Bio-CNG: A Green Alternative to Fossil Fuel

praj

Innovate • Integrate • Deliver

Content

- Biogas Cycle
- Biogas Use
- Biogas Value Chain
- Bio-CNG and CNG/ LPG comparison
- Bio-CNG India Scenario
- Bio-CNG potential segments and availability
- Production Cycle
- Feedstock and their yields
- Cost of Bio-CNG from Various Sources
- Brief about Praj

The biogas cycle

Solar energy

Photosynthesis

Organic Waste Sources

Animal husbandry

Crop harvesting

Industrial processing

Human consumption

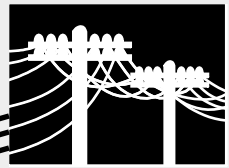
Energy crops

Biofertilizer

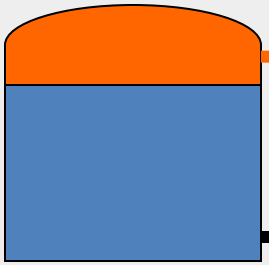
CO_2

H_2O

Electrical and/or thermal energy



Organic wastes



Anaerobic digestion

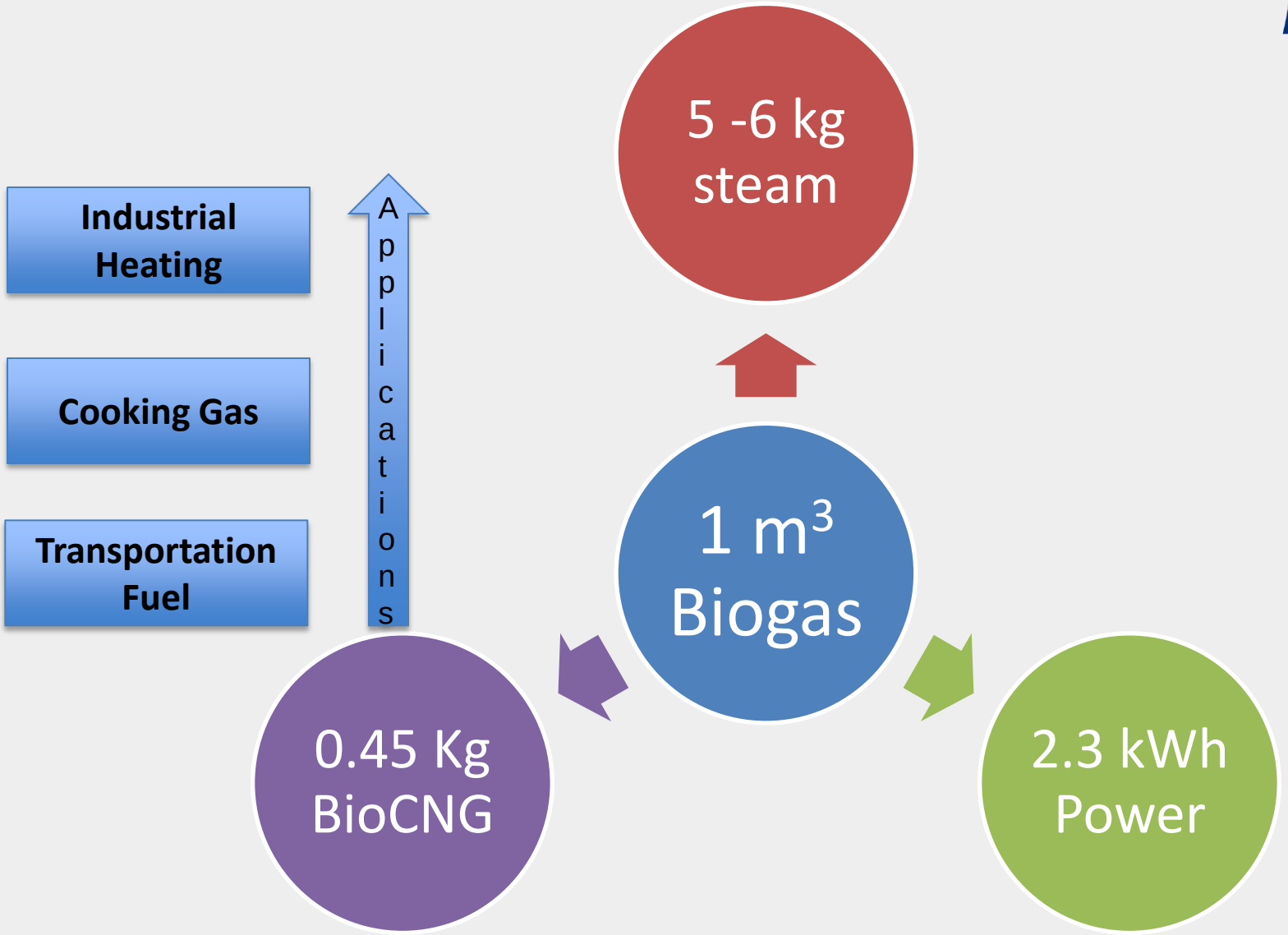
Biogas

Natural gas pipeline

Raw Spent Wash

Cleaning & Upgrading

Biogas - Applications



Bio-CNG vs CNG

Parameter	CNG Composition	Bio-CNG composition
Methane min.	90%	90%
Ethane	6%	Nil
C3 and Higher	3%	Nil
C6 & Higher	0.50%	Nil
Moisture (max.)	5 ppm	5 ppm
Sulfur (max)	20 ppm	16 ppm
Oxygen (max)	0.50%	0.50%
CO_2 (max)	3.50%	4.00%
Hydrogen (max)	0.10%	ND
CO (max)	0.10%	ND
Net Calorific value (kcal/kg)	10,940	11,200 - 11,500

- As per content, CNG and Bio-CNG are nearly the same except that CNG has some higher alkanes.
- Bio-CNG compares favorably with LPG in terms of the heat value.
- Replacement of CNG by Bio-CNG is possible and compares well in terms of heat value.

October 27, 2005

World's first biogas train fueled by cows

The world's first train from Studsvik to run on biogas, a renewable energy source made up of organic waste from cows, has been inaugurated in Sweden and can run for 600 kilometers at a maximum speed of 130 kilometers an hour.

Press Information Bureau
Government of India
Ministry of Railways

09-March-2015 15:03 IST

Use of Alternate Fuel on Indian Railways

