" Biogas Technologies : Indian Experience– an Excellent Opportunity For Energy Security and Clean India "

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Biogas in INDIA

- An estimate indicates that India has a potential of generating 6.38 * 10^{10} m^3 of biogas from 980 million tones of cattle dung alone produced annually from **300 million cattle population**.

- The heat value of this gas amounts to 1.3 X 10^{12} MJ. In addition, 350 million tones of manure would also produce along with biogas.

- Apart from the **4.75 million domestic biogas plants installed in India against the potential of 12 million**, there is a huge potential of installation of medium and large scale biogas plants installation in India in small scale industries, animal rearing farms, poultry farms, distilleries, tanneries, hotels, restaurants, military barracks etc.

Composition of Raw Biogas

Compound	Chem %
Methane CH_4	55–65
Carbon dioxide CO_2	35–45
Nitrogen N_2	0–10
Hydrogen H_2	0–1
Hydrogen Sulfide H_2S	0–3
Moisture	Saturated

Average calorific value of biogas is 20 MJ/m^3 (4713 kcal/m^3).

BIOGAS PLANT DESIGNS

KVIC Model Biogas Plant

DEENBANDHU 2M^3 MODEL FAMILY SIZE BIOGAS PLANT

An happy villager with her biogas connection and equipment


The Compost.

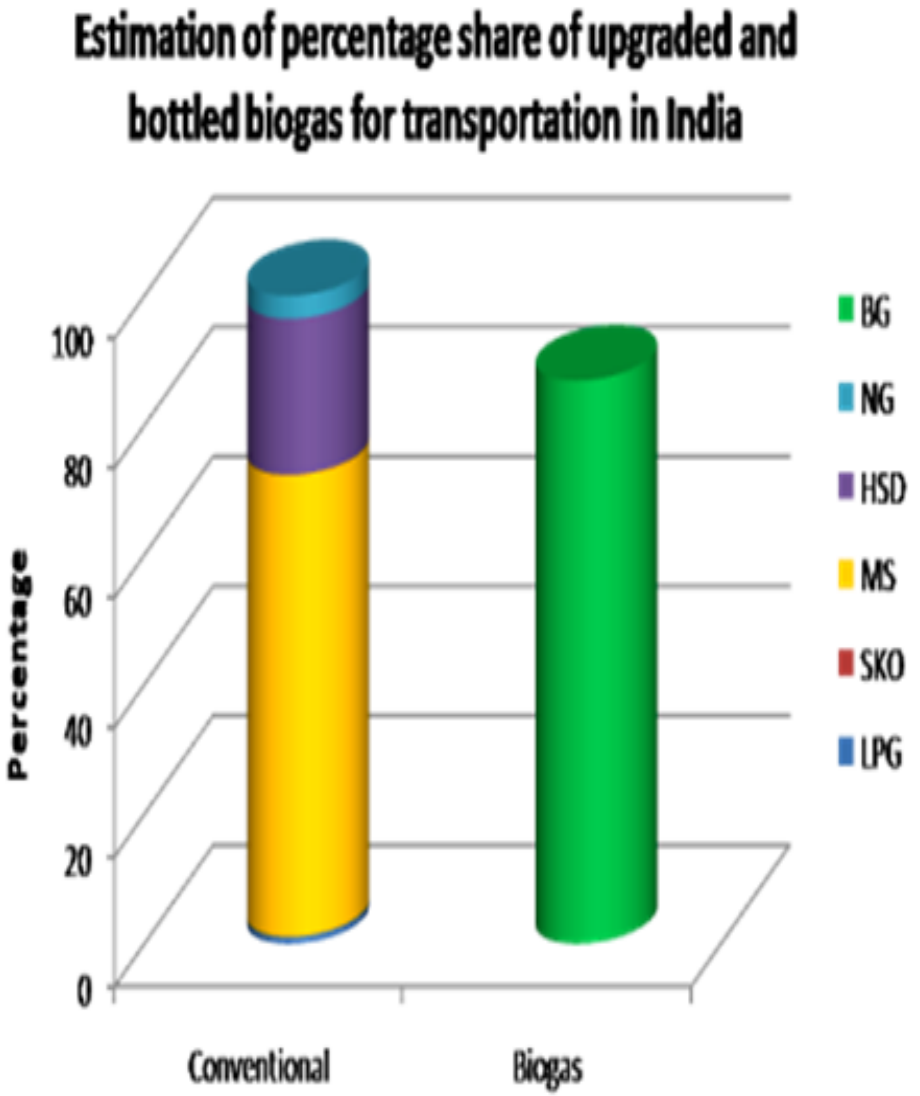
Estimation of Biogas Production Potential from Organic Wastes in India

