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Anaerobic Digestion in Rural India: Current Status and Emerging Markets

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Contents

- Resource base for agricultural AD in India
- Technologies/models/scales
- Government policies
- Emerging markets: case studies
- Conclusions

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Overview of resource base

- **Cattle and other bovine population significant and increasing, but growth rate is small**
- **Regional variances in cattle ownership**
- **Predominantly small owners (possessing less than 4 cattle)**
- **Healthy growth of poultries**

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Potential for Agricultural AD in India

Biogas from cattle dung

Total bovine population (2003) : 272 million

Yearly dung production (@12 kg/day/animal) = 1191.3 million tons

Yearly gas production (@30 lit/kg) : 35739 million m^3 /annum

Biogas from poultry litter

Total poultry population (1997) : 347 million

Yearly dung production (@ 200 g/bird) : 25 million tons

Yearly gas production (@ 116 l/kg) : 2938 million m^3/ annum

Total gas production : 19.34 mtoe (387 mtoe total for India)

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Technologies/ Biogas Plant Models commonly used in India

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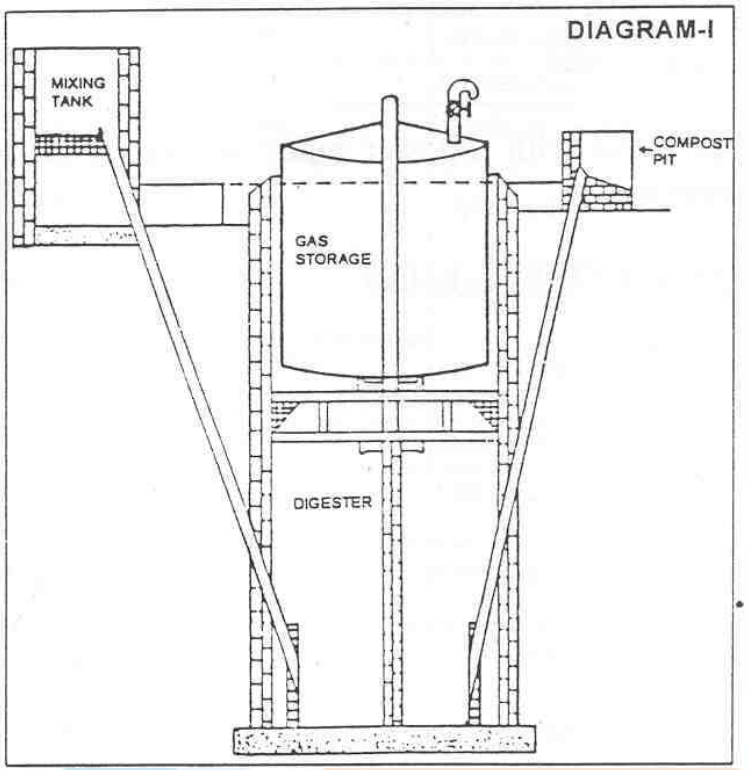
Floating gas holder type Biogas Plant (KVIC Model)

- KVIC model being disseminated since 1962
- Composite unit of a masonry digester and a metallic dome
- Maintenance of constant pressure by upward and downward movement