Based on expert advice from Research Designs and Standards Organisation (RDSO) and Indian Railways Organisation for Alternate Fuels (IROAF), it was decided to blend 5 per cent Bio-diesel on diesel locomotives. Dual fuel engines with Compressed Natural Gas (CNG) and diesel have been introduced on Diesel Electric Multiple Units (DEMUs). Auxiliary Power Unit (APU) is fitted on diesel locomotives to reduce fuel consumption during idling by shutting down main engine. multigenset locomotives, designed to have more than one engine on board, with number of engines working in relation to train load and shutting down on reduced train loads and duty cycles, have been introduced.

Central Electricity authority (CEA) was appointed by Railways for preparing "Energy plan for Indian Railways" and suggesting ways to optimize the cost of buying power for the Railways.

Salient recommendations in CEA Report are as follows:

1. Indian Railways to migrate part of existing traction loads from DISCOMs in a phased manner and procure the same from Generating companies (GENCO) through tariff based bidding/ bilateral arrangements.
2. Indian Railways to explore constructing Railways Transmission line for direct connection to Inter-state Transmission Line for direct connection to Inter-state Transmission System (ISTS)
3. Carry out detailed energy audits.

Zonal Railways have been advised to procure Bio-diesel for use on diesel locomotives. **DEMU train sets have been introduced in service with dual fuel CNG/ diesel engines. 100 diesel locomotives are fitted with APUs**. Two multigenset locomotives are introduced on line.

: The steps taken by Railways to bring down expenditure on electricity are:

Setting up of captive power plant at Nabinagar in Joint Venture (JV) with NTPC, construction of transmission lines, getting power at economic tariff through bilateral arrangements with Damodar Valley Corporation (DVC) and other Generating Companies (GENCOS) progressively and auditing of major electrical installations.

This information was given by the Minister of State for Railways Shri Manoj Sinha in written reply to a question in Lok Sabha today.