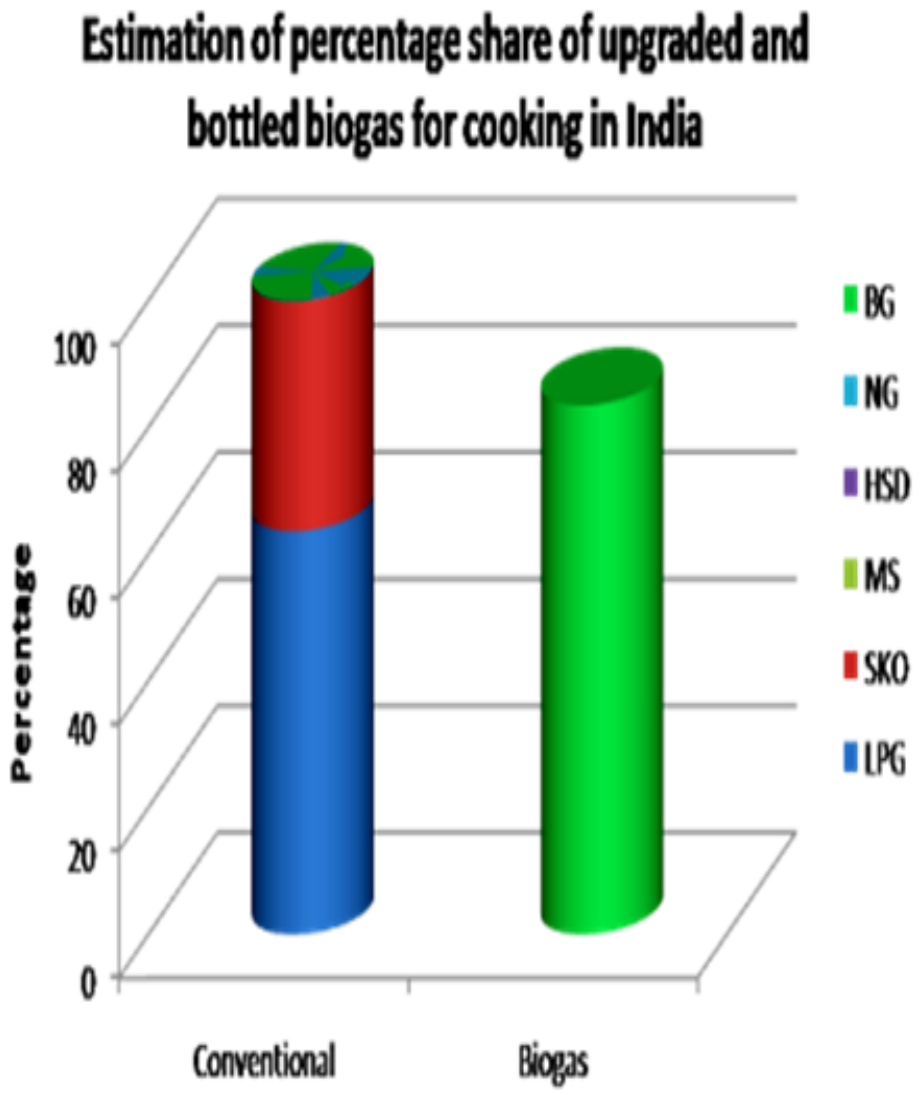
Feed Stock	Biogas Generation Potential	Source	Remarks
Animal Manure (Cattle Dung)	18240 million m^3 $year^{-1}$	Bamboriya, N.D.	The number of family size biogas plants which will utilise the dung are estimated to be 12 million and produce 3448 million m^3 of biogas
	There is a potential for 12 million family-size biogas plants which can produce 3448 million m^3 $year^{-1}$	Rao et al., 2010	Small scale biogas plants are not included in the biogas generation potential estimate.
	18240 (total) – 3448 = 14792 million m^3 $year^{-1}$		This potential is from small, medium and large dairies (Dairies and Dairy Clusters)
Poultry waste	438,227 m^3 day^{-1} = 160 million m^3 $year^{-1}$	Rao et al., 2010	
Crop residue and agro-waste	45.8 million m^3 day^{-1} = 16717 million m^3 $year^{-1}$	Rao et al., 2010	
Vegetable market waste	4000 million m^3 $year^{-1}$	Lal, 2011	One tonne of vegetable waste yields around 80 m^3 of biogas generation per day and 50 million tonnes of vegetable waste is generated annually.
Food waste/canteen waste	1270 million population*0.3 * 0.25 kg food waste $person^{-1}$ = 95 million kg food waste = 5780 million m^3 $year^{-1}$	India on line, 2013; Banks, 2009	Based on 30% of population reside in urban areas and 1 m^3 of biogas from 6 kg of food waste