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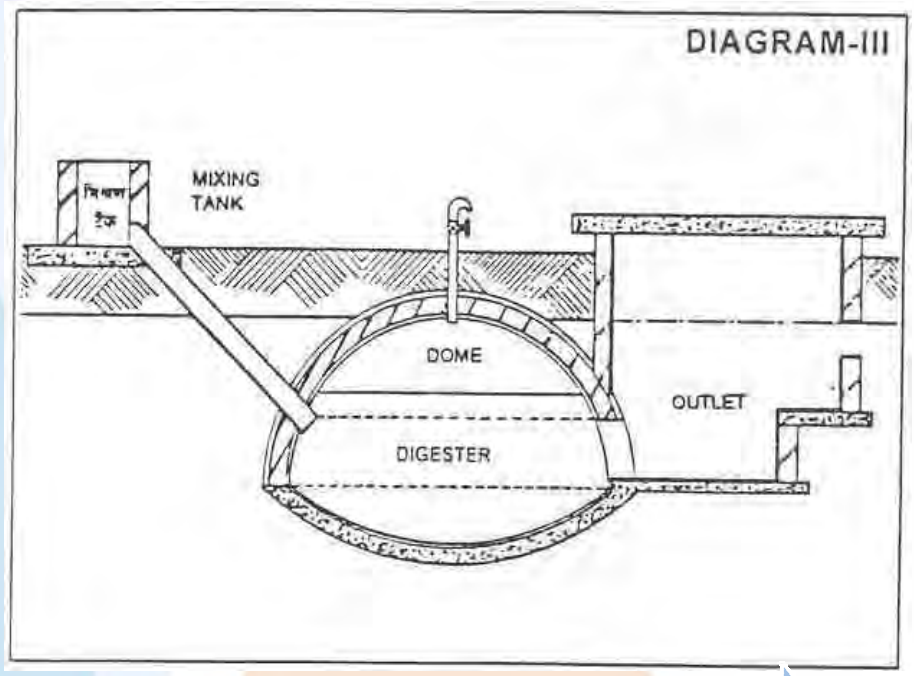
Deenbandhu Model

- Developed in early 80s
- Design consists of segments of two spheres of different diameters joined at their base
- Fluctuating gas pressure
- Lower cost compared to KVIC model



A Deenabandhu Biogas Plant at Deoli Village, Himachal Pradesh.

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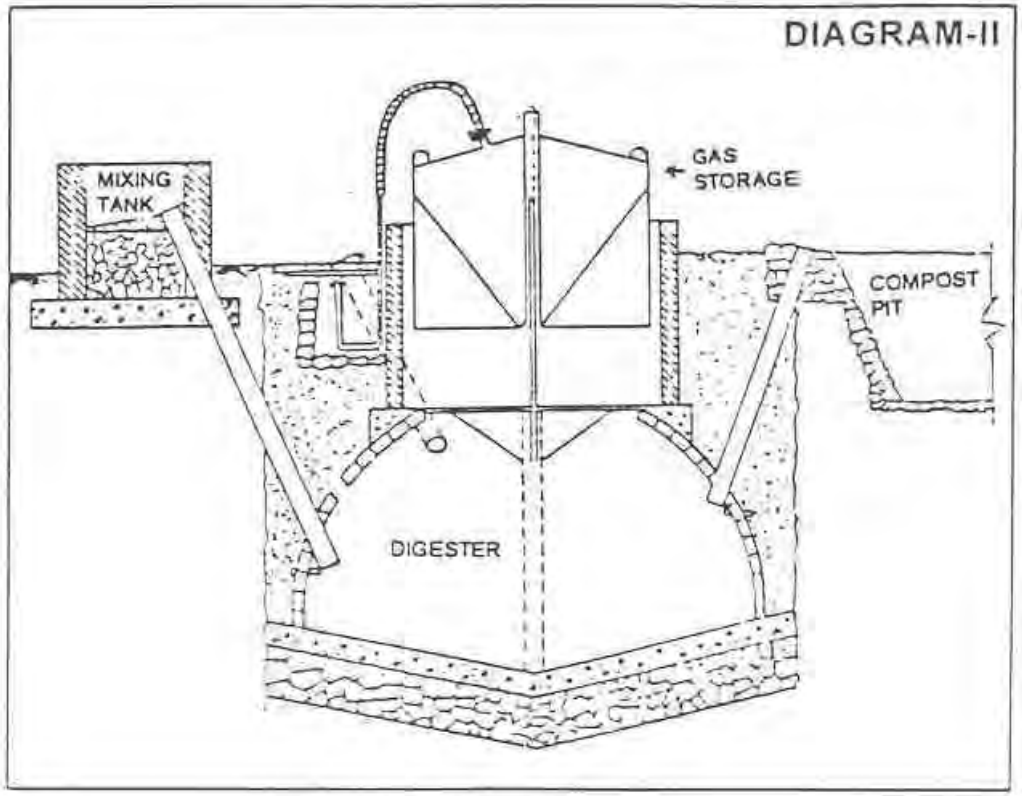
Pragati Model

