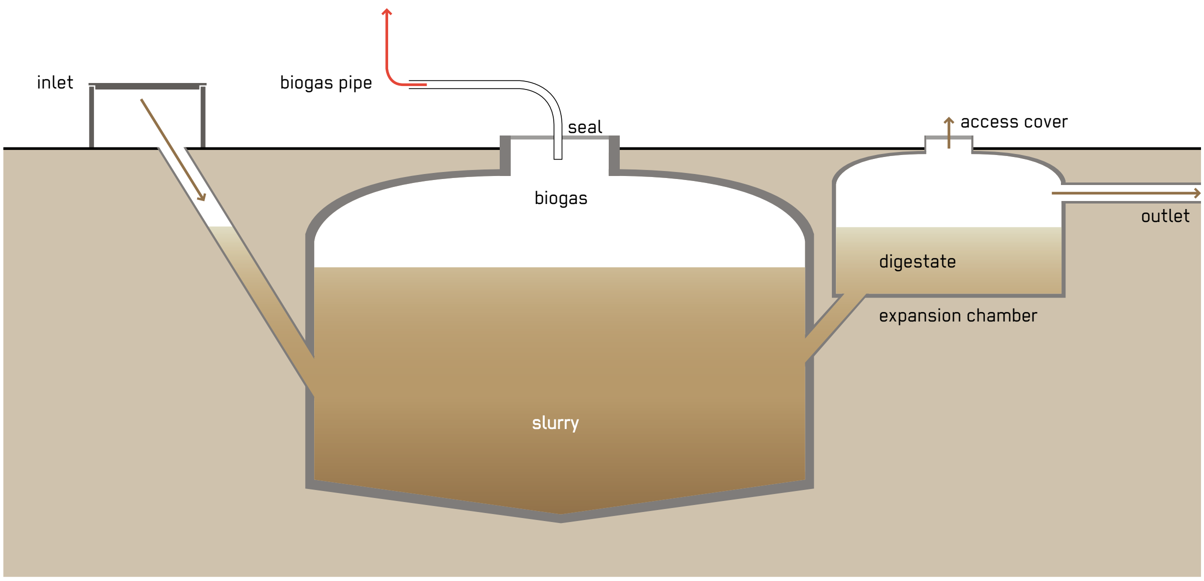
Biogas Reactor

Phase of Emergency	Application Level / Scale	Management Level	Objectives / Key Features
Acute Response * Stabilisation ** Recovery	** Household ** Neighbourhood * City	** Household ** Shared ** Public	Excreta containment, Stabilisation of sludge, Biogas recovery
Space Required	**Technical Complexity**	**Inputs**	**Outputs**
** Medium	** Medium	Excreta, Blackwater, Sludge, Organics	Biogas, Sludge



A Biogas Reactor can efficiently treat different types of wastewater. It is an anaerobic treatment technology that produces a digested sludge (digestate) that can be used as a fertiliser and biogas that can be used for energy. Biogas is a mix of methane, carbon dioxide and other trace gases which can be converted to heat, electricity or light (D.7).

A Biogas Reactor is an airtight chamber which facilitates anaerobic degradation of blackwater, sludge, and/or biodegradable waste. Treatment of wastewater takes place as it enters the digester. Inputs are biologically degraded in an active sludge layer within the digester. The digested sludge is discharged from the overflow point at ground level. The chamber also facilitates the collection of biogas produced in the fermentation processes in the reactor. The digestate is rich in organics and nutrients, and is relatively easy to dewater and manage.

Design Considerations: Biogas Reactors can be built as fixed dome or floating dome digesters. In the fixed dome, the volume of the reactor is constant. As gas is generated it exerts a pressure and displaces the slurry upward into an expansion chamber. When the gas is removed, the slurry flows back into the reactor. The pressure can be used to transport the biogas through the pipes. In a floating dome reactor, the dome rises and falls with the production and withdrawal of gas. Alternatively, the dome can expand (like a balloon). The hydraulic retention time (HRT) in the reactor should be at least 15 days in hot climates and 25 days in temperate climates. For highly pathogenic inputs, a HRT of 60 days should be considered. Sizes can vary from 1,000 L for a single family up to 100,000 L for institutional or public toilet applications. Because the digestate production is continuous, there must be provisions made for its storage, use and/or transport away from the site.

Materials: A Biogas Reactor can be made of bricks, cement, steel, sand, wire for structural strength (e.g. chicken wire), waterproof cement additive (for sealing), water pipes and fittings, a valve and a prefabricated gas outlet pipe. Prefabricated solutions include geo-bags, reinforced fibre plastic modules, and router moulded units and are available from specialist suppliers.

Applicability: This technology is appropriate for treating household wastewater as well as wastewater from institutions such as hospitals and schools. It is not suitable for the acute phase of an emergency, as the biology needs time to start up. It is especially applicable in rural areas where animal manure can be added and there is a need for the digestate as fertiliser and gas for cooking. Biogas Reactors can also be used to stabilise sludge from Pit Latrines **(S.3, S.4)**. Often, a Biogas Reactor is used as an alternative to a Septic Tank **(S.13)** since it offers a similar level of treatment, but with the added benefit of biogas. However, significant gas production cannot be achieved if blackwater is the only input or if the ambient air temperature is below 15 °C. Greywater should not be added as it substantially reduces the HRT. Biogas Reactors are less appropriate for colder climates as the rate of organic matter conversion into biogas is very low. Consequently, the HRT needs to be longer and the design volume substantially increased. Even though Biogas Reactors are watertight, it is not recommended to construct them in areas with high groundwater tables or where there is frequent flooding.

Operation and Maintenance: To start the reactor, it should be inoculated with anaerobic bacteria, e.g. by adding cow dung or Septic Tank sludge. Digestate needs to be removed from the overflow frequently. The frequency will depend on the volume of the tank relative to the input of solids, the amount of indigestible solids, and the ambient temperature, as well as usage and system characteristics. Gas should be monitored and used regularly. Water traps should be checked regularly and valves and gas piping should be cleaned so that corrosion and leaks are prevented. Depending on the design and the inputs, the reactor should be emptied and cleaned every 5 to 10 years.

Health and Safety: The digestate is partially sanitised but still carries a risk of infection, therefore during digestate removal, workers should be equipped with proper personal protective equipment (PPE). Depending on its end-use, emptied liquid and sludge require further treatment prior to use in agriculture. Cleaning of the reactor can be a health-hazard and appropriate safety precautions (wearing proper PPE) should be taken. There are also dangers associated with the flammable gases but risks are the same as with natural gas. There is no additional risk due to the origin of the gas.

Costs: This is a low to medium cost option, both in terms of capital and operational costs. However, additional costs related to the daily operations needed by the reactor should be taken into consideration. Community installations tend to be more economically viable, as long as they are socially accepted. Costs for capacity development and training for operators and users must be budgeted for until the knowledge is well established.

Social Considerations: Social acceptance may be a challenge for communities that are not familiar with using biogas or digestate. Social cohesion can be created through shared management and shared benefits (gas and fertiliser) from Biogas Reactors, however, there is also a risk that benefits are unevenly distributed among users which can lead to conflict.

Strengths and Weaknesses:

(+) Reduced solid waste management cost and faecal sludge transportation costs
(+) Generation of useable products – gas and fertiliser
(+) Long service life (robust)

(−) Requires expert design and skilled construction
(−) Incomplete pathogen removal, the digestate might require further treatment
(−) Limited gas production below 15 °C and when using only blackwater
(−) Medium level investment cost

→ **References and further reading material for this technology can be found on page 192**