Shaktisteller Energy Solutions is a leading up company that renders effective renewable energy solutions. The company focuses on well differentiated technology to provide effective **renewable energy systems** for various rural & urban sectors. We also provide sustainable solutions for solar rooftop systems systems across the country. Shaktisteller Energy Solutions design, build and operate power plants that generate additional benefits for its customers.

The manual developed by **Shaktisteller Energy Solutions** on the design and maintenance of family size biogas plants illustrates the importance of adapting biogas technology to ensure that it works in the local setting, and that its use can be sustained. Our plant has contributed locally towards the reduced use of firewood for cooking and other activities, leading to a reduction in greenhouse gas emissions. Vegetation has been under less pressure, especially in the target villages, as a result of the decreased use of firewood.

Biogas

Biogas is flammable gas obtained from a process called Biomethanation using methanogens or methane producing bacteria. In an anaerobic condition organic waste is digested by methanogens that emit primarily, CH4 (60-70%), CO2, small amounts of H2S, water vapour and other trance elements. The bacteria multiply in an ideal temperature of 25-35°C which is easily available in the tropics. Through biogas we can produce heat for cooking or boiling water and with larger quantities of organic waste, electricity can also be produced. The bi-product of producing bio-gas is slurry of concentrated liquid manure ideal for gardens and farming. By implementing Biogas, we also do out bit to the environment by capturing Methane which is a harmful Greenhouse gas, otherwise contributing to global warming. Interest in biogas systems exists with respect to various objectives: a renewable source of energy for cooking fuel, conversion of manure into an improved fertilizer, waste recycling, rural development, public health and hygiene, pollution control, environmental management, appropriate technology, and technical cooperation.

Comparison of Shaktisteller Energy Solutions water jacketed model biogas plant

Table 1

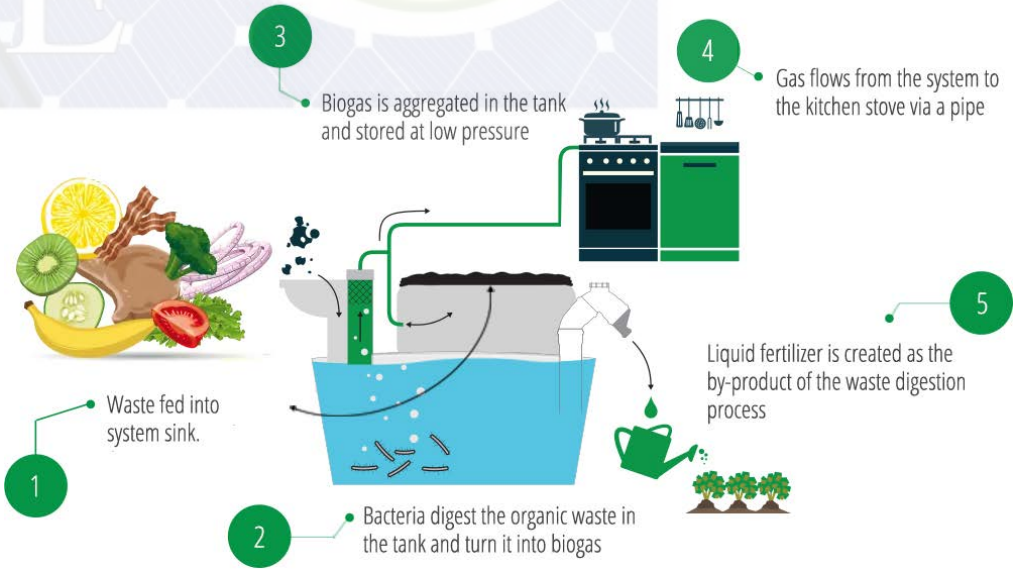
Sl. No.	Parameter	SSE biogas plant	Ordinary model
1	Material of construction	Fiber	Concrete, bricks, steel
2	Space required	Very less	High
3	Gas pressure	Constant	Variable
4	Effect of temperature	Very less	More
5	Maintenance	None	High
6	Amount of feed	Very less	More
7	Investment	Less	High
8	Payback period	2 years	3-4 years
9	Installation	Very easy	Difficult
10	Portability	Yes	No