- Combination of Deenbandhu and KVIC designs
- Lower part of the digester is semi spherical with conical bottom
- Floating drum acts as a gas storage



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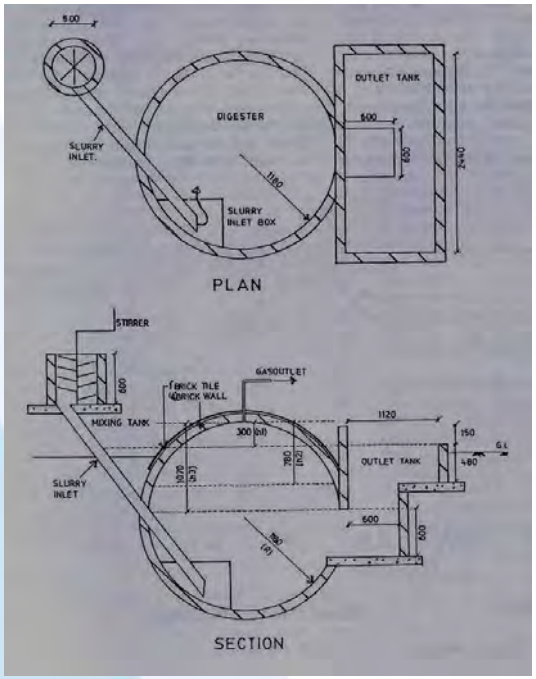
TERI's Mark-4 System



A schematic diagram of the TERi's Mark-4 Bio-gas plant

A view of the TERI's Mark – 4 biogas plant model

Features

- Completely Spherical in shape
- Reinforced dome with layers of Ferro-cement and tile bricks
- Slurry Inlet box to avoid short circuits
- Stirrer to have a homogenous mixture of slurry.
- 60% gas storage

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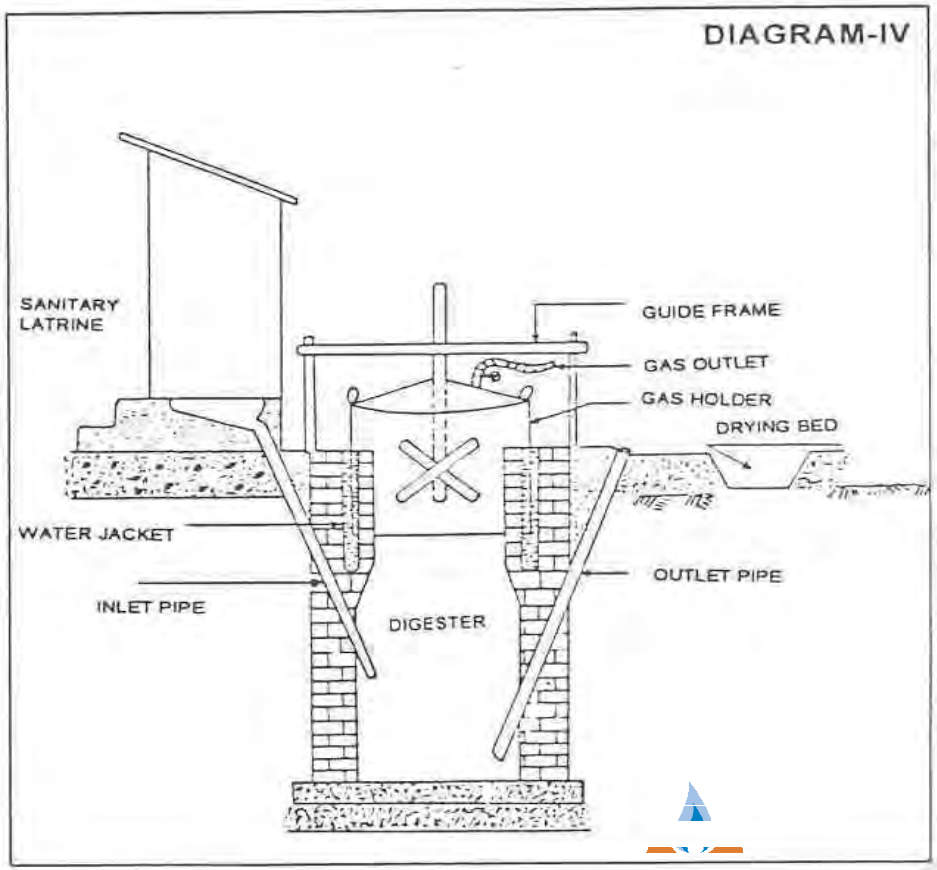
Sanitary latrine with biogas plant