Bio-CNG vs LPG for cooking and heating

Parameter	Bio-CNG composition	LPG Composition	
Methane min.	90%	Propane (min)	95%
Moisture (max.)	5 ppm	Butane (max)	4%
Sulfur (max)	16 ppm	C5 and higher	2%
Oxygen (max)	0.50%	Sulfur (max)	5 ppm
CO_2 (max)	4.00%	Free water	None
Net Calorific value (kcal/kg)	11,200 - 11,500	Net Calorific value (kcal/kg)	11,200

- Calorific value of Bio-CNG and LPG are nearly the same.
- LPG takes up more Oxygen (1:25) against Bio-CNG (1:11).
- LPG is heavier than air hence, settles down and is a potential fire threat. Bio-CNG being lighter gets dispersed in the air preventing any dangerous situation.
- Bio-CNG is cleaner than LPG and does not leave any soot deposit.
- Bio-CNG more economical than commercial LPG. Finding use in Canteens/ Pantries, Hotels …..

Bio-CNG Production Value Chain

Feedstock aggregation/ segregation → Pre-treatment → Anaerobic digestion → Up-gradation → Bio-CNG bottling/ Power

STPs' Sludge (0.34 bn m^3/yr of biogas):
- 84 potential customers of 152.
- Spread is Pan India

Distilleries' Spent Wash (2.2 bn m^3/yr of biogas):
- 400 distilleries in all – 300 already have biogas facility.
- About 45 large ones with Praj – 21% share of Biogas produced

Sugar Industry – Press mud(0.64 bn m^3/yr of biogas):
- 526 active sugar mills.
- Use press-mud as substrate along with RSW if distillery present.

Organic MSW/ Food waste (2.8 bn m^3/yr of biogas):
- Segregation of organic waste from MSW.
- Aggregation of food waste from canteen/ hotels/ restaurants

Biomass waste (38.2 bn m^3/yr of biogas):
- Aggregation of biomass waste from fields.
- Agro processing units – rice mills (husk), fruit juice units, oil extraction units.
- Pre-treatment is the prime differentiator and determines efficiencies..

Bio-CNG Production Steps and Specifications

Feedstock aggregation/ segregation	Pre-treatment	Anaerobic digestion	Up-gradation	Bio-CNG bottling/ Power

Any organic matter can ferment to give biogas:

Liquid Substrate:
- Distilleries' spent wash

Solid Substrate:
- STP's Sludge
- Starch
- Food waste
- Press Mud
- Agro waste
- Segregated Organic waste from MSW

Organic matter to be digested by a consortium of micro-organisms:
- Hydrolysis
- Acidogenesis
- Acetogenesis
- Methogenesis

Raw biogas produced
- Methane – 55 – 70%
- CO_2 – 30 – 45%
- H_2S – 0.1 – 4%
- Ammonia – 0.1%
- N_2 – 1 – 3%
- O_2 – 0.1 – 2%
- Moisture – 1 – 2%

Removal of all impurities to get Bio-CNG/ Bio-Methane/ CBG.

Composition:

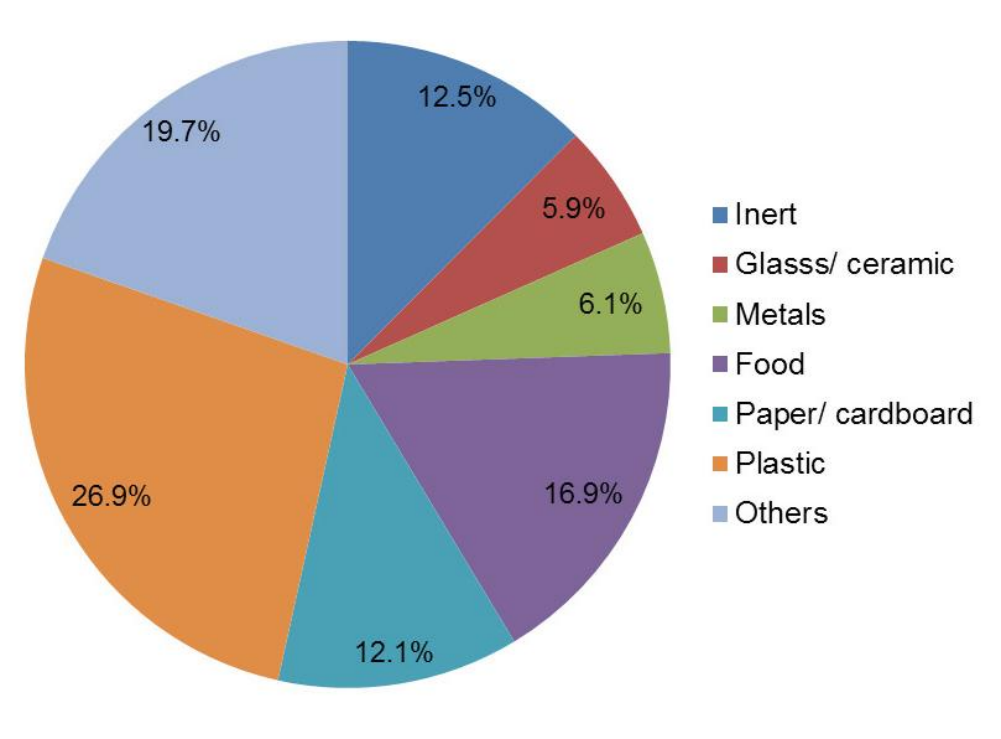
- Methane > 90%
- CO_2 – < 4%
- H_2S – < 16 ppm
- Ammonia – ND
- N_2 – < 0.5%
- O_2 – < 0.5%