Anaerobic digestion

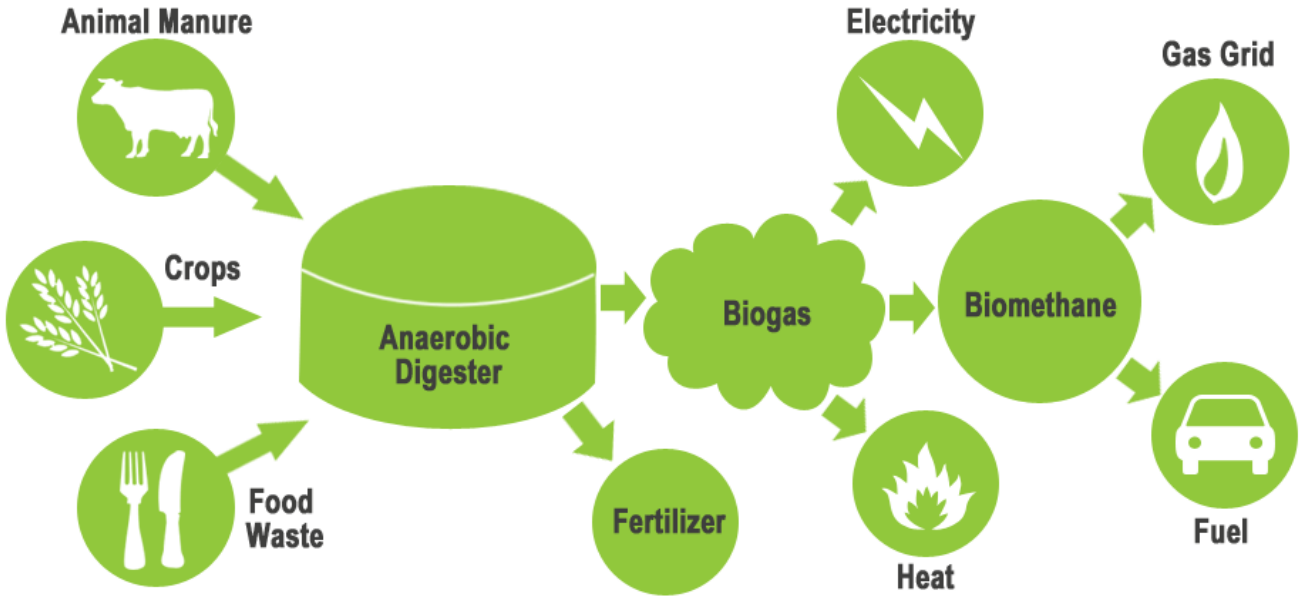
Anaerobic fermentation is the technology used in this treatment plant. The anaerobic fermentation technology has been used for years for the production of biogas plant. The technology may be used for industrial as well as municipal wastewaters. Different models has been developed by different countries on the basis of their requirement. **The Shaktisteller Energy Solutions** adopt KVIC floating drum model which has been developed by *Khadi and Village Industries Commission* and its an approved model of Ministry of New & Renewable Energy, Government of India. The advantage of this model is its low construction cost, high efficiency and can be used for wide range of waste.