- Toilet linked biogas plants for conversion of night soil into biogas
- Popular in rural areas of some western districts
- Serves the purpose of sanitation and conversion of night soil into manure



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BIMA Digester

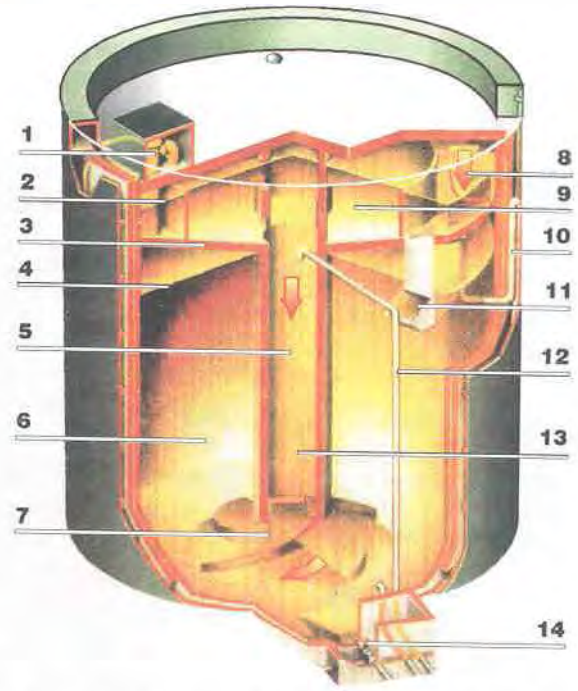

Fig.1

1.Gasdome with automatic mixing valve
2.Max. water level
3.Intermediate ceiling
4.Min. Water Level
5.Input substrate
6.Main Chamber
7.Mixing Wings
8.Effluent Channel
9.Upper Chamber
10.Effluent Pipe
11.Mixing Shaft
12.Feeding Pipe
13.Central Tube
14.Ground Sludge Pipe

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- Advanced system based on the technology of M/s Entec, Austria
- Adopted for a wide range of wastes including MSW, slaughterhouse waste, vegetable wastes and animal dung
- Efficient for such inhomogeneous wastes as It causes mixing of wastes through biogas without any mechanical agitation
- High TS content up to 12%

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TEAM Process:

A Biphasic process for digestion of leafy waste

Acidification

- 6 reactors for extraction of organics
- HRT of 6 days
- Digested waste is a very good manure

Methanation

- High rate methanation reactor- UASB
- HRT-16 h and COD reduction- 90%
- Treatment of high strength leachate to produce biogas (70-75% CH_4)

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Central financial incentives approved for 2006-07 under National Biogas and Manure Management Program (NBMMP)

- Varies for different categories and states (subsidy higher for lower caste etc, and for north eastern states)
- Subsidy of Rs 2700-4500 for KVIC and other models
- Additional subsidy of Rs. 500 for toilet linked plants
- Financial assistance provided for repair of non functional plants, for training, communication and publicity, and demonstration projects for digested slurry.

