

Biogas Technology

Successful projects in Asia and Africa



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With help from



What is Anaerobic Digestion (biogas)?

- Cow is anaerobic digester:
 - gut has population of organisms: break down food for energy
- Biogas plant: contains slurry at 35°C, no oxygen, contain slurry, gas tight



Two scales of biogas

- Large-scale systems
- Industrial processing
- Tank volume:
10,000 m³ and
above
- Feed material:
500 tonnes a
day and
upwards



Two scales of biogas

- Small-scale systems - Asia
- Domestic processing
- Tank volume:
1 to 10 m³
- Feed material:
2 to 60 kg a
day



Inputs to a biogas plant

- Cattle dung seen as good feedstock:
 - correct organisms;
 - food chewed so accessible to organisms
- Other animal dung: pig, horse, chicken
- Human sewage



Inputs to a biogas plant

- Food processing residues
e.g. market wastes
- Vegetable matter
gives more gas
per kg, than dung
(animals & humans
already used energy)
- Used to clean
waste waters
e.g. from coffee or
sugar production.



Inputs to a biogas plant

- Energy Crops

Grown especially for energy production

- Wastes can be mixed: e.g.

- Dung + sewage
- Food residues + sewage

- All can be used at any scale:

- Domestic to Industrial



Outputs from a biogas plant

- Biogas: 60% methane 40% carbon dioxide: high grade fuel
- Used for cooking
 - Replace firewood and charcoal, so reduces deforestation.
 - Replace LPG and kerosene, so saves fossil carbon



Outputs from a biogas plant

- Biogas: used as an engine fuel
 - Static engines to generate electricity
 - Need large amounts of feed material
- 1 tonne/day = 1 kW
- Compress gas - use in vehicles
 - Need 50% energy in gas to do so.



Outputs from a biogas plant

- Compost - value as an organic fertilizer
- Can be used as liquid or dried
- Better to absorb in dry biomass (straw) and then leave to compost



Outputs from a biogas plant

- Compost –add vermi-compost to get very high value fertilizer
- Gives 30% greater crop yields
- Worth £30 a tonne cash-in-hand
- Reduces pests and diseases



History of biogas

- Marsh gas used in C10 BC
 - to heat bath water (Assyria)
 - to make salt from sea water (China)
- First biogas system in India –
 - Leper colony in Mumbai 1859
- “Monster Septic Tank” gave gas for street lights in Exeter 1895.
- Used in sewage systems in Europe from 1930s.

History of biogas

- China
 - 1920: Rural biogas systems developed
 - 1958: National programme started
 - 1978: 7 million plants built, but only 3 million working
 - Part of Chairman Mao's "Great Leap Forward"
 - Emphasis on rural self-support,
 - Built by local people
 - But lacking in quality control

History of biogas

- China
 - 1979: Chengdu Biogas Centre offers quality control
 - New emphasis on training, follow-up and monitoring
 - Individual family plants, use pig dung, human sewage and food wastes
 - Sanitation + gas + compost
- 2009: About 17 million biogas plants (< 50% success)

History of biogas

- China
 - Mainly use underground masonry plants of size 4 to 10 m³
 - Often use a concrete plug in the top of the dome for easy access.
 - Some systems use the approach of removing the slurry every 6 or 12 months as fertilizer and start again.

History of biogas

- India
 - 1897: Mumbai system gas used in lights
 - 1907: gas used in an engine
- 1951: KVIC national programme
 - Developed floating drum design
 - Plants for individual farmers of volume 7 to 35 m³ with cattle dung as feed stock
 - Centrally planned programme with government targets

History of biogas

- India
 - 1961: PRAD (state sector) involved
 - Adapted Chinese dome design as “Janata” plant (4 to 10 m³)
 - 1981: AFPRO (NGO sector) involved
 - Adapted Chinese dome design as Deenbandhu plant (2 to 8 m³)
 - 1981: DNES (government) gives subsidy.
- 2009: 12 million plant built
>60% success rate

History of biogas

- India
 - 2005 ARTI won Ashden Award for a floating drum design made from HDPE water tanks
 - Designed for urban families of volume 1 to 2 m³ with food wastes as feed stock
 - 2007 Biotech won Ashden Award for similar system, made from glass reinforced plastics.
 - Domestic, Institutional and Market scale

History of biogas

- Nepal
 - 1955: Demonstration plant in school
 - 1968: Indian (KVIC) plant at exhibition
 - 1975: Government programme involved Development and Consulting Services (aid programme) and Agricultural Development Bank of Nepal.
 - 1976: Gobar Gas Company set up to continue programme as commercial operation.