Feed Stock	Biogas Generation Potential	Source	Remarks
Municipal waste	9.23 million m^3 day^{-1} = 3369 million m^3 $year^{-1}$	Rao et al., 2010	
Distilleries	1507 million m^3 $year^{-1}$	Global Methane Initiative, 2011	
Dairy Industrial Waste	219409 m^3 day^{-1} = 80 million m^3 $year^{-1}$	Rao et al., 2010	Biogas production from wastewater from various processes (silo washing, can and crate washing, plant washing, tanker washing, milk processing, other dairy products)
Pulp and paper industry	412,278 m^3 day^{-1} = 153 million m^3 $year^{-1}$	Rao et al., 2010 Parivesh, N.D.	
Sugar Industries	0.6 million m^3 day^{-1} (wastewater) + 2.9 million m^3 day^{-1} (press mud) = 1277 million m^3 $year^{-1}$	Global Methane Initiative, 2011. NMP, 2007.	
Slaughter houses	1,494,225 m^3 day^{-1} = 548 million m^3 $year^{-1}$	Rao et al., 2010	
Total Raw Biogas Potential	**48383 million m^3 $year^{-1}$**		Estimated raw biogas production potential in India

- The total biogas generation potential from dairy farms, municipal solid waste, crop residue and agricultural waste, vegetable market, food waste, community toilets, wastewater sludge, industrial waste which includes distilleries, dairy plants, pulp and paper, poultry, slaughter houses, sugar industries excluding wastewater is ***approximately 48383 million m^3 of biogas generation annually***.