There are four key biological and chemical stages of anaerobic digestion:

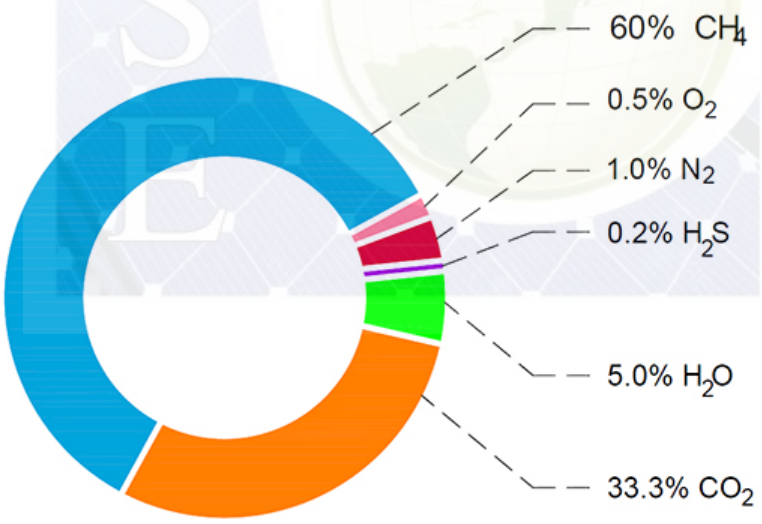
1. Hydrolysis
2. Acidogenesis
3. Acetogenesis
4. Methanogenesis



Anaerobic digestion process:



Biogas Composition:



BIOGAS COMPOSITION MOL%

Our biogas plants can be constructed at individual houses, hotels/restaurants, industrial canteens, institutions, star hotels, college/school hostels, cattle farms, poultry farms, agricultural farms, where ever the bio waste is dumped. Our models have more advantage compared to conventional models.Our portable models can be placed without digging and can be even placed in terrace.

Our biogas plants are known for the following features:

- Excellent Strength
- Completely made up of fiber reinforced plastic
- Expert Fabrication
- Long Life (life span upto 25 years)
- Small space consumption
- Completely portable
- Cost Effective
- Zero maintenance
- High gas output with small quantity of kitchen waste

Components

1. Waste inlet: The organic solid waste is mixed organic waste water in a 1:1 ratio to achieve a homogenous mixture and poured in through this inlet. For obtaining the right bacteria to digest this waste, a one-time dumping of cow dung is required and the bacteria within is allowed to multiply after which the organic waste can be put in everyday

2. Digestion chamber: Anaerobic decomposition takes place and methane gas rises within the chamber while the solid and liquid settle at the bottom

3. Floating dome: The gas rises into a fiber dome or fiber coated metal dome placed above the digestion chamber that constantly floats in a small pool of water. As the gas rises into the dome, the dome also rises and exerts pressure on the internal gas and slurry

4. Gas outlet & tube: The pressure from the dome causes the gas to pass through the gas outlet into a tube which is connected to a gas stove placed in the kitchen

5. Slurry outlet: The solid and liquid waste that collects in the digestion chamber, will rise into the slurry outlet and can be collected with a bucket.

Specifications of biogas plant

Table 2

Sl. No.	Size(cum)	Daily Solid Waste(kg)	Cow dung for installation	Gas Production(hrs)
1	0.75	1.5	20L of 15bucket	1.5
2	1	3	20L of 25bucket	2.5
3	1.5	5	20L of 30bucket	4
4	3	10	1000kg	8
5	4.5	15	1500kg	10

Method of installation:

Site & size selection

1. Select an open sunny site to get the maximum efficiency of the biogas plant.
2. Select the site near the kitchen to avoid condensation and other problems.
3. Select the size according to your waste generation ,availability of area and use
4. Connect the valve to the gas holder by applying proper quantity of Teflon tape. Make sure there is no leakage in between the gas holder and valve.

Placement of the bio gas plant

1. Keep the biogas plant with care.
2. Keep the outlet of slurry as per you convenience to collect and handle the rich slurry for manure.
3. Provide some container/chamber/channel to collect and use the slurry from outlet. In beginning stage larger amount of slurry will be produced.