Power Generation:
- Bio-CNG after removal of H2S
- Generates 2.0 – 2.2 KWH/m3

Cooking Gas (LPG equivalent):
- Can be used in same burners as LPG

Transport fuel (CNG equivalent):
- Can replace CNG in the same engine with slight increase in air.

Waste Produced by Railways



- Railways have estimated open discharge of 4,000 TPD of sewage matter.
- Through installation of closed systems, the treatment of the sewage can yield good amount of:
  - Biogas
  - Bio-Manure
  - Recyclable water

- Total Solid waste produced in 402 major stations is 670 TPD.
- Food waste itself accounts for 114 TPD

Source : Report – CCEW – Decentralised Waste Management in Railways





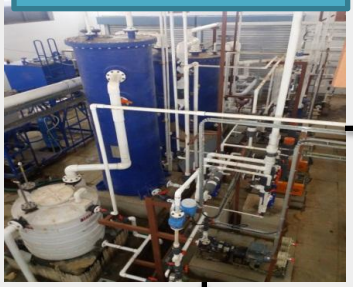
PRAJ'S VALUE ADDITION PROCESS

Bio-methanation

Residue

Compost

H_2S removal



Scrubbed Biogas

Electricity to Grid

Power Generator

Transportation

Compressor

CO_2 Removal

Pure Biogas

Bio-CNG

Cooking/ Heating

Potential Feed stocks for Biogas Production

Animal Manure

- Poultry Dropping
- Cattle Manure

Kitchen waste

- Food waste
- Raw Fruits & Vegetable Waste

Agriculture waste

- Rice straw
- Napier grass

Sewage Slurry

- STP

Typical Biogas Yields

Animal Manure	Biogas Yields	Composition
Poultry Dropping	80 - 100 Nm^3/MT	Methane – 60-65 % v/v CO_2 - 30-35% v/v H_2S – 0.2-0.5 %v/v NH_3 – 0.6 – 1.0 % v/v
Cattle Manure	40 - 50 Nm^3/MT	Methane – 50-55 % v/v CO_2 - 40-45% v/v H_2S – 0.1-0.2 %v/v

Typical Biogas Yields

Agriculture waste	Biogas Yields	Composition
Rice straw	275 -320 Nm3/MT	Methane – 55-60 % v/v CO_2 – 30-35% v/v H_2S – 1-1.5 %v/v
Napier grass	80 -100 Nm3/MT	Methane – 55-60 % v/v CO_2 – 30-35% v/v H_2S – 0.2-0.5 %v/v