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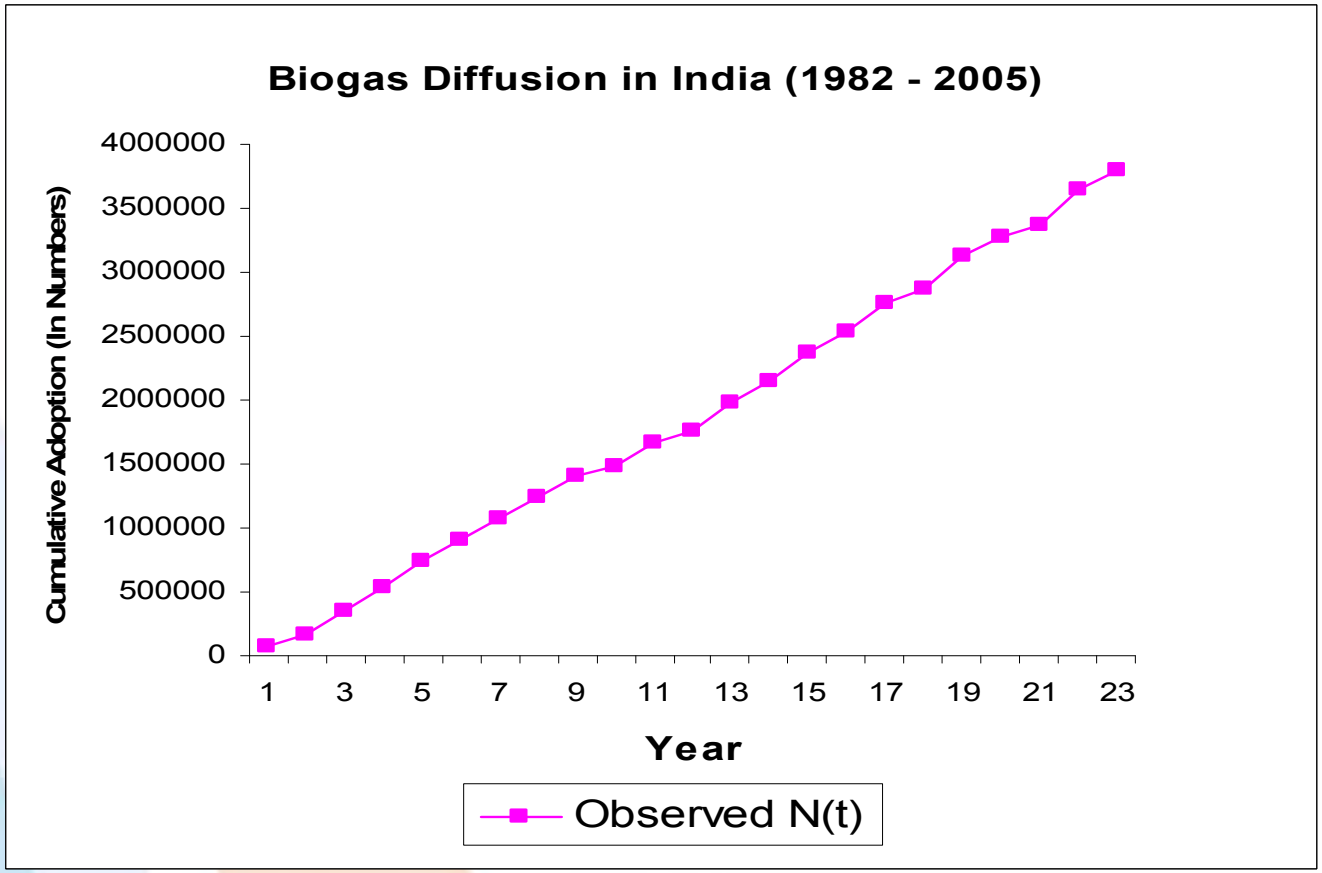
Biogas diffusion in India (1982-2005)