Charging of biogas plant

1. Charge the biogas with cow dung(refer table2)
2. Cow dung should be fresh. Not that putting dry cow dung will effect the functioning of the plant.
3. Cow dung slurry to be mixed with water keeping ratio 1:1
4. Feed the cow dung and water mixture through the inlet pipe.
5. Continue the process till complete quantity (refer the table 2) of mixture is fed into the plant. stop the process when dung filled is coming out through the discharge pipe(Out let)
6. Now open the valve which is connected to the gas holder and fill fresh water in the water jacketed column. Once water is filled to the maximum close the valve in off position.

Biogas generation

1. Keep the valve in close condition to make the generation process initially.
2. Keep monitoring the outlet initially to check for slurry blockage.
3. It takes around 3-6 days to generate biogas depends on the weather and initial cow dung feed. Once the gas is formed the gas holder will lift to its maximum.
4. The gas holder floats in the fresh water. It will attract mosquito, Please add little amount of kerosene to this water.
5. Summer is the best time to initiate the process as the temperature remains around 35-40 Deg. C. which is ideal for biogas generation.
6. Release the first gas generated as it may contain air content.
7. Again keep for a period of 2-3 days and note the drum has lifted and release the gas.
8. Connect the gas valve and delivery pipe for the end use of gas. Ignite the stove and start feeding the biowaste in prescribed quantity. If the flame level is low or the stove didn't ignite, continue step 6.

Useful instructions for user:

When a biogas is newly installed, wait till the plant starts producing combustible gas. Then start introducing small quantity of feedstock on daily basis, which is to be increased up to recommended quantity after one week. Mix the feed stock with water in the ratio 1:1.Slurry level can be checked from the slurry tank. The biogas system contains many species of bacteria. If the amount of feedstock is more than what the methane producing bacteria can digest, fermentation of the extra food by the other bacteria causes acidification of the medium, leading to stoppage of methane production. The methane producing bacteria are active only under neutral conditions. Keep strips of pH paper handy and occasionally check the pH of the effluent to see that the pH remains at 7.The methanogenic bacteria normally live intestines of animals. They work best at about 40 degree Celsius. Therefore the biogas plant should be installed in

a place where it receives sunlight throughout the day. A terrace on top of a house is ideal. Because these bacteria live in the guts of animals, they can digest sugar, starch, proteins, fats and cellulose. The substances that can safely be used as feedstock are spoilt milk, products containing flour of cereal grains, starchy tubers like potato or tapioca, sweet items, fruits, etc. Cake of non edible oilseeds (castor, mahua, karanja, jatropha) also serves as an excellent feedstock. Cellulosic material like green leaves can also be pulped and fed into this biogas system, but cellulose takes longer to digest and produces less biogas than the starchy or sugary material.

In the winter season, the cold temperature makes the bacteria lethargic, producing lesser quantity of gas. This is due to the fact that all the feedstock in not digested. Therefore, reduce the quantity of feedstock to match the gas production. For instance, if you are getting only half as much gas in winter as in the hot season, reduce the quantity of the feedstock by half.

Maximum quantity of waste that can be fed into the plant is 1.5kg of solid biodegradable waste and 5L of liquid waste or water. Maximum feedstock to be introduced into the biogas plant must not increase the recommended quantity. Cooked food, fruits, green leaves etc. contain water. Adjust their quantities, taking into consideration the amount of moisture in the material. If the plant is used for prolonged periods of time, the bacteria remain active even up to 6 months. But when the gas plant is restarted, it should again be filled with water to compensate for the quantity that has evaporated in the meantime, and then start feeding the biogas plant as per standard procedure.