Typical Biogas Yields

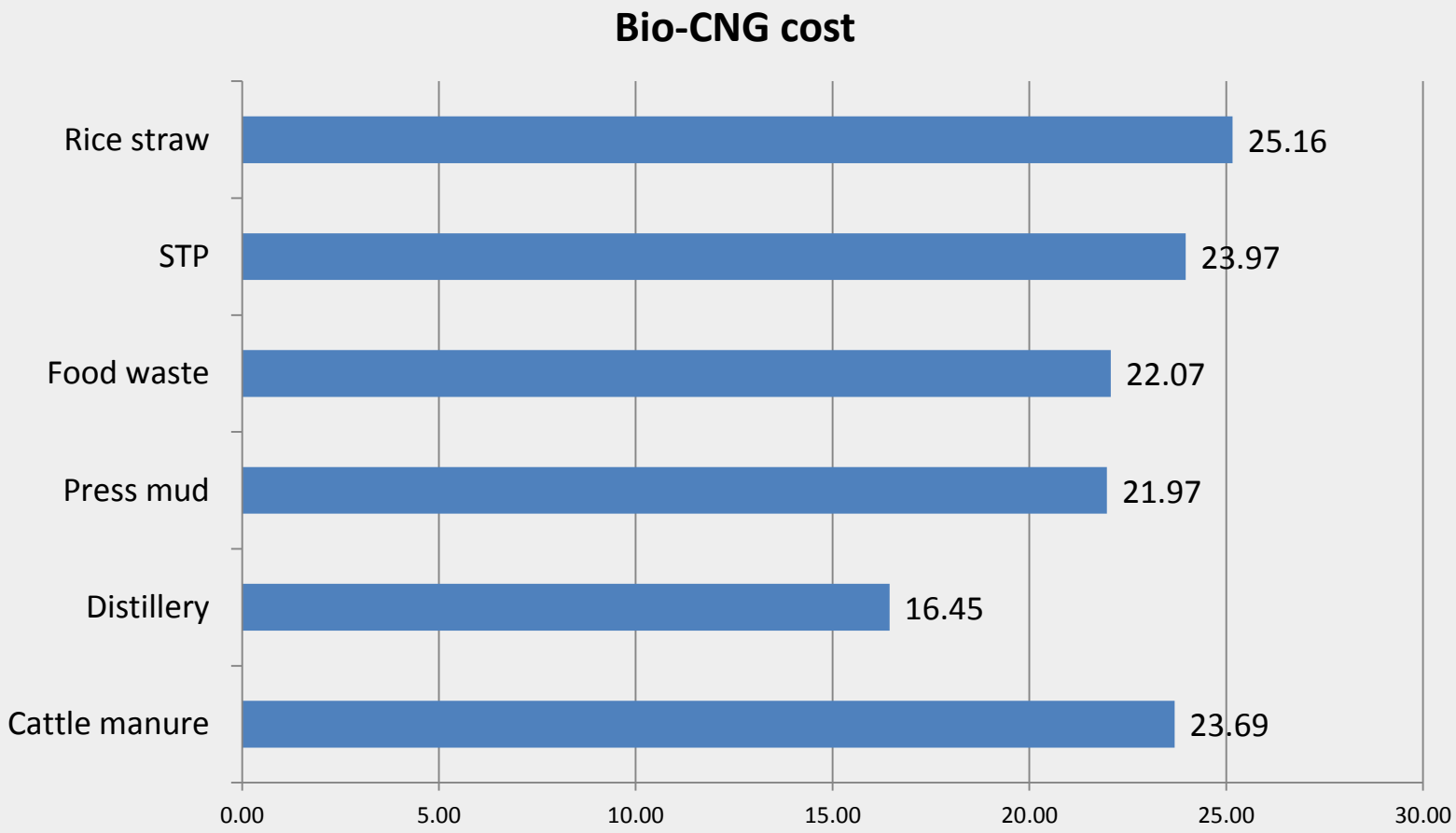
Restaurant waste	Biogas Yields	Composition
Food Waste	60 – 80 Nm^3/MT	Methane – 55-60 % v/v CO_2 – 30-35% v/v H_2S – < 0.1% v/v
Raw vegetables and fruits waste	200 – 250 Nm^3/MT	Methane – 55-60 % v/v CO_2 – 30-35% v/v H_2S – 0.2-0.5 % v/v

Typical Biogas Yields

Sewage Slurry	Biogas Yields	Composition
STP Slurry waste	60 – 80 Nm^3/MT	Methane – 60-65% v/v CO_2 – 30-35% v/v H_2S – < 0.1% v/v

Cost of producing Bio-CNG from various sources

All Figures in Rs/kg



Note: Based on a plant capacity of 5 TPD of Bio-CNG that has a typical payback of 4-5 years with Bio-CNG price of Rs 36/kg

