Anaerobic biogas generation for rural area energy provision

Presented at the Joint Workshop
19 – 21 August 2002
Durban

Overview

- Description of the technology and processes
- Description of the residential and institutional pilot plants
- Cost analyses
- Additional benefits of BGD's
- CDM opportunities
- Concluding remarks

Biogas process

- Produced from organic materials under anaerobic conditions
- The process of decomposition & fermentation is referred to as “digestion”
- Requirements: manure, water, warmth (37^{o} C)
- Bacterial activity is dependant upon:
  - Ratio of water to organic materials
  - Temperature in the digester
  - Type of substrate (C:N ratio)

Biogas process (2)

- Main constituents are methane gas (CH_4) and carbon dioxide (CO_2)
- ~ 70% and 25% respectively
- Balance made up of traces of other gases
- 2 cows OR 60 people $\rightarrow$ 1 m^3 CH_4 per day
- 1 m^3 CH_4 $\cong$ 20 MJ energy $\cong$ 0.5 litre petrol $\cong$ 0.4 kg LP gas

Collection of firewood

- A common sight in rural areas
- This leads ultimately to deforestation and a massive influx of alien vegetation
- Health problems arise from the continued indoor use of wood fuel
- Social impacts

Or, use a convenient renewable resource

Pilot biogas digesters:
Maphephetheni, Ndwedwe, Durban

Residential

Commissioned in Nov 2000, includes toilet input

Volume = 9.5 m^3

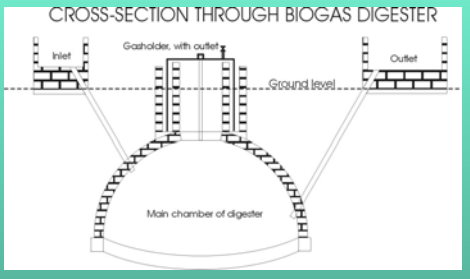
School

1000 kids, 16 toilet input, 2 cow input

Volume = 40 m^3

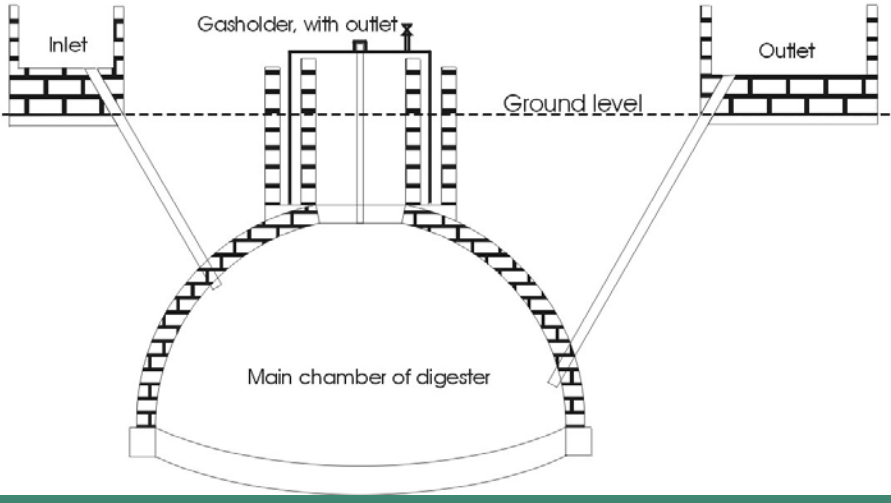
Biogas plant currently being commissioned

Residential biogas digester specs



- 9.5 m^3 digester
- floating dome gasholder of 1.5 m^3 capacity (which fills up twice daily)
- Input = 1 toilet (10 people) + 4 cows
- running water at hand (note recycling of waste water)
- Enough energy (1.2 kg LP gas) to power a fridge continuously, and a gas cooker for 3 hours per day