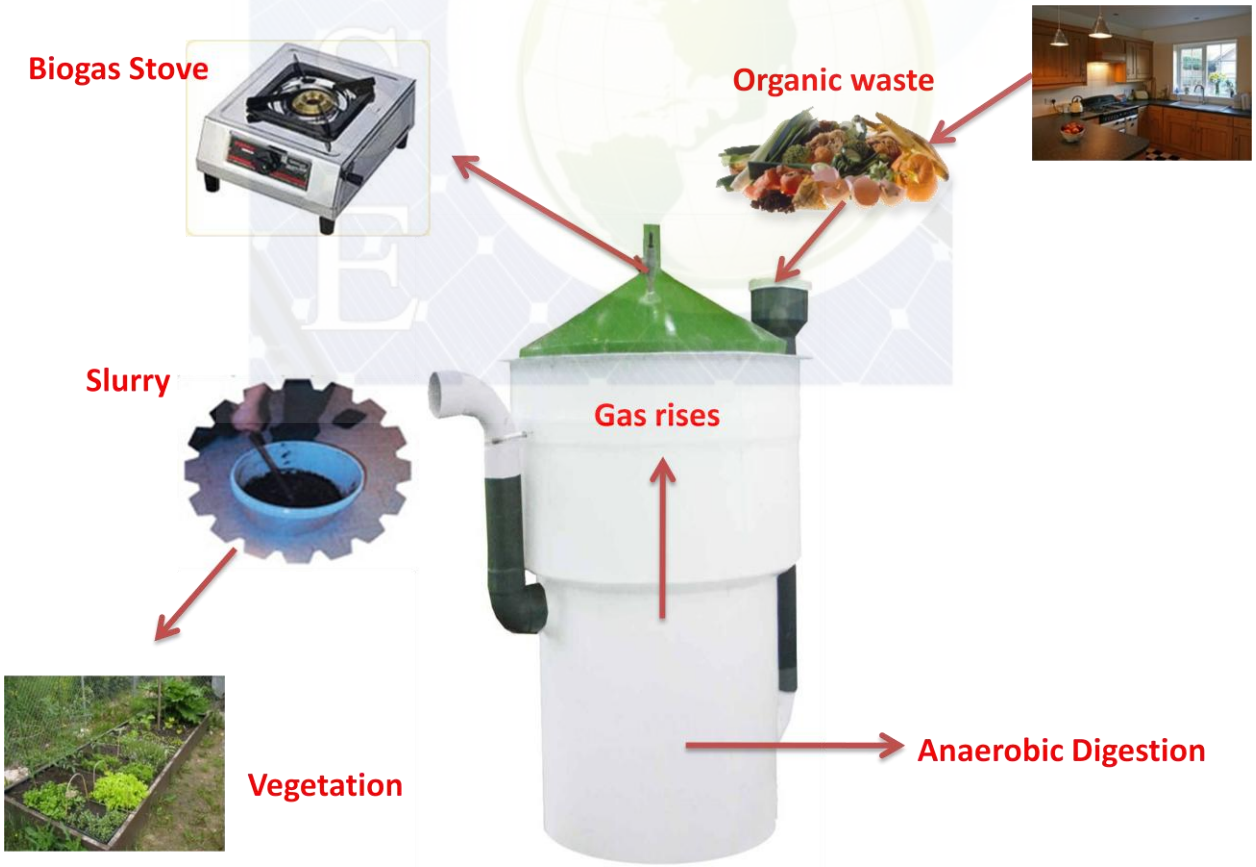
Do's

- Select the size of the plant depending on the quantity of biomass available.
- Install the biogas plant at a place near the kitchen.
- Ensure that the plant is installed in an open space and gets plenty of sunlight for the whole day, round the year.
- Please do charge the biogas plant daily with fresh feed of biomass as per the recommended quantity.
- Take out the digested slurry frequently to avoid adverse effect on the gas generation process.
- Use only good quality biogas burners and gas lamps to use biogas efficiently.
- Open the gas regulator/cock only at the time of its actual use.
- Adjust the flame by turning the air regulator till a blue flame is obtained this will give maximum heat.
- Light the match before opening the gas cock.

Don'ts

- Do not treat this system as waste disposal unit.