What We Do in Praj

Alcohol/ Ethanol plants

Biogas/ Bio-CNG plants

Water and Wastewater Treatment Systems

Critical Process Equipment & Systems

HiPurity Systems

Pharma

Biotech

F&B

Cosmetics

Bio-Products

-Distillery bioconsumables

-Livestock, health & nutrition products

-Human health & nutrition

-Biochemicals

Praj Matrix R&D

R&D facility has world class equipment that help in creating value for customer

CLEAN ROOM FACILITY

- Class 10,000 Facility
- 6 Research Labs over 9,000 sq.ft.
- Biosafety Cabinets
- Anaerobic Glove Boxes
- PCR
- q-PCR
- Cell fusion systems
- FPLC
- IEF
- Ultracentrifuges

BIOPROCESS DEVELOPMENT

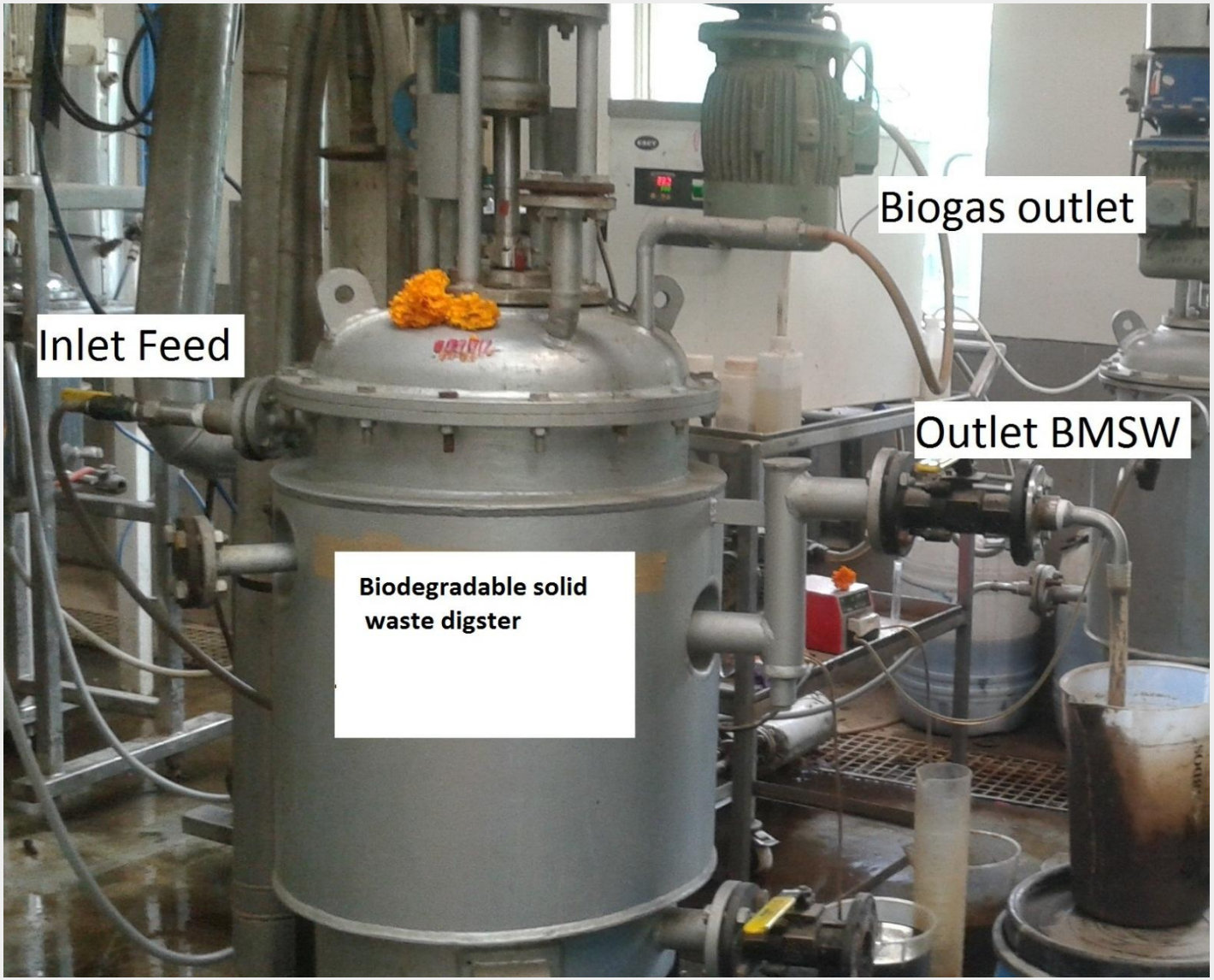
- Sterile fermentation
- Automated Fermenters
- (2 L to 100 L scale)
- S/L separators
- Membrane separation units
- Chromatography columns
- Liquid-Liquid extractors
- Crystallizers
- Vacuum Evaporators
- Dryer & leaching apparatus