Bass: $dN(t)/dt = (p + q\ N(t)/m)*(m - N(t))$

p	*q*	*m*
0.0197048	*0.0634341*	*6343409.95*

t -peak sales*
14.0625139

N(t) - Cumulative Adoption at time t
p - Coefficient of Innovation or External Influence
q - Coefficient of Imitation or Internal Influence
m - Total Potential

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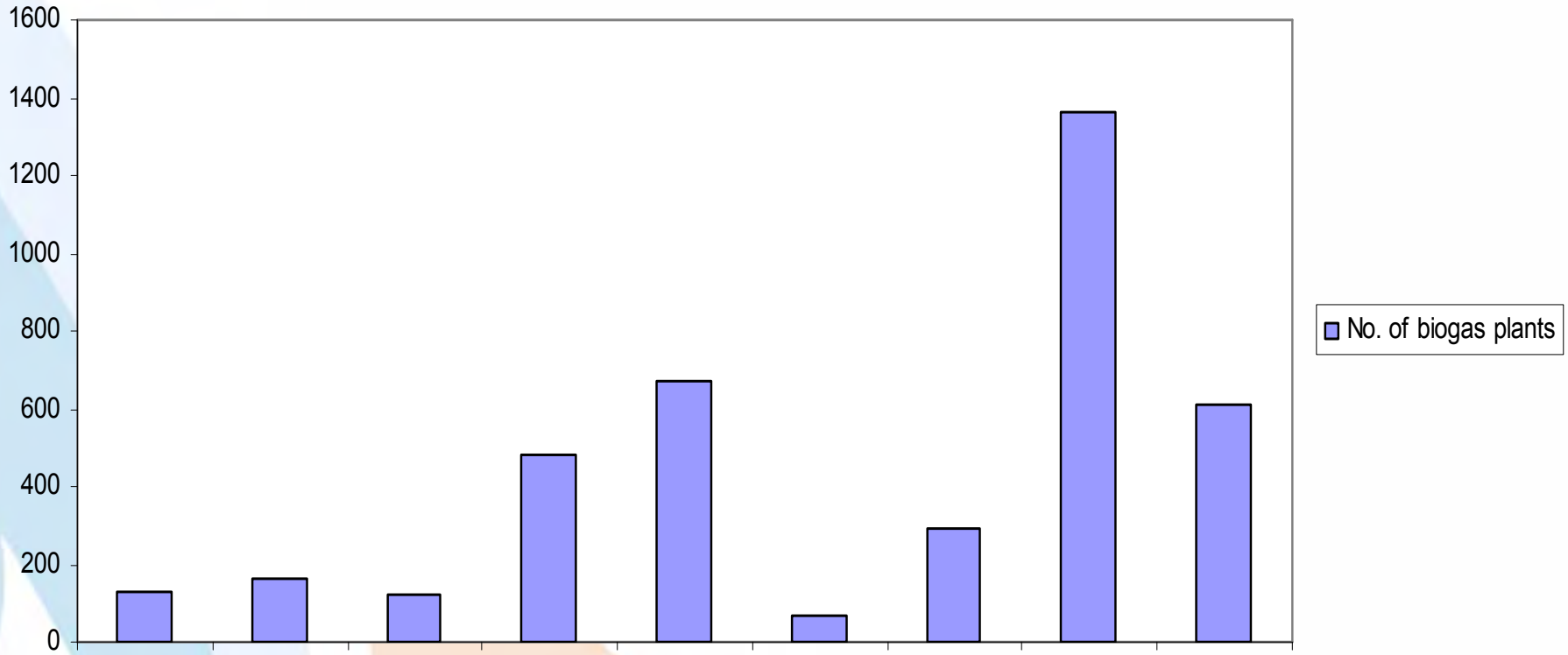
Community biogas systems, institutional plants, and night soil based plants (till March 2002)