History of biogas

- Nepal
 - Pilot programme of 95 plants used KVIC design with metal gas drums.
 - USAID funded R&D project developed fixed dome design: cast-in-place
 - Cattle dung used as feed stock for small farmers, using 4 to 20 m³ systems
 - Community plants tried, but social problems prevented success.

History of biogas

- Nepal
 - 1986: Transferred to local management with UNDP funding and Dutch (SNV) help
 - 1995: BSP started: central co-ordination, using many contractors (now 76)
 - SNV and GTZ provided subsidy
- 2009: 189,122 plants built
98% success rate
- CDM mechanism gives subsidy
 - 2006: won Ashden Award

History of biogas

- Africa
 - Rwanda: Kigali Institute of Science and Technology built sewage systems for overcrowded prisons (10,000 people)
 - Underground masonry plants: 100 m³ volume, linked to make 1,400 m³.
 - Saves 50% of wood for cooking.
 - Funding from Red Cross
 - 2006: Ashden Award

History of biogas

- Africa
 - Biogas Technology West Africa Ltd. building sewage systems for hospitals, schools, colleges, etc.
 - Underground masonry dome systems 60 to 160 m³ volume.
 - Water recovered and used to flush toilets.
 - Gas used for cooking.

Biogas Technologies

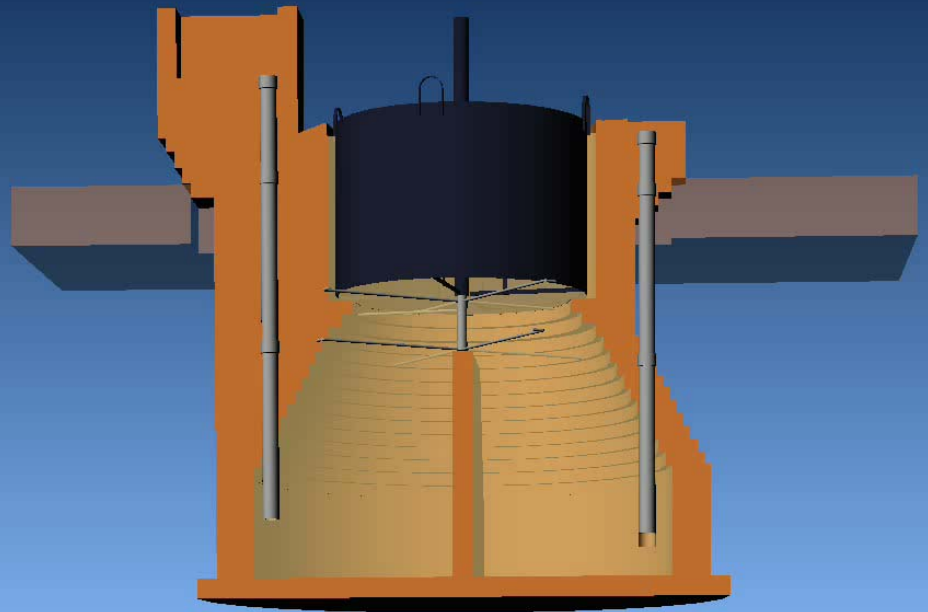
Drum

- Floating drum plant (KVIC design)
- Easy to see gas amount
- Drum can be removed and repaired



Biogas Technologies Drum

- Steel drum expensive
- Needs to be transported to site
- Needs to be painted
- Can be removed if loan not repaid