CHEMICAL PROCESS DEVELOPMENT

- Equipped with High pressure stirred tank reactors (700 ml to 25 L scale)
- SCADA controlled Dual Fix Bed Reactor System
- Granulator
- Fluidized Bed Drier and Hydraulic press
- Continuous Distillation
- Liquid-Liquid Extraction and Crystallization
- Short Path Distillation (0.02 & 0.5 m^2)

*FPLC (Fast protein liquid chromatography), PCR - Polymerase Chain Reaction, IEF- Isoelectric Focusing Systems

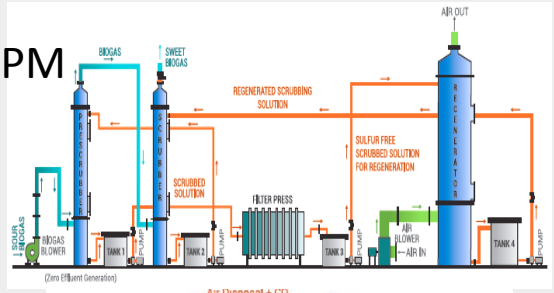
Pilot for optimization of solid waste bio-methanation

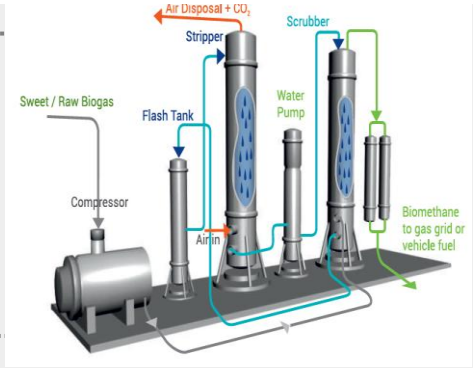


Bio-CNG offerings

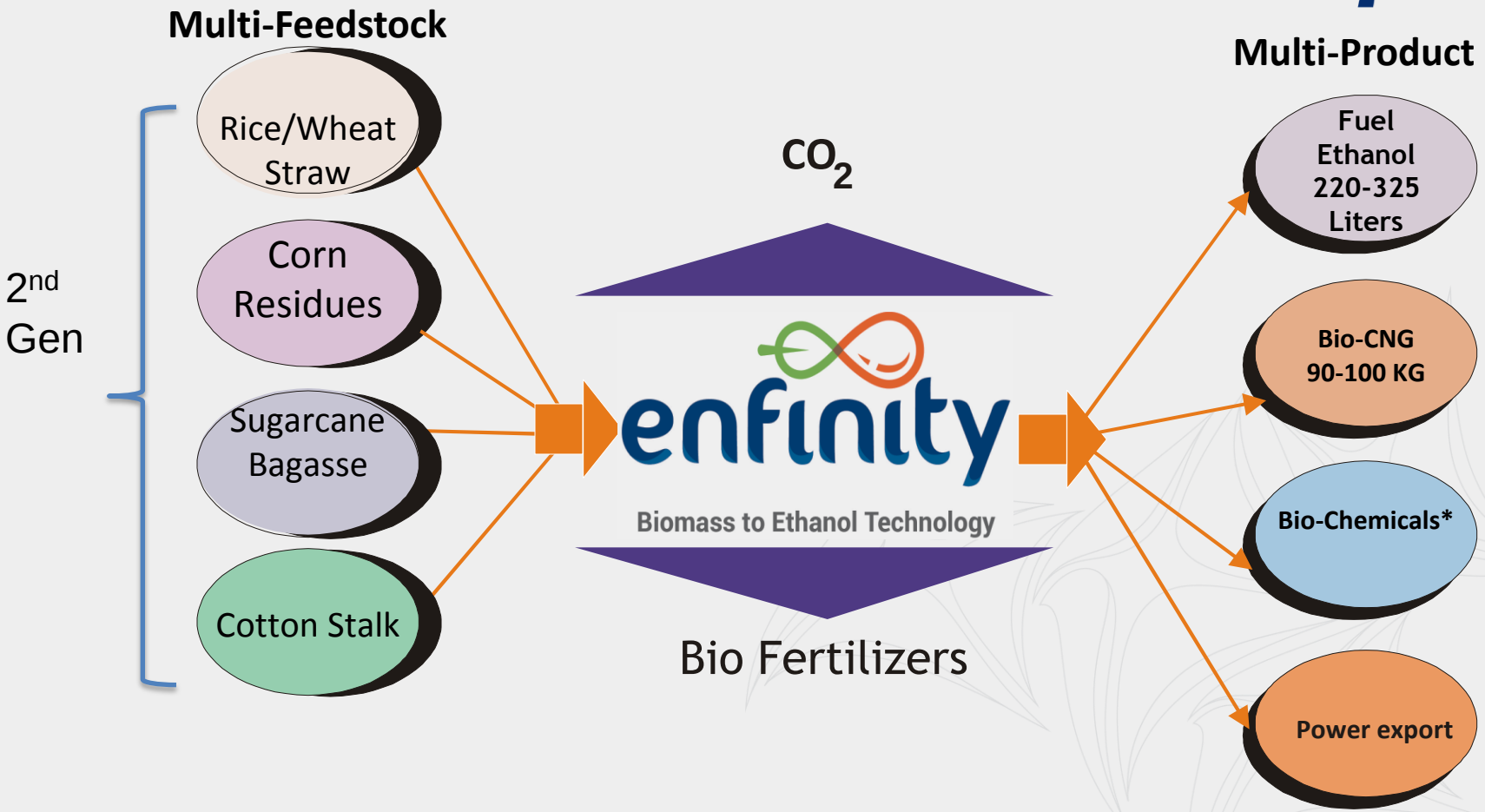
Offerings	Range	USP
1 ECOMET -HT Waste To Energy	Bio methanation of Solid waste	▪ Fully Integrated Plant solution ▪ **Feedstock**: Press mud, Rice straw, Agro waste, Food waste ▪ Unique Mixing system design ▪ Consistent performance ▪ Higher Biogas yields ▪ Special geometry of the reactor
2 EcoClean™ Biogas Scrubbing System	Biogas H_2S Scrubbing System	▪ Easy Start up & shut down ▪ Double Stage Scrubbing- Low <50 PPM H_2S ▪ Pure Chemical Scrubbing ▪ Lower foot-prints ▪ Min. Civil Works