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- Current dissemination mainly through subsidies
- Dependency on imported high cost designs
- CDM as driver for emerging markets
- Conversion to CNG equivalent and decentralized bottling for possible future markets

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Case studies of emerging markets

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Case study 1 : Large AD system based on cattle dung

- Raw Feed (solid concentration 16%) : 235.0 tonnes/day
- Location : Ludhiana, Punjab
- Type of digester : BIMA
- Digester Retention time : 27 days
- Biogas produced : 9116.0 m^3/day
- Biofertilizer Production : 47 tonnes/day
- Auxiliary power requirement : 2600 kWh/day
- Energy generation from plant : 19800 kWh/day
- Power to be exported to grid : 17200 kWh/day

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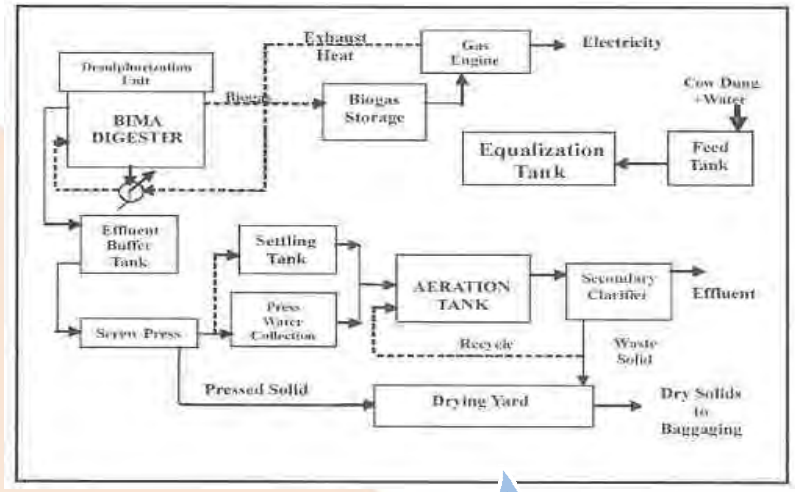
Biogas collection

Two BIMA Digesters and the Gas Holder

Gas engine with associated piping network



Layout of the Process Plant

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Case study 2: Poultry litter biomethanation plant

- Raw feed : 200 tons/day
- Location : Namakkal, Tamil Nadu
- Technology: BIMA digester
- Commissioned: March 2005
- Biogas produced : 18000 m^3
- Retention time: 21 days
- Biofertiliser production: 40 tons/day
- Energy generation from plant: 1.5 MW
- Power exported to the grid: 26760-27686 kWh/day

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Case study 3: Bundling of small plants for carbon credits

• Capacity of biogas plants	2 m^3
• Biogas application	Cooking
• Location	Bagepalli
• Coordinating agency	Women for sustainable development
• Baseline fuel	wood, kerosene
• Total annual baseline emissions (tCO_2e/yr)	3.56 per household
• Total annual CER generation from 5500 biogas plants	19553 tCO_2e
• Total CER for 7 year crediting period	136874 tCO_2e
• Status	Project registered with CDM executive board on 10 December 2005

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Constraints for market development in AD

- Small owners, distributed resource base
- Products of AD (methane, wet manure) not easily saleable in their current forms
- Private players in industrial AD (e.g.,distillery effluents), but few in agricultural AD
- Very little R&D in AD
- Policies not in place for encouraging entrepreneurship

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Conclusions

- High potential for biogas generation from varied sources (animal dung, agro residues)
- Several digester designs for dung, but few for solid wastes
- Policies exist to encourage small scale AD for farmers and electricity generation from large scale plants
- Several constraints for market growth in AD
- Need for R&D and technology development

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