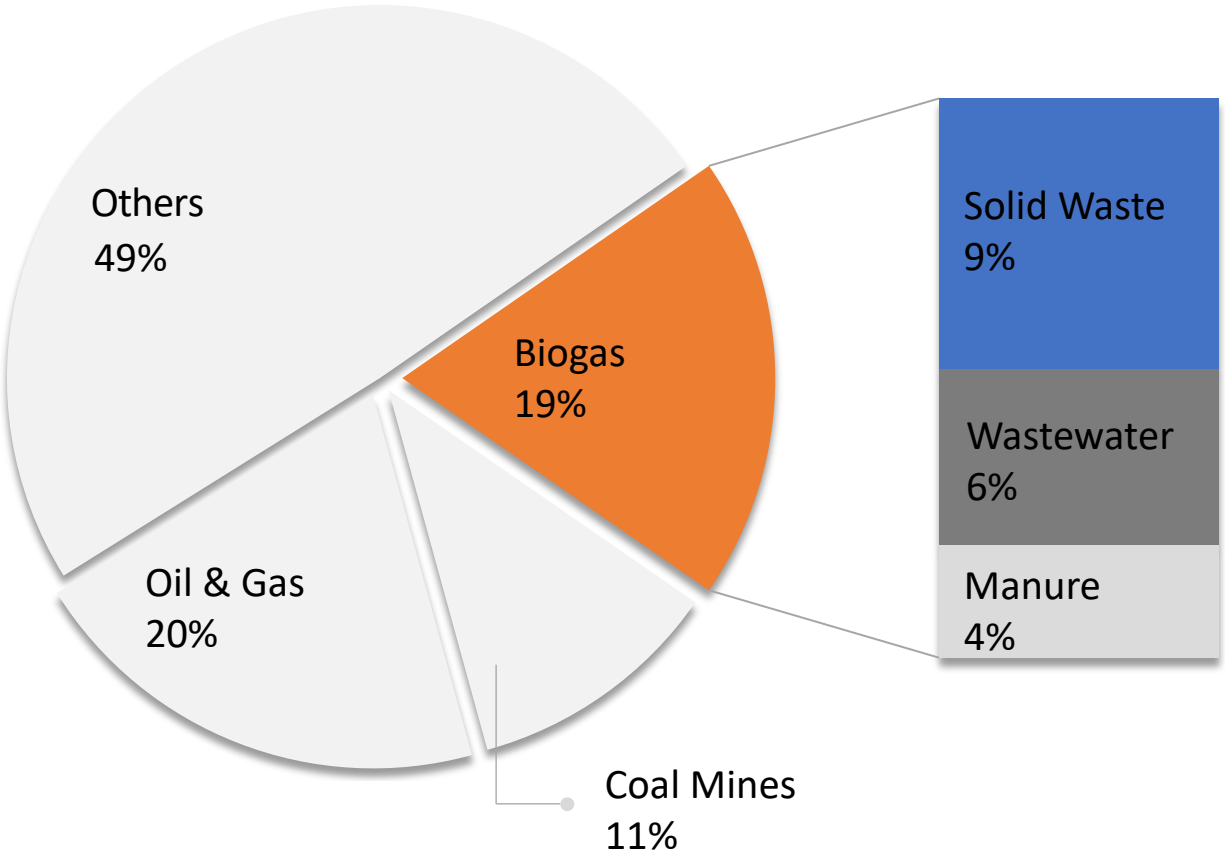
- International public-private partnership focused on advancing:
  - Cost-effective, near-term methane abatement
  - Recovery and use of methane as a valuable energy source
- Provides in-kind technical support to deploy methane mitigation and methane-to-energy projects around the world
- Supports methane mitigation in three key sectors:
  - **Biogas (municipal solid waste, agriculture, wastewater)**
  - Coal mines
  - Oil & gas

Global Methane Initiative

- 49 Partner Countries
- 100s of Project Network members
- Alliances with international organizations focused on methane recovery and use

GMI Partner Countries represent approximately 75% of methane emissions from human activities.

The biogas sector makes up 19% of total human-caused methane emissions



Source: U.S. Environmental Protection Agency Global Non-CO_2 Greenhouse Gas Emission Projections & Mitigation Potential: 2015-2050

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Benefits of Recovering and Using Methane

- Decreased greenhouse gases
- Better air and water quality
- Improved human health
- Enhanced energy security
- Increased worker safety
- Expanded economic growth

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What is Bio-CNG?

- Bio-CNG is the purified form of biogas produced from organic waste such as agricultural residues, animal manure, municipal solid waste and industrial biodegradable waste.
- It is an alternative to conventional compressed natural gas (CNG) for transportation fuel, power generation, and industrial applications such as heating and cooling.

Source: Global Green Growth Institute

Domestic and international commitments have increased demand for biogas technologies

India to develop 5000 large scale bio-CNG plants

Brazil to expand number of biogas facilities

Enabling Environment for Bio-CNG in India

- The Government of India is investing heavily in bio-CNG to
  - Increase domestic energy production
  - Improve rural employment and farmer income
  - Improve waste management
  - Reduce harmful air emissions
- India's national goal is to develop 5,000 large-scale bio-CNG plants
- National policies include:
  - Swachh Bharat Mission, National Policy on Biofuels, Sustainable Alternative Towards Affordable Transportation (SATAT) initiative and many more

U.S. EPA Study

Purpose: Assess the performance of Bio-CNG plants across northern India to identify best practices, challenges, and areas of improvement to support the growth of Bio-CNG sector in India and globally.