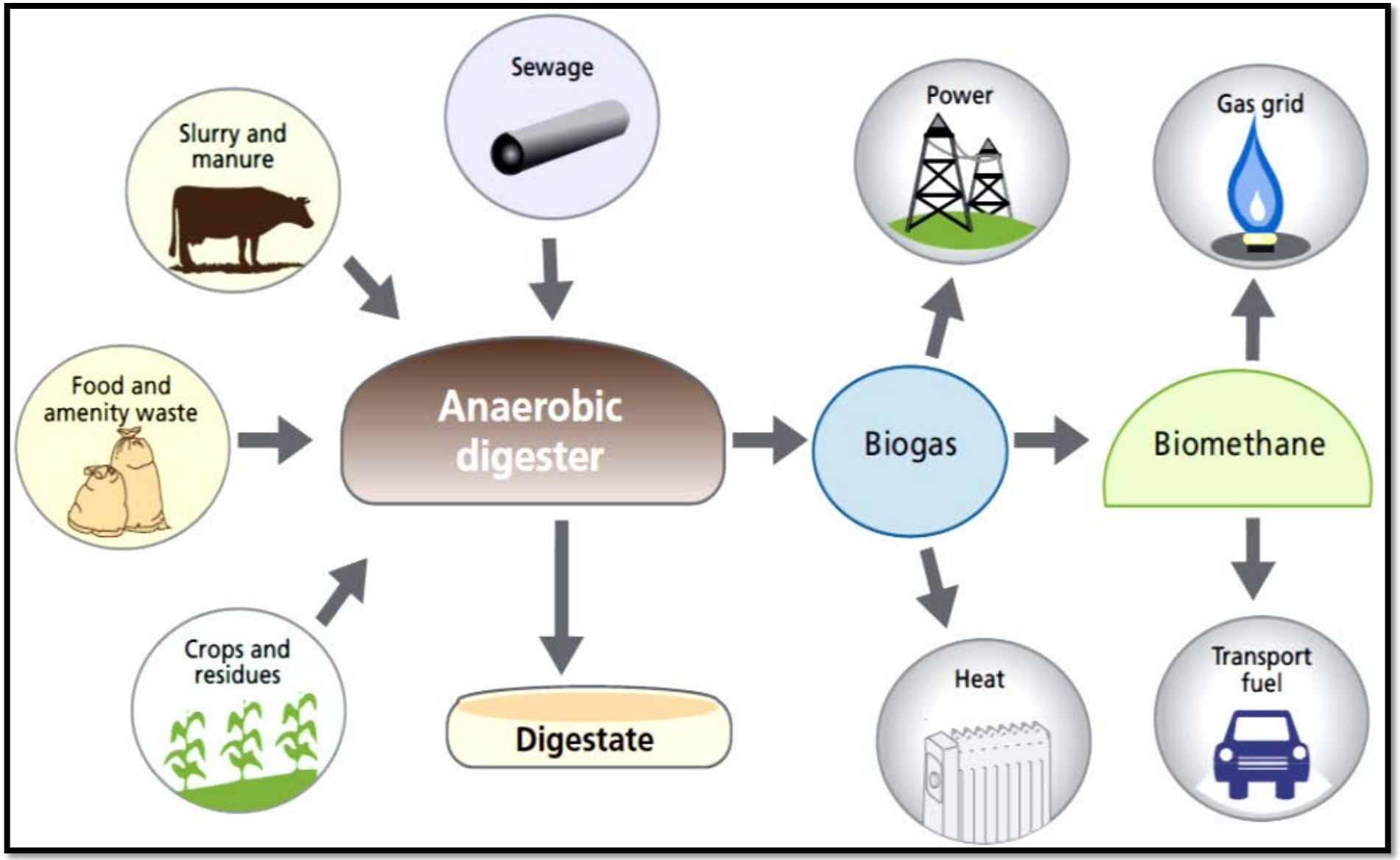
- This much amount of raw biogas if upgraded and bottled can be utilised as a vehicle fuel





Contribution of upgraded biogas in the transportation and cooking sector as a percentage of total petroleum fuels consumption for the year 2011-2012(*Estimations based on the source Indian Petroleum and Natural Gas Statistics - 2011-2012 data and the references quoted in the text above)*

Biogas Production & Utilization



(Source: OFGEM, 2011)

Raw Biogas → Upgraded Biogas

- **A low Grade fuel** (CH_4 55-65 % & CO_2 35-45 %) with lower percentage of methane.
- **Mode of utilisation**
  - The presence of CO_2 besides being non combustible, restrains its compressibility there by making biogas difficult to be stored in containers.

- **A high grade fuel** (CH4 > 90 % and < 10 % other gases) with high percentage of methane.
- **Mode of utilisation**
  - Remote applications
  - Methane burns faster hence yields a higher specific output and thermal efficiency compared to raw biogas when used as engine fuel.
  - Upgrading , compression and bottling facilitates easy storage and transportation as a vehicle fuel

Comparison Between Selected Parameters for Common Upgrading Processes

Methods / Parameters	High pressure water scrubbing	Chemical Absorption	Pressure Swing Absorption	Membrane Separation	Cryogenic
Gas Pre Cleaning Requirement	No	Yes	Yes	Yes	Yes
Working Pressure	9-10 Bar	1 Bar	4 – 7 bar	4-7 bar	40 bar
Methane Loss	1– 2 %	1-2 %	1-2 %	10 - 15 %	1-2%
% purity attained of upgraded Biogas	95-98 %	Upto 99 %	95 - 99 %	Upto 90 %	Upto 99 %
Heat requirement	-	Required	-	-	-
Operating Cost	Low	Moderate	Moderate	Low	High
Initial Cost	Low	Moderate	Moderate	Moderate	High
Process Handling	Easy	Complex	Easy	Easy	Complex

Biogas enrichment and bottling system with biogas vehicle at IIT Delhi, India


BIOGAS OPERATED VEHICLE
Demonstration and Performance Evaluation
IIT Delhi
Sponsored by
PCRA