Biogas Technologies

Drum

- Several biogas projects in East Africa have used KVIC design

BUT

- Steel drum can rust



Biogas Technologies Dome

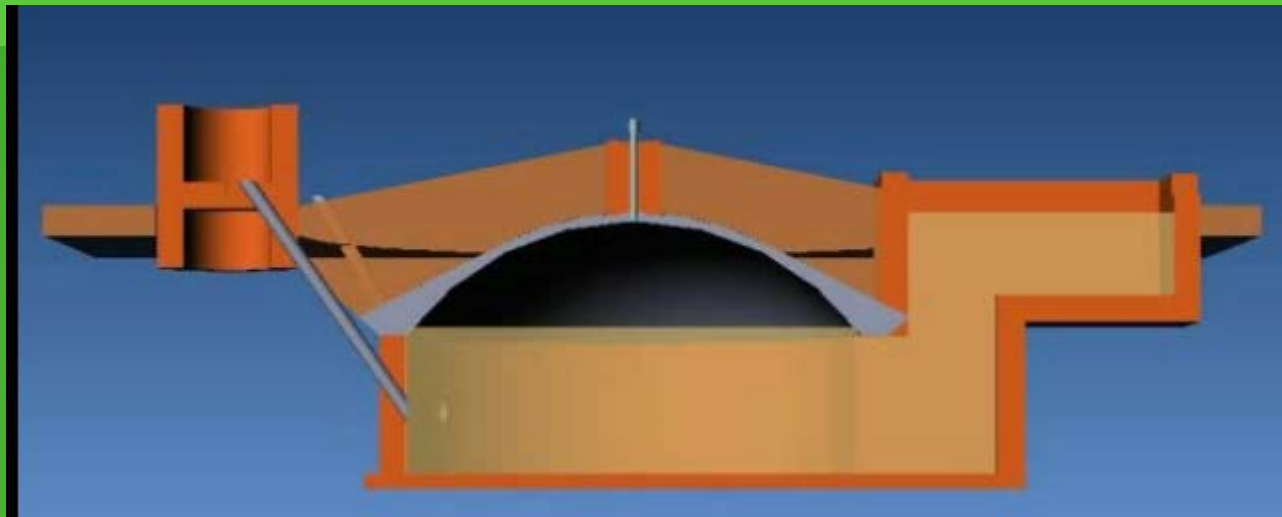
- DCS design as used in Nepal, similar to Janata design (PRAD) in India
- Uses cast-in-place concrete dome
- Lower cost, but high labour requirement



Biogas Technologies

Dome

- Uses displacement of slurry into reservoir to collect gas
- Concrete dome needs to be sealed to make it gas tight
- Long life time, if made correctly



Biogas Technologies

Dome

- Deenbandhu design made of bricks
- High labour requirement
- Uses displacement principle
- Long life time, if made correctly



Biogas Technologies Dome

- Brick dome used for 100 m³ plants
- Linked up to give 1,400 m³ plant
- KIST project for prisons in Rwanda.
- BTWAL for hospitals, school etc. in Ghana.



Biogas Technologies Dome

- Construction approach simple
- Needs highly skilled masons
- Spherical shape gives high strength
- Need weight of soil to keep dome under compression.



Kingdom Bioenergy Proposed Design

- Prototype built in 1983 in Nepal
- Uses an underground concrete system
 - Used in agricultural college.
 - 8 more built in 2007 for large agricultural operations in Nepal