Study results will be published soon!

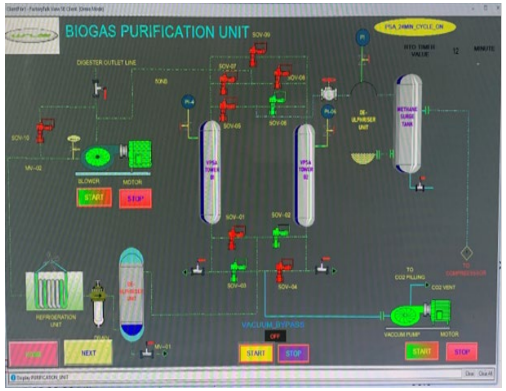
Overview of Study

- 11 Bio-CNG project sites across five states of northern India
- Qualitative and quantitative data was collected to evaluate factors contributing to success or failures of the plants.
- **Diverse feedstocks analyzed**: press mud, cow dung, poultry litter, sewage sludge and paddy straw.
- **Technology types:**
  - Pressure Swing Adsorption (PSA)
  - Vacuum Pressure Swing Adsorption (VPSA)
  - Membrane Pressure Swing Adsorption (MPSA)
  - Water Scrubbing

Understanding Bio-CNG Processes

Bio-CNG Production Process

Feedstock Collection → Pre-treatment → Anaerobic Digestion → Biogas Purification → Compression & Storage → Distribution & Utilization



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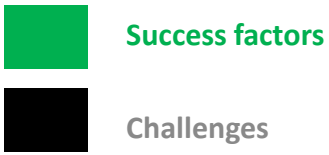
Summary of Biogas Purification Technologies

(based on feedback and experiences from the plants)

Purification technology	Operational Performance	Advantages	Disadvantages
Pressure Swing Adsorption (PSA)	• 80-99% efficiency • 0.5-20% methane loss	• Capable of high efficiency • Widely available • Easy to use • Lower initial cost	• Variable performance • Inconsistent gas production • High maintenance costs • Higher energy consumption
Vacuum Pressure Swing Adsorption (VPSA)	• 96-98% efficiency • <2% methane loss	• High efficiency • Lower energy consumption	• High maintenance costs
Membrane Pressure Swing Adsorption (MPSA)	• 96% efficiency • 3% methane loss	• High efficiency • Lower energy consumption	• High maintenance costs • Not widely available; extended equipment delays impacted operation
Water Scrubbing	• 98% efficiency • <1% methane loss	• High efficiency • Least technically complex • Low maintenance costs	• Requires significant water consumption

Observed Successes and Challenges



❑Feedstock supply and quality

- **Long term contracts with diverse suppliers**
- **Implementing storage solutions**
- Inconsistent supply, Price volatility
- Inadequate storage

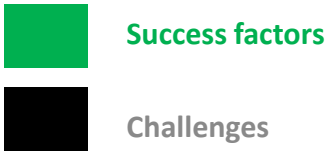
❑Purification equipment

- **Technologies like PSA and VPSA achieved 99% efficiency in biogas production**
- **Adherence to standards IS16087 ensured quality**
- Appropriate technology, Monitoring systems
- High maintenance cost

❑Equipment operations and commissioning

- **Plants adhering to maintenance protocols – minimal downtime and higher operational efficiency**
- Quality standards for equipment
- Standard operating procedures

Observed Successes and Challenges



❑Staffing and training

- **Staff training and knowledge sharing culture enhanced operational efficiency**
- Capacity building
- incentivizing retention of skilled labor

❑End product sales

- **Few plants diversified revenue streams through digestate and Bio-CNG sales**
- Market research
- Product development appropriate to the region

❑Permitting and financing

- **Plants that could navigate the permitting process demonstrated resilience and success in project execution.**
- **Partnerships and government support helped few project to overcome financial challenges**
- Permitting
- Educating financial institutions on Bio-CNG & national initiatives

Recommendations for Enhancing Success of Bio-CNG Projects

- Standardization of Feedstock Agreements
- Investment in Storage Infrastructure – feedstock and Bio-CNG
- Monitoring and Technical Support
- Market Research and Product Diversification
- Capacity Building of Operational Staff
- Streamlined Permitting and Financial Instruments
- Incentivizing Investment and Collaboration

GMI Tools and Resources to Support Methane Reductions from the Waste Sector

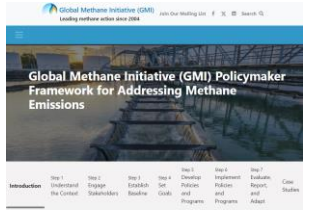
Tools

- Solid Waste Emissions Estimation Tool (SWEET)
- Anaerobic Digestion Screening Tool
- Organics Economics (OrganEcs)
- Landfill Gas Screening Tool

SWEET
SOLID WASTE EMISSIONS ESTIMATION TOOL

Resources

- Waste Characterization Handbook
- Policymaker's Framework for Addressing Methane Emissions
- Policy Maker's Handbook for Measurement, Reporting, and Verification (MRV) in the Biogas Sector
- Risk Analysis Checklist for Biogas Projects



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Thank You!

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Study results and recommendations will be published on globalmethane.org soon!

Questions?

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