- Do not install the gas plant at a long distance from the point of gas utilization to save the cost of pipeline.
- Avoid feeding orange skin, onion peel and egg shell into the plant.
- Do not introduce strong substance, saw dust, sticks or dry leaves etc. The feed stock needs to be in semi liquid slurry from for faster digestion.
- Do not install the plant under a tree or shadow area.
- Do not compact soil loosely around the plant in case of underground installation otherwise it may get damaged.
- Do not add more than the required quantity of water, doing so might affect the efficiency of gas production.
- Do not add water with detergent or oily substances to make slurry for daily charging.
- Do not spill water near biogas plant in case of underground installation.
- Do not use burner in the open, otherwise there will be enormous loss of heat.
- Do not leave the gas regulator (valve) open when the gas is not in use.
- Do not inhale the biogas, as it may be hazardous.
- Do not be impatient to get gas after initial loading of slurry, as it may take 30-45 days for gas production depending upon quality of initial cow dung. No foreign material should be added.



Tips to housewives

- The input should be in the ratio of one part water and one part solid waste.
  Solution: Save up the water used to wash rice, dhals & vegetables, mix with wet waste and pour the mixture into the inlet
- The optimum temperature within the digester is 25-30° C. When temperatures drop and you find the output of gas low.
  Solution: Add luke warm water. Make luke warm water from
  - Whey of paneer
  - Whey of pasta/noodles/rice
  - Remaining water from a pressure cooker
  - Any hot tawa/dish after cooking to be immersed in waste water
- The upper drum floats in fresh water which attracts mosquitoes.
  Solution: Convert it into an aquarium by adding guppy fish that will eat the mosquito larvae

Common causes of biogas failure and their remedies

Acidification of the medium: It generally occurs when the system receives more feedstock than it can digest. In such case, the medium also produces foul smell. Pour a few buckets of water through the inlet pipe to dilute the medium. Then mix about 1kg of calcium hydroxide with about 10 liters of water and pour it, through the inlet pipe. Agitate the liquid in the digester by rotating with the help of solid rod. Check the pH of the liquid in the digester. If the pH has not come back to 7, repeat the process till the pH is restored to 7.Wait for a few days to allow the methanogenic bacteria to multiply in the medium. If the system does not produce gas, then recharge with 3/4th of initial cow dung or reinstall the whole system. If a leak is detected between the gas holder and the metallic gas cock, seal the leak by applying an epoxy compound with hardener at the joint. Accumulation of water in the rubber pipe: If the gas holder has risen, and yet the gas is not reaching the burner, accumulation of water in the pipeline is generally the cause. Disconnect the pipe from the gas burner and let it fall on the ground, so that the accumulated water flows out of it. This process is called bleeding. Connect the pipe again after bleeding. Also check if the gas flow is blocked at the gas cock or at the inlet of the burner. In such cases, remove the block. There is a chance for scum formation inside the digester, so please rotate the plant 2-3 times to remove the scum formation.

Figure 3 water traps

Table shows a number of the benefits of biogas utilization, set against the related drawbacks of presently used alternatives.

Present problems	Benefits of Biogas
Depletion of forests for firewood and causation of ecological imbalance and climatic changes	Positive impact on deforestation; relieves a portion of the labour force from having to collect wood and transport coal; helps conserve local energy resources
Burning of dung cakes: source of environmental pollution; decreases inorganic nutrients; night soil transportation a hazard to health	Inexpensive solution to problem of rural fuel shortage; improvements in the living and health standards of rural and village communities; provides employment opportunities in spin-off small-scale industries
Untreated manure, organic wastes, and residues lost as valuable fertilizer	Residual sludge is applied as top-dressing; good soil conditioner; inorganic residue useful for land reclamation
Untreated refuse and organic wastes a direct threat to health	Effective destruction of intestinal pathogens and parasites; end-products non-polluting, cheap; odors non-offensive
Initial high cost resulting from installation, maintenance, storage, and distribution costs of end-products	System pays for itself
Social constraints and psychological prejudice to use of human waste materials	Income-generator and apt example of self-reliance and self-sufficiency

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