Digester used with pre-digester

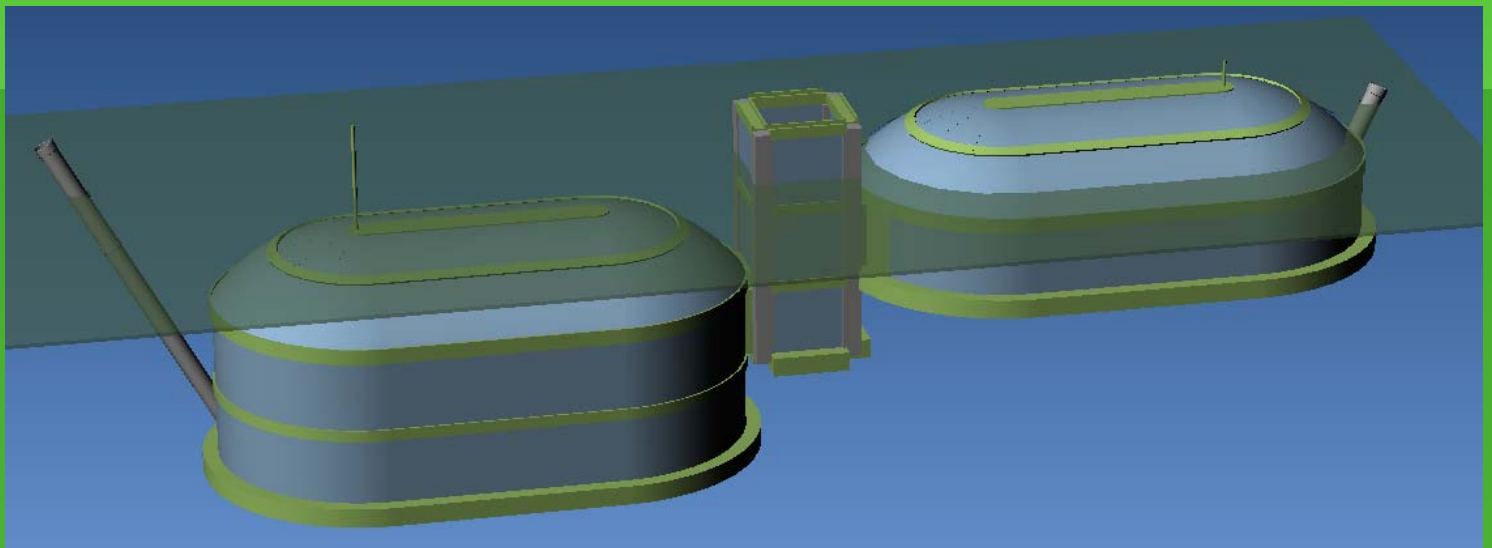
Bioplex system (www.bioplexltd.com)

- Trailer mounted – reduces handling
- Fixed mounting also possible
- 57°C fast hydrolysis meets PAS110 for compost



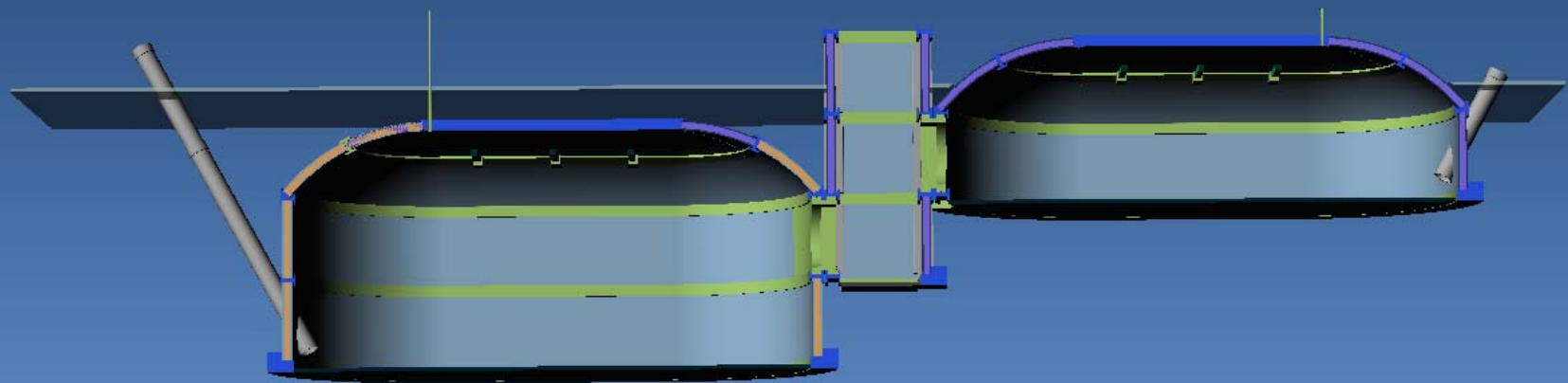
Advantages of Kingdom Bioenergy digester

- Flexible system: can be made in a range of sizes to suit farm operation;
- Low cost: based on underground Asian designs;



Advantages of Kingdom Bioenergy digester

- Adapted to UK:
 - pre-cast concrete sections; quick to build
 - well insulated
- Use farming or food residues or both



Income/saving streams from AD

- Gas
 - Generate electricity (ROCs)
 - On farm for heat (replace LPG)
- Compost (smell free)
 - On farm to replace inorganic fertilizer
 - For sale as compost (PAS 110)
- Gate fees for food waste
- New opportunities for biogas in UK and across the world

Questions?



www.kingdombio.com

Book: Running a Biogas Programme: A Handbook

Practical Action Publishers (1988)

Updated version being written



www.ashdenawards.org