Biogas
vehicle

Feasible Scenarios for the Adoption of Upgraded & Bottled Biogas in India

Captive/ In-house Use

- Biogas upgrading and bottling in rural areas (Cattle sheds)
- Biogas upgrading and bottling in market communities like hostels, fruit and vegetable market, marriage halls, community toilets.
- Biogas upgrading and bottling in urban areas serving housing societies/ housing clusters (WWTP, Sewage Treatment Plants, medium scale biogas production)

Pilot plant at Bhilwara cattle shed

Technology at IIT Delhi

***Scenario I**: Captive/In-house use (If the scale of biogas production is large then bottled biogas can be sold outside as well)*

Model a: Biogas upgrading and bottling in rural areas (Cattle sheds, dairies)

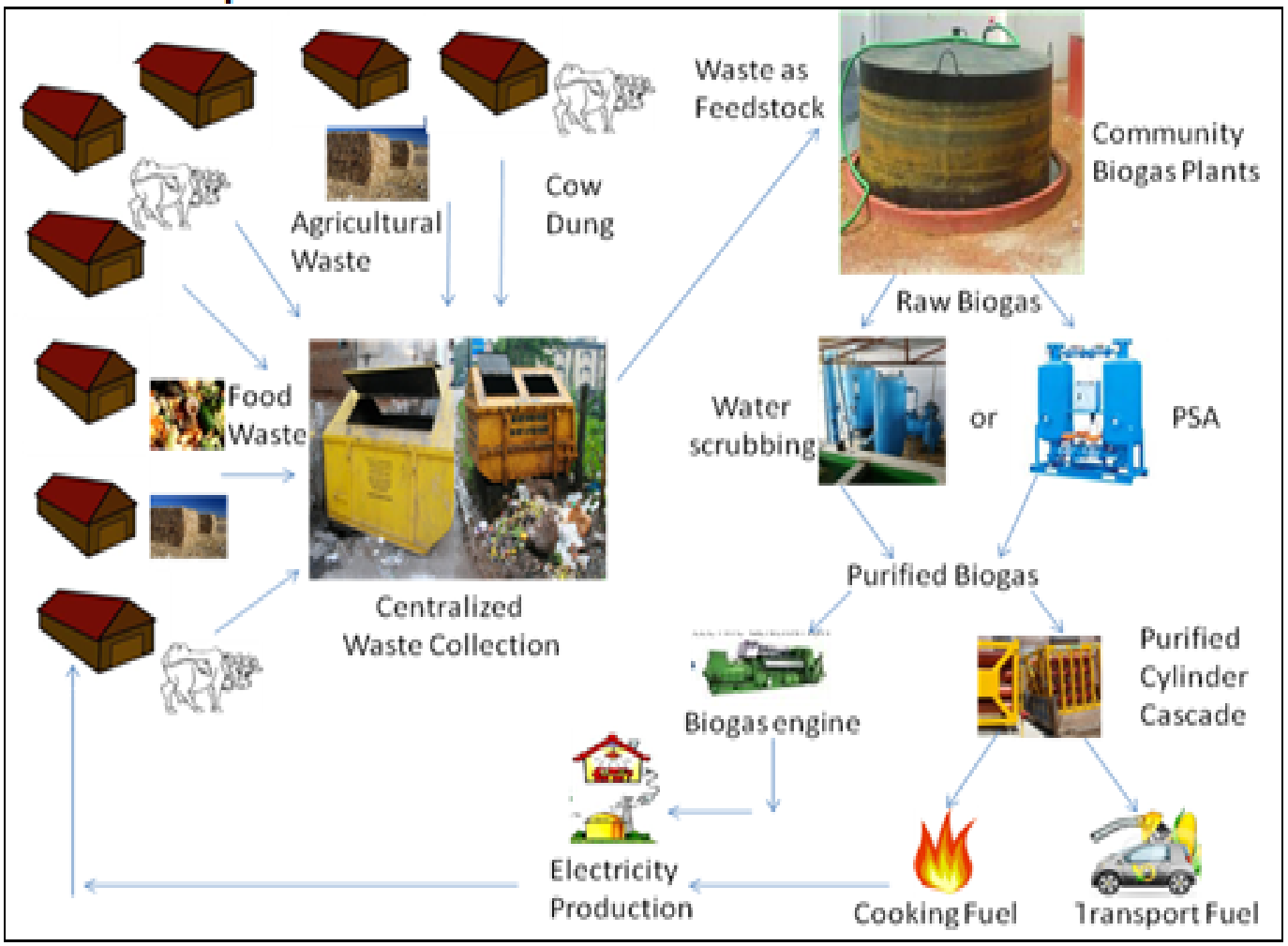
Biogas Plant at Cattle Shed in Jaipur

Biogas Enrichment Plant

Biogas upgrading and bottling plant in cattle shed

Bottled biogas run three wheeler for captive use in a cattle shed

Model b: Biogas upgrading and bottling in communities like hostels, fruit and vegetable markets, marriage halls, community toilets