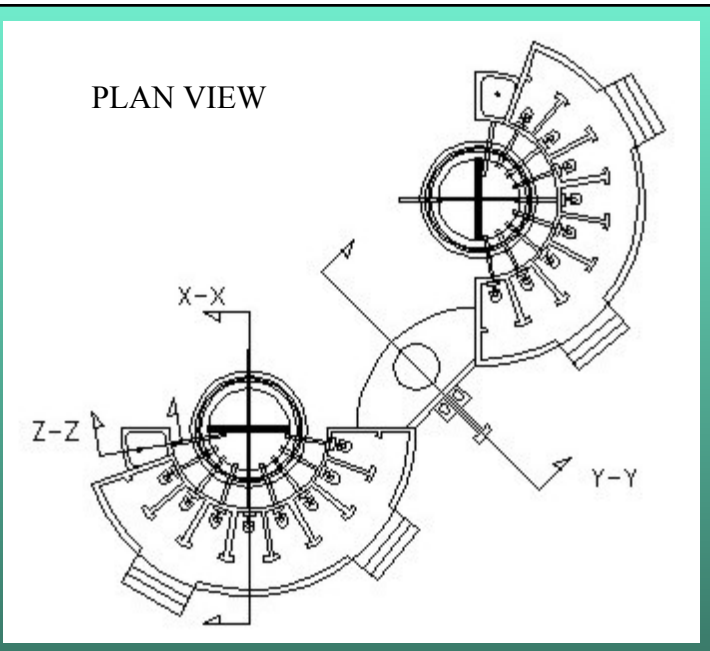
CROSS-SECTION THROUGH BIOGAS DIGESTER



School biogas digester specs

- 40 m^3 digester (2 x 20 m^3 digesters)
- 2 floating dome gasholders of 11 m^3 capacity
- Input = 16 toilets (1000 people) + 2 cows
- running water at hand
- Enough electrical energy to power 10 desktop computers for 8 hours every day
- Biogas is also used for cooking and refrigeration at the school

PLAN VIEW



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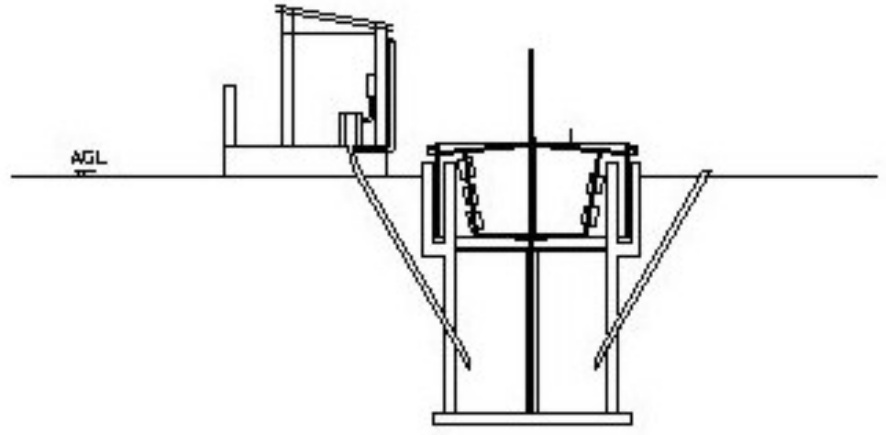

Schools electrification potential

- Currently, about 16,000 rural schools without electricity – and many 1000's of these will not get grid power in the foreseeable future
- Half of these have inadequate, or no, sanitation facilities
- Biofertiliser increases soil fertility, impacts positively on school feeding schemes, *muthi* plants, and HIV/AIDS
- Suitable starting point for community development (Food in Schools Self-Help to Health program)

Institutional (school) biogas digester: What the DME has to say …

The Project is of considerable importance to South Africa as it provides a potential sustainable solution to off-grid power generation. Appropriately designed and applied biogas/genset hybrid systems could add sustainable and adequate electricity capacity to off-grid schools to utilise modern technology such as computers and the Internet, while simultaneously enhancing sanitation and providing organic fertiliser at these institutions. The Project intends to research by practical demonstration the applicability of the system; the success of the project could have an enormous impact on the rural schools' energy and health provision policies in South Africa.

Residential system (7 kWh/day *thermal*): the costs

- Biogas digester + toilet = R 5,500
- LP Gas involves renting a gas bottle, buying a cooker and buying LPG on an ongoing basis; initial capital cost = R 180
- Over 20 years, the levelised energy cost for the two systems is identical, at R 0.30/kWh

School system (8 kWh/day *electrical*): the costs

Power supply	**Life cycle cost (20 years)**	**Levelised energy cost**
Biogas/2 kVA diesel	R 225 000	R4.65/kWh
Stand-alone solar	R 280 000	R 5.75/kWh
Stand-alone 2 kVA diesel	R 221 000	R 4.56/kWh

Additional benefits

(not accounted for in the costing)

- Sanitation (Cholera!)
- Social/menial labour
- Local/global environmental
- Health (respiratory/eye)
- Food security
- Accessible energy
- Job creation

Clean Development Mechanism opportunites

- Climate mitigation: each year one residential digester offsets the emission of 4.9 tonnes of CO2
- Potential for 300,000 residential BGD's in SA alone, or 1,455,000 tonnes CO2 per annum
- These figures based both on carbon offsets (avoided fuelwood burning) as well as avoided methane emissions from drying dung.
- Commercial opportunities includes dairies, feedlots, and piggeries

Concluding remarks

- From a sustainable development perspective, biogas technology, while providing all the benefits outlined above, can also be utilised as a means to direct foreign investment towards the aims of the National Development Program, and the Integrated Development Planning process.
- It achieves these results independent of the fluctuations in the value of the South African Rand and by generating employment opportunities in local communities.
- Biogas technology should be increasingly seen as the favoured alternative to many of South Africa's, and communities', development problems.