	Biogas CO_2 Scrubbing System	▪ > 95% Methane Purity ▪ Low Capital Investment ▪ Low Opex ▪ Ease of Operation ▪ Process Works at ambient temp.


Hindustan Waste treatment (P) Ltd,





Multi-Feedstock, Multi Product 'SMART Bio Refinery'



Praj innovative 2G Bio refinery provides higher returns

Key Highlights of Praj's Integrated Demo Plant

- **Integrated Bio refinery Demonstration Plant** : Capacity – 1 MLPA Ethanol production
- Multi feedstock processing capability: Rice (paddy) Straw, Cotton stalk, Corn Cobs & Corn Stover, Sugar Cane bagasse & Cane trash, Wheat Straw etc.
- Multi-product - The plant is designed to produce Bio-ethanol, Bio-gas / Bio-CNG, Bio fertilizer, Provision for Production of Bio chemicals, Isobutanol – Jet fuel
- End to End Technology demonstration from feedstock processing till end product and waste water treatment
- Zero Process Liquid Discharge
- Process Integration for optimization of Energy & Water consumption

Oil Marketing Company officials witnessed demo plant operations

Inauguration of Demo Plant – 7th May 2017

Praj ‘s 2G demonstration plant

Praj ‘s 2G demonstration plant

Thanks For Your Attention

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