Schematic diagram of Biogas Entrepreneurship Model I *(Source: Author)*

Model c: Biogas upgrading and bottling in urban areas serving housing societies/housing clusters (WWTP, Sewage Treatment Plants, medium-scale biogas production)

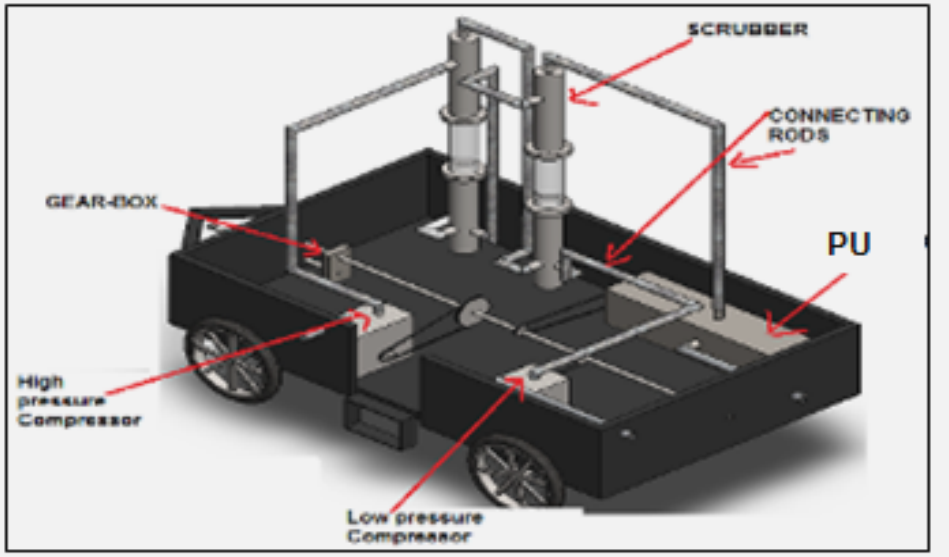
***Scenario II**: Selling of Bottled Biogas as a Fuel*

Model a: Biogas upgrading and bottling at remote location from the site of production of waste (collection of waste from different locations and transportation to a centralised site for biogas production and upgrading)

Selling of Bottled Biogas as a transport and cooking Fuel

Model b: Mobile upgrading and bottling system for cluster of villages

Model c: In urban areas – in housing societies, clusters of households



View of the Mobile Unit (Source: Author)

Community Level Biogas Plant for Piped Distribution of Biogas Near Valsad (Gujarat)

Unnat Bharat Abhiyan...

All available organic wastes should be used for biogas production.

Providing rural and urban energy with sanitation and bio-fertilizer for organic farming

Swachh Bharat Abhiyan...

Various kinds of wastes needs to be handled and disposed off to achieve the objectives.

Strategic

There is strong need to initiate a "National Biogas Technology Mission" in the country.

The Objective

- **Promotion of biogas technology for ensuring energy security, sanitation and bio-fertilizer production using organic waste linking with Swachh Bharat Abhiyan.**

Installation of 10 Million biogas plants having various capacities as per the actual availability of raw material in the field for various applications, i.e., cooking, power generation and automobile application.

Proposal for Implementation strategy

- **Increasing awareness among the rural mass through various programmes.**
- **Providing repair and maintenance facilities for proper operation of biogas plant and associated technologies.**
- **Involvement of SNA, NGOs, entrepreneurs in biogas production and supply**
- **Making it a mass movement as green energy and organic farming initiative**
- **For conducting research and technology development for individual specific organic waste and standardization of biogas plant (family size, community and large scale technology scale up), and technology dissemination.**

Is It The Future

OR

THANK YOU